GLS Conference Proceedings 2017
GLS Conference Proceedings 2017

Amanda Barany (Ed.), Stefan Slater (Ed.), Constance Steinkuehler (Ed.)
Contents

Letter from the Conference Chair xvii
GLS 12 Conference Committee xix
GLS 12 Volunteers xxi
GLS Showcase Award Ceremony xxiii

Part I. Full Papers

1. Hello, World
   Building Accessibility in Game Design
   Jennifer Dalsen (University of Wisconsin – Madison)

2. Tenacious Assessments
   Using In-Game Behaviors to Measure Student Persistence and Challenge Navigation
   Laura J. Malkiewich (Teachers College Columbia University), Alison Lee (Teachers College Columbia University), Stefan Slater (Teachers College Columbia University), & Catherine C. Chase (Teachers College Columbia University)

3. Rule the Roost
   Designing a Game That Builds STEM Identity for Girls
   Laura Beukema (Twin Cities PBS) & Joan Freese (Twin Cities PBS)

4. Inciting Out-Of-Game Transfer
   Adapting Contrast-Based Instruction For Educational Games
   Catherine C. Chase (Teachers College, Columbia University), Erik Harpstead (Carnegie Mellon University), & Vincent Aleven (Carnegie Mellon University)

5. Do You See What I See?
   Visual Attention Patterns of Adolescents With and Without ASD to a Dynamic Videogame Stimulus
   Erinn Finke (Penn State University), Benjamin Hickerson (University of North Carolina Greensboro), & Krista Wilkinson (Penn State University)

6. From “So Cool” to “I’m Bored”
   Longitudinal Trends in Activity Monitors and Gaming
   Danielle Hagood (University of California, Davis) & Cynthia Carter Ching (University of California, Davis)

7. Game-Based Learning for Identity Change
   Aroutis Foster (Drexel University), Mamta Shah (Drexel University), & Amanda Barany (Drexel University)
8. How Music Affects Learning in a 3D Gaming Environment
   An Experiment
   Ryan L. Sittler (California University of Pennsylvania)

9. Gamification, Digital Game-Based Learning and Serious Games a Critical Literature Review
   Rebecca Ly (University of Sydney)

10. Children’s conceptions of stories in educational games
    Osvaldo Jiménez (University of the Pacific)

11. When is a Game Not a Game?
    Considering Player Perceptions of An Educational Game Through Reality, Meaning, and Play
    Jackie Barnes (Northeastern University) & Casper Harteveld (Northeastern University)

12. Implementing Evolution in Video Games
    Barrie Robison (University of Idaho), Terence Soule (University of Idaho), Christopher Mirabzadeh (University of Idaho), David Streett (University of Idaho), & Nicholas Wood (University of Idaho)

13. How'd That Happen?!
    Failure in Game Spaces to Prepare Students for Future Learning
    Alison Lee (Teachers College, Columbia University), Connie Liu (Teachers College, Columbia University), Mathurada Jullamon (Teachers College, Columbia University), & John Black (Teachers College, Columbia University)

14. Making Design Activities Gameful Using a Role-Playing Card Game
    Beaumie Kim (University of Calgary) & Diali Gupta (University of Calgary)

15. Invasion of the Energy Monsters
    A Spooky Game About Saving Energy
    Michael S. Horn (Learning Sciences and Computer Science, Northwestern University), Amartya Banerjee (Computer Science, Northwestern University), Pryce Davis (Learning Sciences, Northwestern University), & Reed Stevens, (Learning Sciences, Northwestern University)

16. Understanding the Gap
    Gender Similarities and Differences in Persistence and Self-Efficacy in a Coding Game
    Alison Lee (Teachers College, Columbia University), Laura Malkiewich (Teachers College, Columbia University), Stefan Slater (Teachers College, Columbia University), & Catherine C. Chase (Teachers College, Columbia University)

17. An Astronomy Education Game for Facebook
    Learning From Those Games You Love to Hate
    James Harold (Space Science Institute), Kate Haley-Goldman (Audience Viewpoint)s, & Dean Hines (Space Science Institute; Space Telescope Science Institute)
<table>
<thead>
<tr>
<th>18.</th>
<th>Understanding Habits of Participatory Civics in High School Students’ Crafting and Coding of Collaborative Game Controllers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gideon Dishon (University of Philadelphia) &amp; Yasmin B. Kafai (University of Philadelphia)</td>
</tr>
<tr>
<td>19.</td>
<td>Environmental Attitudes in Youth-Created Computer Games about Climate Change</td>
</tr>
<tr>
<td></td>
<td>Gillian Puttick (TERC), Eli Tucker-Raymond (TERC), &amp; Jackie Barnes (Northeastern University)</td>
</tr>
<tr>
<td>20.</td>
<td>How Student Game Designers Design Learning into Games</td>
</tr>
<tr>
<td></td>
<td>Charlotte Lærke Weitze (Aalborg University, Campus Copenhagen)</td>
</tr>
<tr>
<td>21.</td>
<td>Designing Scientific Argumentation into the Mission HydroSci Game Based Learning Curriculum</td>
</tr>
<tr>
<td></td>
<td>Joe Griffin (University of Missouri), So Mi Kim (University of Missouri), Justin Sigoloff (University of Missouri), Troy Sadler (University of Missouri), Jim Laffey (University of Missouri), &amp; Ryan Babiuch (University of Missouri)</td>
</tr>
<tr>
<td>22.</td>
<td>New Design Principles for Mobile History Games</td>
</tr>
<tr>
<td></td>
<td>Owen Gottlieb (Rochester Institute of Technology)</td>
</tr>
<tr>
<td>23.</td>
<td>I Choose…This One!</td>
</tr>
<tr>
<td></td>
<td>Exploring Student Motivation in Response to Assignment Choice</td>
</tr>
<tr>
<td></td>
<td>Benjamin D. Plummer (University of Michigan), Caitlin Holman (University of Michigan), &amp; Barry Fishman (University of Michigan)</td>
</tr>
<tr>
<td>24.</td>
<td>How a History of Racing Games Can Inform Contemporary Game Design Education</td>
</tr>
<tr>
<td></td>
<td>Eric Nunez (Marist College)</td>
</tr>
<tr>
<td></td>
<td>James M. Laffey (University of Missouri), Troy Sadler (University of Missouri), Sean Goggins (University of Missouri), Joseph Griffin (University of Missouri), So Mi Kim (University of Missouri), Justin Sigoloff (University of Missouri), Eric, Wulff (University of Missouri), &amp; Andrew Womack (University of Missouri) Yetunde Folajimi (Northeastern University), Britton Horn (Northeastern University), Jackie Barnes (Northeastern University), Amy Hoover (Northeastern University), Gillian Smith (Northeastern University), &amp; Casper Harteveld (Northeastern University),</td>
</tr>
<tr>
<td>26.</td>
<td>Critical Thinking with Aesthetic Elements of Minecraft</td>
</tr>
<tr>
<td></td>
<td>Diali Gupta (Werklund School of Education, University of Calgary, Canada) &amp; Beaumie Kim(Werklund School of Education, University of Calgary, Canada)</td>
</tr>
<tr>
<td>27.</td>
<td>Culture-narration games</td>
</tr>
<tr>
<td></td>
<td>a definition and pilot study</td>
</tr>
<tr>
<td></td>
<td>Paul Gestwicki (Ball State University), Kaley Rittichier (Ball State University), &amp; Austin DeArmond (Ball State University)</td>
</tr>
</tbody>
</table>
28. Privacy, Pedagogy and Protocols
   A Preliminary Report on a Cross-Border Alternate Reality Game to Teach Digital Citizenship
   John Fallon (Fairfield Country Day School) & Paul Darvasi (Royal St. George’s College)

29. Who Benefited Most from Game-Based Learning in Special Education Settings?
   Jungmin Kwon (Seoul National University of Education)

30. Occupied Paris
   Cultural Immersion in the Past
   Terri J. Nelson (California State University, San Bernardino)

31. When You Play the Game of Thrones...Everyone Wins!
   Fanfiction and Role-Playing Games for Fiction Writers
   Trent Hergenrader (Rochester Institute of Technology)

32. Exploring the Effects of Dynamic Avatars on Performance and Engagement in Educational Games
   Dominic Kao (Massachusetts Institute of Technology) & Fox Harrell (Massachusetts Institute of Technology)

33. Computational Fluency as Argumentation Support at the Community Level in Scratch
   Crystle Martin (University of California, Irvine)

34. How Do Presence, Flow, and Identification Affect Players’ Empathy and Interest in Learning from a Serious Computer Game?
   Christine Bachen (Santa Clara University), Pedro Hernandez-Ramos (Santa Clara University), Chad Raphael (Santa Clara University), & Amanda Waldron (Brookings Institution)

35. More Than Making Games
   Exploring the Professional Pathways of Women in the Game Industry
   Amanda Ochsner (University of Southern California)

36. Thinking like Writers and Critics
   How Adolescent Boys Experience Narrative-Driven Games
   Robert Hein (The Pennsylvania State University), Jason A. Engerman (The Pennsylvania State University), Nathan Turcotte (The Pennsylvania State University), Adam Macaluso (The Pennsylvania State University), & Sagun Giri (The Pennsylvania State University)

37. Landscape Analysis of Second Language Learning Games

38. Mentira
   The Death and Life of an Augmented Reality Curriculum
   Christopher L. Holden (University of New Mexico), Julie M. Sykes (University of Oregon), & Steven L. Thorne (Portland State University & University of Groningen)
Part II. Symposia

39. **Telescope to Tablet**
   Using Real World Data to Design an Astronomy Game
   Jennifer Dalsen (University of Wisconsin – Madison), Kurt Squire (University of Wisconsin - Madison), & Michael Beall (Learning Games Network)

38. **Designing Educational Games For Early Learners**
   Competing and Complementary Perspectives of Developers, Researchers, and Learning Experts
   Naomi Hupert (Education Development Center), Jillian Orr (WGBH), Camellia Sanford (Rockman et al), & Phil Vahey (SRI Education)

41. **Design considerations in game dashboards for teachers**
   Kevin Miklasz (BrainPOP), Charlotte Duncan (Learning Games Network), & Anne-Marie Hoxie (Classroom, Inc.)

42. **Personalized Learning in Practice**
   Gaming Pedagogy in a Personalized Classroom
   Rich Halverson (UW Madison), Sarah Hackett (UW Madison), Jim McLure (Institute for Personalized Learning), Eric Anderson (KM Perform School for Arts & Performance), Jill Gurtner (Clark Street Community School UW Madison), Tyler Brunsell (Clark Street Community School), Corey Dean (Clark Street Community School), Alan Barnicle (UW Madison), Tanushree Rawat (UW Madison), Julia Rutlege (UW Madison), Arlene Strikwerda (UW Madison), Emily Schindler (UW Madison), Beau Johnson (UW Madison), & Curtis Mould (UW Madison)

43. **Designing Games with Assessment in Mind**
   Diverse Processes of Integrating Design Thinking with Evidence-Centered Design

44. **Gamified Cultural Transformation**
   In the Classroom and Beyond
   Yu-Kai Chou (Octalysis Group), Jerry Fuqua (the Octalysis Group), William LeVoir-Barry (IBM), & Andrew Posselt (Dean Clinic)

45. **Learning about "Self"**
   Game + Design + Therapy
   Heidi McDonald (Centerstone Research), Sabine Harrer (Vienna University), Doris C. Rusch (DePaul University), Susan Imus, (Columbia College), Adam Mayes (Uppsala University), & Martine Pederson (Indspark)

46. **Creating Learning Experiences for the Playful Classroom**
   Kathy Yu Burek (Classroom, Inc), Kara Carpenter (Teachley), Allisyn Levy (BrainPOP), Anne Richards (Cracking Wise Interactive), & Christine Zanchi (Curriculum Associates)
47. **The Assessment Game**  
Moving Beyond Traditional Measures  
Barbara Chamberlin (New Mexico State University Learning Games Lab), Jodi Asbell-Clarke (EdGE at TERC), Michelle Riconscente (Designs for Learning), & Allisyn Levy (BrainPOP)  

48. **Diversifying Barbie and Mortal Kombat**  
Addressing Gender and Race in Inclusive Gaming Conference Design, Critical Educational Practice, and Intersectional Research  
Yasmin Kafai (University of Pennsylvania), Kishonna Gray (MIT/Eastern Kentucky University), Gabriela Richard (Pennsylvania State University), & Sarah Schoemann (Georgia Institute of Technology)  

49. **The Great Dragon Swooping Cough**  
Stories about Learning Designs in Promoting Participation and Engagement with a Virtual Epidemic  
Deborah Fields (Utah State University), Yasmin Kafai (University of Pennsylvania), Jen Sun (Numedeon Inc.), Nina Fefferman, (Rutgers University), Estee Ellis (University of Pennsylvania), Ben DeVane (Iowa University), Michael T. Giang (Mount St. Mary’s University), & Jackie Wong (University of Pennsylvania)  

**Part III. Workshops**  

50. **Using Games to Teach Computer Science Concepts**  
Elisabeth Gee (Arizona State University), Kelly Tran (Arizona State University), Earl Aguilera (Arizona State University), Casper Harteveld (Arizona State University), Gillian Smith (Northeastern University), Jacqueline Barnes (Northeastern University), Yetunde Folajimi (Northeastern University), Carolee Stewart-Gardiner (Kean University), Stephanie Eordanidis (Kean University), & Gail Carmichael, (Shopify)  

51. **Designing Design Research for Game Development**  
Carly A. Kocurek (Illinois Institute of Technology), Michael DeAnda (Illinois Institute of Technology), & Jennifer L. Miller (Illinois Institute of Technology)  

52. **Publish Mobile Narrative Games with the PlayableMedia Story Builder**  
Juli James (University of North Texas, PlayableMedia), Retha Hill, (Arizona State University, PlayableMedia), & Adam Ingram-Goble (PlayableMedia)  

53. **Designing for DIY**  
Talking through Tensions, Lessons, and Questions to Guide Innovative Learning Environments  
Deborah A. Fields (Utah State University), Sara M. Grimes (University of Toronto), Jayne C. Lammers (University of Rochester), & Alecia Magnifico (University of New Hampshire)
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.</td>
<td>Visualizing Game Data</td>
<td>Collaborative Dashboard Design for Researchers and Teachers by Researchers and Teachers</td>
<td>441</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mark Stenerson (University of Wisconsin) &amp; Aybuke Gul Turker (University of Wisconsin)</td>
<td></td>
</tr>
<tr>
<td>55.</td>
<td>Twine Game Jam</td>
<td>Kelly Tran (Arizona State University), Earl Aguilera (Arizona State University), &amp; Mark Chen (Free Agent)</td>
<td>445</td>
</tr>
<tr>
<td>56.</td>
<td>Early Careers Workshop</td>
<td>Building a Network for Early Career Scholars of Games and Learning</td>
<td>449</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Owen Gottlieb (Rochester Institute of Technology/ConverJent) &amp; Crystle Martin (University of California, Irvine)</td>
<td></td>
</tr>
<tr>
<td>57.</td>
<td>Clash Royale, A Casual Deck-Building Battle Arena for Parents and Kids to Battle and Build</td>
<td>Eric Klopfer (Massachusetts Institute of Technology), Oren Klopfer (McCall Middle School), &amp; Maya Klopfer (The Lynch School)</td>
<td>453</td>
</tr>
<tr>
<td>58.</td>
<td>Perceptual, Decision-Making, and Learning Processes During Video Gameplay</td>
<td>An Analysis of Infamous – Second Son with the Gamer Response and Decision (GRAD) Framework</td>
<td>459</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sam von Gillern (Iowa State University)</td>
<td></td>
</tr>
<tr>
<td>59.</td>
<td>Well-Played Narrative Adaptivity</td>
<td>Consequentiality and Story Pathways in Dreamfall Chapters</td>
<td>469</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V. Elizabeth Owen (Age of Learning)</td>
<td></td>
</tr>
<tr>
<td>60.</td>
<td>Soteria</td>
<td>Teaching Strategies to Overcome Anxiety</td>
<td>477</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Doris C. Rusch (DePaul University)</td>
<td></td>
</tr>
<tr>
<td>61.</td>
<td>Business Analytics Mobile Game</td>
<td>Duke Wong (Wrainbo)</td>
<td>487</td>
</tr>
<tr>
<td>62.</td>
<td>Community in Crisis</td>
<td>Kathy Burek (Classroom, Inc.)</td>
<td>491</td>
</tr>
</tbody>
</table>
63. Highlighting MazeStar
A Platform for Studying Avatar Use in Computer Science Learning Environments
Dominic Kao (Massachusetts Institute of Technology), Fox Harrell (Massachusetts Institute of Technology), Chong-U Lim (Massachusetts Institute of Technology), Sneha Veeragoudar Harrell (Massachusetts Institute of Technology), Maya Wagoner (Massachusetts Institute of Technology), & Helen Ho (Massachusetts Institute of Technology)

495

64. The Da Vinci Coders
Teaching Programming with a Board Game
Nora Husani (Miami University), Alyse Capaccio (Miami University), Danny Capaccio (Miami University), Lauren McKenzie (Miami University), & Bob De Schutter (Miami University)

499

65. JUMPGYM
A Jumping Exergame For Waiting Areas
Mmachi G. Obiorah (Northwestern University), Emily Harburg (Northwestern University), John Franklin (Northwestern University), Brianna Downs (Northwestern University), Sean Ye (Northwestern University), Maarten Bos (Northwestern University), & Michael Horn (Northwestern University)

503

66. Unsavory
Clay Ewing (University of Miami)

507

67. Cerebrex Ultimate
Hugo Enriquez (Galileo University) & Ali Lemus (Galileo University)

511

68. FANschool
Turning students into fans of learning
Eric Nelson (FANschool)

515

69. Invasion of the Energy Monsters
A Spooky Game About Saving Energy
Michael S. Horn (Learning Sciences and Computer Science, Northwestern University) & Amartya Banerjee (Computer Science, Northwestern University)

519

70. Trade to the top
Teaching economics and complex systems through the Lead Caravan multi-player game
Vishesh Kumar (University of Wisconsin-Madison), Mike Tissenbaum, (University of Wisconsin-Madison), & Matthew Berland (University of Wisconsin-Madison)

523

71. River of Justice
Conflict Resolution in a Complex World
Earl Aguilera (Center for Games and Impact, Arizona State University) & Sasha Barab (Center for Games and Impact, Arizona State University)

527
<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.</td>
<td>Revealing Stealth Health: Examining Agency in Physical Activity Games</td>
<td>Cynthia Carter Ching (University of California, Davis), Sara Schaefer (University of California, Davis), &amp; Roxanne Rashedi (University of California, Davis)</td>
</tr>
<tr>
<td>73.</td>
<td>Grand Test Auto: Designing Simulator Assessments of Game-based Mental Models of Automotive Safety Technology</td>
<td>Ben J. Miller (University of Iowa), Ethan Valentine (University of Iowa), Yile Zhou (University of Iowa), Joyce Moore (University of Iowa) &amp; Benjamin DeVane (University of Iowa)</td>
</tr>
<tr>
<td>74.</td>
<td>EarthGames: Making Games Centered Around Climate Change</td>
<td>Kurt Blancaflor (University of Washington), Dargan Frierson (University of Washington), Josh Lawler (University of Washington), Daniel Zhu (University of Washington), Sally Wei (University of Washington), Rabea Baroudi (University of Washington), &amp; Zane Brant (University of Washington)</td>
</tr>
<tr>
<td>75.</td>
<td>Player Agency and Content Retention in Educational Games</td>
<td>Jenifer Doll (Educational Psychology, University of Minnesota), Keisha Varma (Educational Psychology, University of Minnesota), &amp; William Bart (Educational Psychology, University of Minnesota)</td>
</tr>
<tr>
<td>76.</td>
<td>Crossover Gamified Design: Learning and Assessment for Sustainable Engineering Education</td>
<td>Fariha Hayat Salman (Pennsylvania State University)</td>
</tr>
<tr>
<td>77.</td>
<td>MasterSwords: Competition, collaboration, and community in a multimodal battle of words</td>
<td>Kristana Textor (The Warner School of Education, University of Rochester) &amp; Lynn Gatto (The Warner School of Education, University of Rochester)</td>
</tr>
<tr>
<td>78.</td>
<td>Beyond the Campus Walking Tour: An ARIS Augmented Learning Expedition</td>
<td>Sara Ringbauer (University of Missouri-Columbia), So Mi Kim (University of Missouri-Columbia), Fatih Demir (University of Missouri-Columbia), Michele Kroll (University of Missouri-Columbia), Shann Bosaller (University of Missouri-Columbia), Joe Griffin (University of Missouri-Columbia), Hao He (University of Missouri-Columbia), Nilay Muslu (University of Missouri-Columbia), &amp; Isa Jahnke (University of Missouri-Columbia)</td>
</tr>
</tbody>
</table>
79. Proteus Play on a STEM-Game Platform
Examining the role of avatar identity and self-relevance on STEM attitudes and motivation
Letícia Cherchiglia (Michigan State University), Amanda Klug (Michigan State University), Will Renius (Michigan State University), Samantha Oldenburg (Michigan State University), Harrison Sanders (Michigan State University), Rachel Stacey (Michigan State University), Celina Wanek (Michigan State University), Michael Beyene (Michigan State University), & Rabindra Ratan (Michigan State University)

80. Gaming as Epistemic Practice
Heidrun Allert (Kiel University), Christoph Richter (Kiel University), & Marten Friedrichsen (Kiel University)

81. Towards Improved Literacy in Computer Programming Among Artists
Elliot Gertner (Ventura College) & Ventura Patrician Waterman (Santa Ana College)

82. Mission HydroSci
Designing a Game for NGSS
James M. Laffey (University of Missouri), Troy Sadler (University of Missouri), Sean Goggins (University of Missouri), Joseph Griffin (University of Missouri), So Mi Kim (University of Missouri), Justin Sigoloff (University of Missouri), Eric, Wulff (University of Missouri), & Andrew Womack (University of Missouri)

83. Testing an Educational Videogame in a Setting with Limited Technology Access
Hugo Enriquez (Universidad Galileo Guatemala) & Ali Lemus (Universidad Galileo Guatemala)

84. Towards an Understanding of Player Decisions and Learning During Video Gameplay
The Gamer Response and Decision Framework
Sam von Gillern (Iowa State University)

85. iV's and iPads
How Joint Media Engagement Helps Children “Cope with Pokes”
Ben J. Miller (University of Iowa), Kirsten Hanrahan (University of Iowa), Ann Marie McCarthy (University of Iowa), & Benjamin DeVane (University of Iowa)

86. How do Pre-K Teachers and Students Experience Literacy Games?
Exploring affordances of table games in a preschool classroom
Katherine Sydik (University of Nebraska-Lincoln)

87. Literacy and Learning through Game Design
An Afterschool Twine Workshop
Kelly Tran (Arizona State University) & Mikaela Wallin (Arizona State University)
88. Out-of-school literacies back into classroom
   Game, video and prosumer
   Tieh-huai Chang (National Central University), Fei-Ching Chen (National
   Central University), & Ming-Fong Jan (National Central University)
89. How a Storytelling Game is Played in a Preschool Classroom
   Jeremy Sydik (University of Nebraska Lincoln)
90. Building the Deck
   Creating a Library Card Game for Outreach to Transfer Students
   Kelly Giles (James Madison University Libraries & Educational
   Technologies), Kristen Shuyler (James Madison University Libraries &
   Educational Technologies), Andrew Evans (James Madison University Libraries
   & Educational Technologies), & Jon Reed (James Madison University Libraries
   & Educational Technologies)
91. More than Me
   Exploring Educational Possibilities through Multiplayer Location-Based
   Augmented Reality Games
   Judy Perry (MIT Scheller Teacher Education Program), Lisa Stump (MIT
   Scheller Teacher Education Program), & Arjun Narayanan (MIT Scheller
   Teacher Education Program)
92. Life Beyond the Grant
   Creative Dissemination Strategies
   Susan Baron (Missouri Botanical Garden), Bob Coulter (Missouri Botanical
   Garden), Judy Perry (Massachusetts Institute of Technology), Eric Klopfer
   (Massachusetts Institute of Technology), & Lisa Stump (Massachusetts Institute
   of Technology)
93. Videogames and Distributed Teaching and Learning Systems
   Jeffrey B. Holmes (Arizona State University), Kelly M. Tran (Arizona State
   University), & Elisabeth Gee (Arizona State University)
94. Stereotypes, Games and Your Bladedancer Self
   Using avatar customization to reduce stereotype threat effects
   Joseph Fordham (Michigan State University), Rabindra Ratan (Michigan State
   University), Whitney Zhou (Michigan State University), Luke Sienko (Michigan
   State University), Kyle Silva (Michigan State University), Celina Wanek
   (Michigan State University), Madison Ozdych (Michigan State University), &
   Adam Cockman (Michigan State University)
95. Let’s Be A Real Estate Entrepreneur!
   A Game of Socially (Ir)Responsible Real Estate Development
   Richard Eberhardt & Sara Verrilli
96. UAA Spirit Quest
   Lessons from a Campus-wide Game Development Project
   Jennifer C. Stone (University of Alaska Anchorage), Kenrick Mock (University
   of Alaska Anchorage), & Dave Dannenberg (University of Alaska Anchorage)
97. Parent-child Joint App Use and Early Numeracy Development
   Yile Zhou (The University of Iowa) & Benjamin DeVane (The University of Iowa)

98. Taxonomy and Flow
   Engaging Virtual Classrooms Using Player Archetypes
   Stephen Mallory (University of Texas at Dallas)

99. Ethics Simulators
   Utilizing Digital Games to Study Ethical Decision Making in an Immersive Context
   Allison Reeck (Inver Hills Community College) & Dr. Chelsea Lovejoy (University of Wisconsin – Stout)

About ETC Press
GLS began 12 years ago with Jim, Betty, Rich, Erica, Kurt, and myself, based on 3 fundamental tenets:

- Learning is living, not preparation for living (Dewey, 1897)
- Teachers were the driving wheel, not simply a variable or noise in the algorithm
- Technology amplifies, so you better choose what you want to support:
  - Tests or content
  - Disconnection or interaction
  - Injustice or equity

We all know which of these sides we’re on. It is these commitments that mark us from other efforts. But, as many of you know, Kurt and I are leaving for UC-Irvine. Been a good run…

Last year of GLS

While Kurt and I transition to CA, the GLS center, annual conference, proceedings, special journal issues, showcase awards, art exhibits, boozy dinners, stickers, socks, and all our pervasive girl elf gaucherie will end this year in Madison WI, where it began and where it belongs. This event has been the labor of love of UW faculty and especially students who have pulled this thing off on a shoestring budget and for little more than an occasional beer or introduction to one of our esteemed attendees for 12 years straight. So we’ve decided to honor that by letting GLS end here, this year, in Madison where it belongs.

End to an era but, by no means, the end to our work.

We no longer have to make the plausibility argument that interactive media can enrich the intellectual lives of learners, or that design is as important as theory when it comes to making digital media for schools and kids.

But we have our work set out for us in other areas:

- Games have in places gotten caught in the net of our national obsession with K-12 assessment, with pressure on formative assessment to give way to surveillance and classification.
- Games are, in many conversations, still locked in the rhetoric of corporatization and addiction to screens rather than community and connection.
- Game making and creating has yet to be given the same seat at the table as consumption.
- And then there’s the question of equity. Soooooo much is broken and needs to be fixed.

We have our work cut out for us. And the end of GLS only marks the beginning of bigger, broader, and more ambitious efforts. So you can expect two big announcements in the upcoming weeks:
• **One here locally at UW Madison.** Erica Halverson, Matthew Berland, with our colleagues in Science and Math are about to launch a new initiative to put the creative engine of arts back into STEM.

• **And one at UCI,** where Kurt and I will join the faculty in Informatics to work with colleagues including Mimi Ito, Rebecca Black, Bill Tomlinson, Bonnie Nardi, to name a few. Stay tuned or a big announcement at this year’s Digital Media and Learning Conference (DML) on October 5-7 in Irvine CA. “Let’s build. Let’s design. Let’s solve.”

When I first joined White House staff in 2012, Tim Kalil (Deputy Director of OSTP) posed me a seemingly simple question that has stayed with me since, What games (experiences) are so important that every citizen should have the opportunity to play them?

I can think of a couple. But at the top of that list is the experience of participating to a community in such a way that you feel you can help make a difference. Because once a person has that experience, apathy or cynicism are no longer real options.

This is the lasting lesson this community has given me. And I am grateful for it.

I hope you see yourselves as I see you:

• Champions for change
• Fierce advocates
• Makers, doers, designers, thinkers, and teachers for the next generation.

Our work is not over. We’re only getting started.

**Constance Steinkuehler, GLS 12 Conference Chair**
GLS 12 Conference Committee

Constance Steinkuehler, Chair (University of Wisconsin-Madison)

Caroline Hardin, Co-Chair (University of Wisconsin-Madison)

Stefan Slater, Proceedings Editor (University of Pennsylvania)

Amanda Barany, Proceedings Editor (Drexel University)

Jennifer Dalsen, Volunteer & Accessibility Coordinator (University of Wisconsin-Madison)

Dennis Ramirez, Showcase Curator (University of Southern California)

Craig G. Anderson, Upload & Download Captain (University of Wisconsin-Madison)

Karin Spader, Poster Session Curator (University of Wisconsin-Madison)

**GLS 12 Day Captains**

John Binzak, Jonathan Elmergreen, Anna Jordan-Douglass, & Vanessa Meschke
GLS 12 Volunteers

Keyleigh Bitters, Alexi Brooks, Helen Chen, Will Jordon Cooley, Tim Courses, Drew Davidson, Grant Dobbe, Sean Duncan, Kara Edelstein, Estee Ellis, Quinn Elmer, David Gagnon, Joey Huang, Ellen Jameson, Francis Klein, Vishesh Kumar, Laura Malkiewich, Jack Meuwissen, Jessie Nixon, Conor O’Malley, Julie Robison, Rita Roloff, Jazmyn Russell, Jenny Saucerman, Angie Schiappacasse, Emily Schindler, Colin Skinner, Cody Snelling, Isaac Sung, Lane Sunwall, Kat Sweet, Mike Tissenbaum, Aybuke Turker, Matt Ziegler

GLS 12 Reviewers

GLS Showcase Award Ceremony

Chair: Dennis Ramirez

Judges Panel: Tim Gerritsen, Kevin Miklasz, Reed Stevens

1st Place: Energy Monsters
Michael Horn & Amartya Banerjee

2nd Place: CodeMancer
Robert Lockhart

3rd Place: Fiscal Ship
Eric Church
Full Papers
1.

Hello, World

Building Accessibility in Game Design

Jennifer Dalsen (University of Wisconsin – Madison)

Abstract

There are over 5.6 million students with disabilities in special education services. These students vary in disability type, learning preferences and educational needs. For many, games-based learning and educational apps awaken untapped abilities. More schools, recognizing technology as a tool for learning, are rapidly adopting tablets, computers and other devices into the classroom setting. But what does access truly mean? The purpose of this session is to deconstruct the word ‘access’ in game design. In particular, how principles of universal design for learning can be applied at the forefront of game development. I close with a look at how front-loading design to accommodate learners of diverse needs will ultimately benefit user and developer alike.

Introduction

The Individuals with Disabilities Education Act (IDEA) currently serves over 5.6 million students in the United States. Under this federal document, IDEA is required to identify, locate and evaluate children with disabilities. No child with a disability can be denied an appropriate program. For many students, these appropriate programs include academic accommodations and legal assurances of a Fair and Appropriate Public Education (FAPE). Today, 13 disability categories are officially recognized under IDEA (2004): autism, deaf-blindness, deafness, emotional disturbance, hearing impairment, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech or language impairment, traumatic brain injury and visual impairment. These disability categories serve as an umbrella for evaluation and play one of several key roles in the development of a student’s Individualized Education Plan (IEP). The objective behind IEPs is to ensure students with disabilities not only gain equal access and opportunity to material (Mead, 1999; Yell, 1998), but are provided the necessary supports to further their education in postgraduate life.

This paper briefly describes disability services and how game developers can increase accessible features in game design. I begin with a look at assistive technology programs and supports. From there, I connect technology use to Universal Design for Learning (UDL) practices. I close with recommendations on building accessible features into all games – not just games for students with disabilities – in order to create more successful products.
Disability and Assistive Technology Services

IEPs are designed to accommodate a child’s specific academic needs. For example, a student may receive extra time on math exams due to a learning disability. Alternatively, a child with a visual impairment may be granted assistive technology software in order to interpret information on a computer screen. There is no standardized “check box” when it comes to what technology is most appropriate to assign. Instead, IEP teams determine the best technological equipment based on numerous factors, including disability type, cost and resource availability. Importantly, assistive technology is becoming a popular tool for students with disabilities, particularly as more schools shift to 1:1 computers and tablets. Recognizing the importance of technology and its benefits to access, IDEA has since included assistive technology as a standard assessment for every child with an IEP. Assistive technology is defined under IDEA (1997) as: “Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customize, that is used to increase, maintain, or improve functional capabilities of a child with a disability.” This definition is purposefully vague in order to allow educators and students to identify tools most appropriate for supporting each individual’s unique learning needs.

UDL practices are becoming more common as mainstream teachers use technology to accommodate student needs. More specifically, the framework is helping teachers build multiple means of representation, engagement and expression in lesson plans. As a result, teachers can design a curriculum that accommodates student needs based on personal preferences, abilities and skills. In short, UDL practices are designed for students of all backgrounds (Rose & Meyer, 2002), leading to the hopeful promise of more inclusive learning environments.

Disability and Games

Games-based learning covers various content areas, including science education, math education, environmental awareness and social change. For many special education teachers, games are now a way to engage children in core subjects and implement social or behavioral interventions (Baranowski et. al, 2008; Finke, Hickerson & McLaughlin, 2015; Blum-Dimaya et. al, 2010; Sarokoff, et. al, 2011). Unfortunately, games designed to accommodate specific disability types do not always promote inclusive learning spaces. This creates a major problem for both teacher and user, especially when apps are created for a single population or disability type. Suddenly, the consumer world is bombarded with an uptick of poorly designed educational games to support students with disabilities, or Cr(apps). Such applications create a false pretense of what games should be (Dalsen, 2016).

Under the premise that specific games should be exclusively designed to accommodate disability needs, students with disabilities are acquiring educational materials that unintentionally restrict peer interaction and single out differences (Bierre et. al, 2005; Yuan, Folmer, & Harris Jr, 2011). Given this, students with disabilities risk isolation in the classroom setting during games-based activities. An alternative way of viewing games and disability is through an inclusive lens, where accessibility is a natural part of the design process. By removing disability from the forefront of design in exchange for creating dialogues on digital access and literacies, student achievement will increase across the board.
Simple Guidelines

Here and throughout the rest of this paper, the word access is defined as interacting with an educational app or game. This definition is important as too often the word access in technology is misinterpreted as gaining a physical resource. Table I represents some preliminary guidelines to access in design.

### Table 1. Guidelines to access.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Example Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>Is the text too heavy?</td>
<td>Text-to-Speech Compatibility</td>
</tr>
<tr>
<td>Are phrases universal?</td>
<td>Visual and Audio Directions</td>
</tr>
<tr>
<td>What is the reading level of users playing the game?</td>
<td>Language Option (e.g. Spanish, Hmong)</td>
</tr>
<tr>
<td>Resource Availability</td>
<td></td>
</tr>
<tr>
<td>What platforms do users own or have access to?</td>
<td>2+ platform options</td>
</tr>
<tr>
<td>How expensive is your software to buy?</td>
<td>Student or Teacher Discount</td>
</tr>
<tr>
<td>Website Access</td>
<td></td>
</tr>
<tr>
<td>How easy can users with assistive technology access the software on your site?</td>
<td>Make sure your website follows the ADA guidelines and has a text-only option.</td>
</tr>
<tr>
<td>Movement</td>
<td></td>
</tr>
<tr>
<td>How much dexterity is needed in order to accomplish a goal?</td>
<td>Do not embed text inside of images as assistive technology software (e.g. JAWS) will not recognize the words.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Further Recommendations

1. **Be mindful of assistive technology.** Not every device is compatible with assistive technology services. For example, an individual with limited dexterity cannot easily manipulate game items on a tablet device. However, this same individual can use assistive technology on a desktop to complete the same game levels. Game developers should test their devices against assistive technology products in order to verify compatibility. Importantly, having access to different assistive technology models during beta testing is crucial as school owned devices are not frequently updated. Thus, one student may have an assistive technology device that is 2 years old, whereas another has a device that is over 5 years old.

2. **Designers should always plan for varied literacy rates.** Students in the same grade level will have varied reading abilities. Narratives with more complex and unexplained definitions can frustrate and/or create anxiety for some players. Thus, it is crucial to create a flexible narrative that students with lower reading levels can engage in. Alternatively, having an almanac or reference guide as a way to highlight keywords.

3. **Every designer must become familiar with disability law.** More school districts are under pressure to ensure assistive and educational technologies have accessible features built into their program. While the designer may not have a formal degree in disability law, they should connect
with personnel who can serve as valuable consultants to this framework.

4. **Ask students, parents, grandparents, educators and special education assistants for feedback.** Many students with significant disabilities need assistance with application access and games-based learning. By understanding what challenges parents and caregivers encounter when students access material, developers can plan for smoother, more accessible products.

5. Most importantly, **make accessibility features appear as fluid and natural as possible.** The goal of games-based learning for students with disabilities is not to create a separate game. Instead, to make a game that allows students to participate in the mainstream setting.

**Conclusion**

Games-based learning for students with disabilities is a promising avenue to explore. Importantly, designing games with disability in mind requires attention to multiple means of representation, an understanding of educational law and remembering to include accessible features throughout the entire design process. In the future, game developers should collaborate with educators, community leaders and individuals with disabilities to create inclusive game environments. Finally, game developers and educators need to reconsider the definition of access. Access is not merely gaining a physical resource. Instead, access is meaningful interaction with the game or app.

**References**


2.

Tenacious Assessments

Using In-Game Behaviors to Measure Student Persistence and Challenge Navigation

Laura J. Malkiewich (Teachers College Columbia University), Alison Lee (Teachers College Columbia University), Stefan Slater (Teachers College Columbia University), & Catherine C. Chase (Teachers College Columbia University)

Abstract

Video game log data provides a unique opportunity to study how student gaming behavior relates to learning. Literature has investigated embedded assessments for learning in games, but less work measures students’ motivational behaviors in games. This paper explores a variety of persistence and challenge navigation measures based on student behaviors taken from log data of students playing a coding video game. Some of these measures are highly correlated with learning, and a classic measure of persistence. Results suggest new ways of measuring motivational behaviors in games. These new measures provide more fine-grained data than traditional assessments of motivation, and they can be used to assess positive learning behaviors during gameplay.

Introduction

To engage in practices that foster deep learning, students must learn how to approach and respond to challenging situations effectively. Highly motivated individuals – those with growth mindsets, mastery learning goals, high self-efficacy, or high intrinsic motivation – more often choose to engage in challenging learning tasks and persist at them (Bandura, 1977; Deci, Koestner, & Ryan, 1999; Dweck & Molden, 2005). These motivated behaviors are productive for learning, particularly with content that is challenging or requires multiple attempts, such as inquiry and creative problem-solving tasks.

Games are an interesting space in which to study and measure how people navigate challenging situations, especially since challenge is one of the defining elements of games (Baranauskas, Neto, & Borges, 1999; Garris, Ahlers, & Driskell, 2002). Games often present challenging problem-solving situations, and many games are leveled such that the next problem is just beyond the player’s current ability, naturally imposing some degree of challenge on the player. Paradoxically, working through a challenge, particularly when it leads to failure, can be both motivating (Malone, 1981) and emotionally taxing (Juul, 2013).

And yet, games are a space where people voluntarily engage in challenge and persist at it. Children and adolescents spend an average of 90 mins/day playing video games (Rideout et al., 2010), and over half of adolescents find online games “addictive” (Yee, 2006). Bracing statistics of video game sales ($15.4 billion in the U.S. in 2014, Adkins, 2015) echo these findings. One study even found that adult
gamers spent more time attempting to solve a challenging task than non-gamers (Ventura, Shute, & Zhao, 2013). Thus, even though games present players with challenging situations, players seem to respond productively. This makes games an ideal place for measuring how students navigate a challenge, which includes challenge-approach and challenge-response behaviors.

Another reason why games are an ideal place to measure how students behave around challenging situations is that games provide an incredible amount of choice and control (Garris, Ahlers, & Driskell, 2002; Malone, 1981). For instance, players can often choose to revisit previous levels or approach a challenging problem in more or less complex ways. Contrast this with the intelligent tutoring system (Corbett, Koedinger, & Anderson, 1997), a popular computer-based learning environment, where learners cannot choose the problem they want to work on, and there is a limited number of solutions that the system deems correct. The large set of choices provided within games enables the exploration of what people naturally do when given alternatives.

Finally, computerized games can collect fine-grained, moment-to-moment log data, which affords detailed investigations of student behavior in learning situations. For instance, log data allows us to explore the frequency and time spent on specific in-game behaviors or how learners approach individual problem attempts vs. their final solution. Many of these measures of in-game behavior historically have been used in an effort to create embedded assessments that avoid the necessity of paper-and-pencil tests (Nelson, Ketelhut, & Schifter, 2009; Shute, 2011). However, our focus is somewhat unique in that we measure non-cognitive behaviors, such as persistence at challenging tasks or challenge-seeking behaviors. Ultimately, many of these measures relate to how much students learn from the game.

Measuring student persistence and motivation during learning is not novel, but fine-grained video game log data provides much more information than standard behavioral measures of motivation. Classic behavioral measures of motivation include persistence times and the choice to engage in different types of tasks (Schunk, Meece, & Pintrich, 2012; Toure-Tillery & Fishbach, 2014). To measure persistence during challenge, researchers frequently give learners an “unsolvable task” and measure how long students work on it before quitting (Baumeister et al., 1998; Fishbach, Dhar, & Zhang, 2006; Ventura & Shute, 2013). However, clickstream level data provides a much more nuanced picture of motivated behavior such as the moment-to-moment decisions learners make around challenge and whether they choose to solve problems in effortful ways or not. These more fine-grained measures may predict learning better than more global, traditional measures of persistence and choice (Schwartz & Arena, 2013).

In this paper, we explore several measures of three constructs that relate to how people navigate challenge in the context of an educational game that teaches computer programming. The first is how players approach a challenging situation. In addition to the usual challenge-approach measures (such as whether people choose easy or hard problems), we can also explore the kind of learning behaviors students choose to engage in (e.g., what kind of code do they choose to attempt?). The second construct we set out to measure is how players respond to challenge. We first looked at traditional measures, like time spent on a challenging task before quitting. We then explored the specific behaviors learners chose to engage in after failure. Did they immediately retry the problem or did they spend time reflecting on a hint before trying again? Did they stop writing complex code when they couldn’t get it to work? The third construct we examined is what we call general persistence. While measures of players’ response to challenge focuses on what players do when given a particularly hard task or after failing a task, general persistence is simply the willingness to continue playing the game. While we have argued above that
games are generally challenging, there are certainly easier and harder levels, and the category of general persistence does not distinguish amongst them (whereas the first two constructs explore approach and response to only the most challenging situations within the game).

Our broad goal is to identify promising measures of in-game behavior that are indicative of players’ motivations for solving challenging problems in an educational game. We focus on measuring three constructs: challenge approach, challenge response, and general persistence. To do this, we embarked on several analyses. First, using a set of a priori constraints (defined in the Methods section), we identified several logged actions that relate to these constructs. To whittle this list of measures down to those that are the most valid, we examined their relationship with a standard behavioral measure of motivation that assesses persistence in the face of challenge – how much time players were willing to spend on an unsolvable coding task. Finally, we explored the association between each of these measures and learning outcomes on a paper posttest, to identify which types of challenge navigation behaviors are associated with learning. Our findings have implications for the creation of novel behavioral measures of motivation, particularly in the context of challenge, both within computerized games and potentially in other computer-based learning environments.

Methods

Participants

Thirty-seven fifth grade students (54.1% female) were recruited from an urban charter school after-school program. Prior to the study, 89% of participants had no programming experience; the rest had less than a month’s worth of programming experience.

Procedure

Students were randomly assigned to the Full Game condition (n=18) or the Minimal Game condition (n=19). Both games used block-based code, similar to Scratch (Maloney et al., 2010). In each game level, students solved problems by writing code to navigate an agent over obstacles and reach a goal. If students solved a problem correctly, they would move on to the next level. If not, students would see an automatically generated hint about how to solve the problem and were given the chance to attempt the problem again. Both games contained identical problems and hints. However, the Full Game contained additional standard game features such as a narrative story, high quality graphics, sound, feedback and performance metrics and just-for-fun bonus levels (that contained no coding content). For both conditions, the relationships both amongst motivational measures and between learning outcomes and motivational measures were similar, so the analyses in this paper collapse across conditions. For information on how game conditions affected persistence, challenge navigation, and learning see Malkiewich et al, 2016.

During gameplay, students had access to “action” blocks, that make the character walk or jump, or “parameter” blocks such as repeating loops and if/then conditional commands that need to be filled with action blocks to work. Student produced codes that only used action blocks were labeled “basic”. Codes that implemented rote usage of parameter blocks were labeled “intermediate”, and codes that adapted
parameter blocks to suit the given problem were labeled “complex”. Each game level was assigned a difficulty level, depending on how parameter or action blocks could be used in that level. Easy levels only had action blocks, medium levels had action blocks and one parameter block, and hard levels had action and multiple parameter blocks. In addition to generic problem difficulty, levels were labeled as “relative-hard” if the level proved particularly hard for that one student (the student needed an above average number of attempts to solve the problem). Levels were gated, meaning that a student could not progress to the next level in the game until the current level had been completed. Levels were “completed” with successful problem solutions. Players were given an unlimited number of “attempts” to solve each level. After a student played through the whole game once, all levels were “unlocked” and the student could choose to play any level.

Each student participated in the study for five, 40-minute sessions: a pretest session, two game play sessions, a challenge session, and a posttest session. In the pretest session, students took a paper pretest to assess their prior knowledge of coding. In the two game play sessions, students played the game individually on iPads. In the fourth session, students attempted an unsolvable coding challenge (the challenge task). In the final session, all students completed a paper posttest.

Measures

Learning was measured by assessing student scores on the pretest and posttest. The paper pretest consisted of four test items on constructing code, interpreting code, and planning, a relevant skill to programming (Pea & Kurland, 1984). The posttest was a 16-question paper test that included isomorphic problems to all the pretest questions, plus an additional 12 questions about conceptualizing, writing, interpreting, and debugging types of code that the students had not seen until playing the game.

Our classic persistence measure recorded the amount of time students spent working on the challenge task. The challenge task was an unsolvable, novel level embedded in the game the students were playing. Students were told that to complete the challenge level, they had to solve the challenge task using no more than a certain number of blocks. Unbeknownst to the students, this number of blocks was less than the minimum required to successfully solve the problem. Therefore, students experienced failure at every attempt; even when students thought that they solved the problem, they were told by the researchers that they used too many blocks in their solution and they could try again. At any time, students were given the option to continue trying to solve the challenge level (for up to 40 minutes), or quit to explore computer-based science simulations.

Challenge approach, challenge response, and general persistence measures were created from behaviors observed in gameplay data. Gameplay data was collected using screen recordings and embedded log capture. Due to technical difficulties, some video and log data was lost, so all measures of student coding behaviors and time spent coding only involve a portion of the total study sample (N=18; n=9 for each group). Over 150 measures were created to capture various behaviors relating to how students navigate challenge. Of those, eleven measures were chosen – seven measures of how students approach challenge, three measures of how students respond to challenge, and one measure of general persistence (Table 1). Measures were chosen according to the following guidelines:

1. Measures of how frequently students engaged in behavior (count data) were not used because the two game conditions moved at different speeds (i.e., students could play more levels in the
same amount of time in one condition), and we didn’t want behavioral measures to be confounded with condition. Instead, all measures were recorded as percent occurrence or time spent on a behavior.

2. Measures were chosen to assess behaviors where students were dealing with challenge. Challenge was defined as tasks in the game that were particularly difficult for students in general (e.g. completing hard levels, successfully writing complex code, failed level attempts) or relatively (these “relative-hard” levels are those for which a student took many attempts to solve the problem).

3. Measures were only picked if they were not confounded with student skill. For example, the number of attempts a student takes on a level measures both persistence (how long a student is willing to try a problem before quitting) and competence (how well a student can code). Since there is no way to parse out how much attempt count accounts for student persistence versus competence, measures like these were not used.

4. Behaviors that occurred rarely in our dataset (less than 5% occurrence) were not included.

Using these guidelines, the following measures were created to assess challenge-approach, challenge-response, and general persistence:

<table>
<thead>
<tr>
<th>Construct</th>
<th>Measure</th>
<th>Description</th>
<th>Type of Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge Approach</td>
<td>Immediate Replays</td>
<td>% levels immediately replayed after successful completion</td>
<td>Negative, choose to play non-challenging levels</td>
</tr>
<tr>
<td></td>
<td>Hards Replayed</td>
<td>% hard levels replayed after game completed</td>
<td>Positive, choose to play challenging levels</td>
</tr>
<tr>
<td></td>
<td>Moves to Hard</td>
<td>% non-chronological transitions to harder levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hards Solved Complex</td>
<td>% hard levels solved with complex code</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hards Started Complex</td>
<td>% hard levels with complex code on 1st attempt</td>
<td>Positive, choose to try challenging code</td>
</tr>
<tr>
<td></td>
<td>Levels Solved Complex</td>
<td>% all levels solved with complex code</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Relative-Hard Solved Complex</td>
<td>% relative-hard levels solved with complex code</td>
<td></td>
</tr>
<tr>
<td>Challenge Response</td>
<td>Careful Hard Retries</td>
<td>% hard level attempts where students spent above-average time after a failed attempt</td>
<td>Positive, reflect after challenge (failure)</td>
</tr>
<tr>
<td></td>
<td>Careful Hint Reads</td>
<td>% hints where students spent above-average time looking at the hint after a failed attempt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Relative-Hard Code Downgrades</td>
<td>% transitions to simpler code on the next attempt of relative-hard levels (e.g. move from complex to basic code)</td>
<td>Negative, give up on trying challenging code</td>
</tr>
<tr>
<td>General Persistence</td>
<td>Coding Time Day 2</td>
<td>Total coding time on Day 2 of gameplay, excluding off-task time (e.g. bonus levels, etc.)</td>
<td>Positive, persist at game</td>
</tr>
</tbody>
</table>

* On Day 1 of gameplay the game was novel, so students spent the majority of their time coding, but on Day 2 students spent more time off-task, and few students persisted at coding for the entire session.

Table 1. Measures of challenge navigation behaviors.

Results

Challenge navigation measures were first correlated with challenge time, our classic behavioral measure of motivation in the face of challenge, as a means of validation (Table 2). Four measures of in-game student behaviors were significantly correlated with challenge time. Hards Solved Complex ($r = 0.54,$
Relative-Hards Solved Complex ($r = 0.67, p = .003$), and Coding Time Day 2 ($r = 0.57, p = .01$), were all positively associated with challenge time, indicating that students who persist more on a challenging game level also write more complex code in challenging levels and generally persist longer in the game. Similarly, the response to challenge measure Relative-Hard Code Downgrades ($r = -0.56, p = .02$) was negatively associated with challenge time, which indicates that students who persist less on a challenging game level also choose to give up on writing challenging code more often. After applying the Benjamini-Hochberg correction (Benjamini & Hochberg, 1995) to control for false discoveries, only Relative-Hards Solved Complex and Coding Time Day 2 were significantly correlated with challenge time, suggesting that these in-game measures of approach to challenge and general persistence are potentially good measures of student motivation in challenging situations.

To determine which measures most effectively predicted student coding knowledge after gameplay, we then computed correlations between posttest scores and measures of challenge navigation and persistence. Only measures for challenge approach were highly correlated with posttest scores. These included Hards Solved Complex ($r = 0.76, p < .01$), Hards Started Complex ($r = 0.71, p < .01$), and Levels Solved Complex ($r = 0.70, p < .01$). All three of these correlations maintained significance after the Benjamini-Hochberg correction. Their relationships suggest that taking risks in challenging situations, operationalized as general student willingness to use more sophisticated code when attempting difficult problems, was positively associated with learning outcomes.

<table>
<thead>
<tr>
<th>Classic Persistence</th>
<th>1</th>
<th>Challenge Time</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td>2</td>
<td>Posttest Score</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Persistence</td>
<td>3</td>
<td>Coding Time Day 2</td>
<td>57*</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Challenge Approach</td>
<td>4</td>
<td>Immediate Repays</td>
<td>.16</td>
<td>.15</td>
<td>.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Hards Replayed</td>
<td>0.00</td>
<td>.16</td>
<td>.09</td>
<td>-.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Moves to Hard</td>
<td>.29</td>
<td>.18</td>
<td>.60**</td>
<td>-.13</td>
<td>.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Hards Solved Complex</td>
<td>.54*</td>
<td>.76**</td>
<td>.38</td>
<td>.09</td>
<td>.30</td>
<td>-.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Hards Started Complex</td>
<td>.43</td>
<td>.71**</td>
<td>.30</td>
<td>.09</td>
<td>.44</td>
<td>-.07</td>
<td>.90**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Levels Solved Complex</td>
<td>.46</td>
<td>.70**</td>
<td>.17</td>
<td>.14</td>
<td>.18</td>
<td>-.12</td>
<td>.84**</td>
<td>.83**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Relative-Hards Solved Complex</td>
<td>.67**</td>
<td>.46</td>
<td>.25</td>
<td>.18</td>
<td>-.09</td>
<td>.08</td>
<td>.70**</td>
<td>.49**</td>
<td>.61**</td>
<td>.67**</td>
</tr>
<tr>
<td>Challenge Response</td>
<td>11</td>
<td>Careful Hard Retries</td>
<td>.27</td>
<td>.19</td>
<td>.75</td>
<td>.26</td>
<td>.14</td>
<td>.10</td>
<td>.08</td>
<td>.01</td>
<td>.33</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Careful Hint Reads</td>
<td>.17</td>
<td>.08</td>
<td>.45</td>
<td>.02</td>
<td>-.05</td>
<td>-.16</td>
<td>.00</td>
<td>-.08</td>
<td>.09</td>
<td>.21</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Relative-Hard Code Downgrades</td>
<td>.36*</td>
<td>.17</td>
<td>-.26</td>
<td>.14</td>
<td>.07</td>
<td>.05</td>
<td>-.12</td>
<td>.08</td>
<td>.02</td>
<td>-.57*</td>
</tr>
</tbody>
</table>

Table 2. Correlation matrix of challenge navigation behaviors.

These correlations suggest that certain in-game behaviors can be used to measure student persistence and learning. However, many other factors could still be confounded with these measures, including students’ prior knowledge. Are students who exhibit these positive challenge-seeking behaviors only persisting and learning because they have more prior knowledge? One potential explanation for why students who exhibit more challenge seeking also persist longer on the challenge task, is that they simply know more coding techniques to try while attempting to complete the challenge task. To explore this question, correlation matrices were re-run as partial correlations, controlling for pretest scores (Table 3). After applying the Benjamini-Hochberg correction, both Relative-Hards Solved Complex ($r = 0.64, p < .01$) and Relative-Hard Code Downgrades ($r = -0.62, p < .01$) maintained significant correlations with Challenge Time, while Hards Solved Complex ($r = 0.70, p < .01$) and Hards Started Complex ($r = 0.62, p = .01$) maintained significant correlations with posttest score. This suggests that choosing to write challenging code and persisting at it is related to players’ motivations in the face of challenge and learning respectively, even when controlling for student prior knowledge.
Table 3. Partial correlation matrix of challenge navigation behaviors, controlling for pretest.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic Persistence</td>
<td>0</td>
<td>.04</td>
<td>.15</td>
<td>.15</td>
<td>.00</td>
<td>.26</td>
<td>.16</td>
<td>.27</td>
<td>.03</td>
<td>.07</td>
<td>.12</td>
<td>.06</td>
</tr>
<tr>
<td>Learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coding Time Day 2</td>
<td>60*</td>
<td>.25</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
<td>.22</td>
</tr>
<tr>
<td>Challenge Approach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate Replays</td>
<td>-.09</td>
<td>.17</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
<td>.64</td>
</tr>
<tr>
<td>Hards Replayed</td>
<td>-.15</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>Moves to Hard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hards Solved Complex</td>
<td>47</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
</tr>
<tr>
<td>Levels Solved Complex</td>
<td>37</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>Levels Started Complex</td>
<td>33</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
<td>.07</td>
</tr>
<tr>
<td>Hards Solved Complex</td>
<td>64</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
</tr>
<tr>
<td>Relative-Hard Code Downgrades</td>
<td>- .02</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
</tr>
</tbody>
</table>

**p < .01, *p < .05

These partial correlations suggest that certain in-game measures predict unique variance in challenge time and posttest scores. To identify which measures predicted significant unique variance, and how much, we ran a series of step-wise linear regressions by first adding pretest to the model, and then adding the most strongly correlated measures first. When pretest score was linearly regressed on Challenge Time, it did not explain significant variance in Challenge Time, \( p = .87 \). Relative-Hards Solved Complex, when added to the model, ultimately explained 44.7% more unique variance in Challenge time than pretest alone, \( F(1,14) = 11.36, p < .01 \). Finally, Relative-Hard Code Downgrades was added to the model, and failed to explain any more unique variance in Challenge Time, \( p = .23 \).

To examine associations with learning, pretest score was linearly regressed on posttest score but failed to explain any unique variance, \( p = .15 \). Hards Solved Complex, when added to the model, explained 50.2% additional unique variance in posttest score, controlling for pretest, \( F(1,15) = 20.09, p < .01 \). When Hards Started Complex was added to the model, it did not explain any more unique variance in posttest score (\( p = .83 \)) most likely because Hards Solved Complex and Hards Started Complex were very highly correlated, \( r = 0.90, p < .01 \). Results suggest that students who are committed to writing complex code in challenging situations are more motivated in the face of challenge and learn more.

Discussion

Based on this exploratory analysis, challenge approach in-game behaviors seem to best measure student motivation and learning, while challenge response and general persistence were less productive measures. Relative-Hards Solved Complex, a measure of how willing students were to use complex code to solve problems that they specifically struggled with, was the best predictor of how much time students spent trying to solve a novel, impossible problem that acted as a classical measure of persistence in the face of challenge. Meanwhile, students’ willingness to solve hard problems with complex code more generally was a weaker predictor of challenge time but the best predictor of posttest scores.

Together, these measures suggest that the more willing students are to approach challenge the more they were willing to persist, and ultimately learn in this game environment. These measures demonstrate how fine-grained log data can be used as valid assessments of behaviors that have positive effects on student learning. It is important to note that in this study, more traditional measures of challenge navigation (e.g. choosing to play a hard vs. an easy level) and general persistence did not relate to learning outcomes. This suggests a strong benefit of exploring more fine-grained behavioral measures of challenge navigation.
Conclusion

This study was ultimately able to identify a few measures of student behaviors that predicted persistence and learning. Specifically, challenge-approach measures that assess a student’s willingness to try out difficult strategies on hard problems were the most predictive. This research suggests that game log data has a largely unexplored potential for measuring situated instances of student persistence and challenge navigation. Additionally, it suggests that game researchers should be more varied in the ways they define, operationalize, and measure student motivation. Instead of just looking at total persistence times, measures relating to student’s willingness to engage productively in challenging tasks seem to be important, and relate strongly to student learning.

Ultimately, we were limited in this study by our small sample size and the fact that students only played one game. Our measures of challenge approach, challenge response, and general persistence were confined by the structure and mechanics of this particular game. Future work should consider the effects of other measures of challenge navigation, and how these measures might be adapted for different game environments. For example, if a game did not have gating, then the next level a student chooses after failure would be more indicative of challenge-response behavior, and less of a challenge-approach behavior. Future work should also seek to replicate these findings with a larger sample of student players.

Acknowledgments

We thank participating teachers and students. We would also like to thank Joan Cejudo for his programming work on this project.

References


3.

Rule the Roost

Designing a Game That Builds STEM Identity for Girls
Laura Beukema (Twin Cities PBS) & Joan Freese (Twin Cities PBS)

Abstract

A strong STEM identity is crucial to both choosing and persisting through STEM careers. This is especially true for women and young girls, who face additional barriers including common misconceptions and a lack of role models. SciGirls is a transmedia initiative that addresses these barriers by engaging tween girls with STEM experiences and changing their perceptions of STEM. Rule the Roost is an online game that promotes the development of a strong, positive STEM identity through the integration of SciGirls gender equitable strategies, citizen science, and creative game design. Elements of alternate reality gaming and self-directed learning engage players in completing real world projects that develop STEM and 21st century skills. These skills, connected to game skills and experience points, are reflected as part of an online profile defining the player’s STEM identity, which can ultimately transfer to her personal identity.

Science for Girls

The mission of SciGirls – changing how millions of girls think about science, technology, engineering, and math (STEM) – addresses barriers to STEM that include a lack of identity (girls’ perception of themselves as scientists or engineers), low self-esteem resulting from stereotypes around girls’ lack of ability and interest, and limited exposure to female role models in STEM. To help girls emerge from the challenging tween years with a positive attitude towards STEM, SciGirls provides meaningful experiences through a robust, three-pronged transmedia effort that includes television, outreach, and online experiences. Underlying this effort are research-based strategies and a SciGirl “identity” that together lay the foundation for a unique and powerful game: Rule the Roost.

The Importance of Identity

During the middle school years, girls are developing their own interests and recognizing their academic strengths. Unfortunately, by the end of these crucial tween years, many girls do not think of themselves as smart or capable enough to engage in STEM. Several researchers point to “identity” as one of the main barriers to girls’ perceptions of themselves as scientists (Eccles, 2011; Fenichel & Schweingruber, 2010). Identity is a powerful construct to address the STEM barriers facing young girls because it integrates self-concept, sense of agency, content confidence, personal relevance, interest and motivation. The freedom to fashion identities in play is an important affordance of games (Klopfer, Osterweil, &
Salen, 2009). While experimenting with different identities and practicing various behaviors players are defining themselves, and by providing STEM-influenced identities to play with, Rule the Roost creates the opportunity for a STEM identity to be a part of that definition of self.

The SciGirls Seven

At the core of SciGirls is The SciGirls Seven (see Table 1), a set of research-based strategies proven to increase girls’ interest in STEM and improve their attitudes towards STEM (Flagg 2010, 2012). These strategies encourage collaborative, meaningful, creative, and open-ended activities; promote a growth mindset and critical thinking; and emphasize the use of female STEM role models – all of which are crucial to addressing the specific barriers preventing girls from choosing STEM.

<table>
<thead>
<tr>
<th></th>
<th>Girls benefit from collaboration, especially when they can participate and communicate fairly. (Parker &amp; Rennie, 2002; Sciclebury &amp; Baker, 2007; Werner &amp; Denner, 2009). Highlight the social part of science - working and learning together. Create a community atmosphere that encourages girls to share their ideas and value each contribution.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Girls are motivated by projects they find personally relevant and meaningful. (Liston, Peterson, &amp; Ragan, 2008; Lyon &amp; Jafri, 2010; Mostache et al, 2013; Patrick, Mantzicopoulos &amp; Samarapungavan, 2009; Thompson &amp; Windschitl, 2005). Motivate girls with projects that are important and can make a difference. Use STEM as a tool to explore topics that girls can connect to with similar situations from their own lives.</td>
</tr>
<tr>
<td>3</td>
<td>Girls enjoy hands-on, open-ended projects and investigations. (Chatman et al., 2008; Denner &amp; Werner, 2007). Promote exploration, imagination, and invention by encouraging girls to ask questions and find their own approach to projects. Focus on the “why” and “how” over finding a “right” answer.</td>
</tr>
<tr>
<td>4</td>
<td>Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents, and preferred learning styles. (Calabrese Barton et al., 2013; Calabrese Barton, Tan, &amp; Rivet, 2008; Eisenhart &amp; Finkel, 1998; Lyon &amp; Jafri, 2010). Give girls ownership of every step of the process including designing their approach, collecting data, and communicating results. Encourage girls to develop their own ways of exploring and sharing knowledge.</td>
</tr>
<tr>
<td>5</td>
<td>Girls’ confidence and performance improves in response to specific, positive feedback on things they can control—such as effort, strategies, and behaviors. (Blackwell, Trzesniewski &amp; Dweck, 2007; Dweck, 2000; Halpern et al., 2007; Kim et al., 2007; Mueller &amp; Dweck, 1998). Allow girls to fail or struggle and emphasize that their skills can be improved with practice. Share individual ideas, knowledge and accomplishments with the group.</td>
</tr>
<tr>
<td>6</td>
<td>Girls gain confidence and trust in their own reasoning when encouraged to think critically. (Chatman et al., 2008; Eisenhart &amp; Finkel, 1998; Kim et al., 2007). Lead girls to ask questions and think creatively. Focus on the problem, consider different approaches and solutions, and re-examine ideas.</td>
</tr>
<tr>
<td>7</td>
<td>Girls benefit from relationships with role models and mentors. (Holmes, Redmond, Thomas &amp; High, 2012; Liston, Peterson &amp; Ragan, 2008; Lyon &amp; Jafri, 2010; Mostache et al., 2013; Weber, 2011). Leverage role models to demonstrate how girls can succeed in STEM and inspire girls to pursue STEM. Include stories that allow girls to relate to role models and mentors as real people who are more than just their careers.</td>
</tr>
</tbody>
</table>

Table 1. The SciGirls Seven.

The SciGirls Seven foster collaboration, communication, creativity and critical thinking – all tools for STEM success and positive STEM identity building. STEM experiences that allow girls to apply
their own creativity and individual approaches encourage girls to develop a sense of agency and confidence in STEM content. Meaningful, interest driven, and personally relevant projects motivate girls to make stronger connections between their personal identity and their STEM identity. Emphasis on a growth mindset further promotes confidence and builds the resilience girls need to persevere and overcome barriers. Finally, exposure to female role models that challenge stereotypes reveals to girls that engagement with STEM and a STEM identity can be both possible and positive.

The SciGirl Identity

The above strategies, and their connections to STEM identity, became the foundation for a redesigned SciGirls website and new games. The approach sought to create a ‘SciGirl’ identity that defines qualities needed to succeed in STEM (see Table 2). An initial need to create a better experience for user profiles and user-generated projects evolved into an integrated game-profile experience that features, promotes, and celebrates each SciGirl. Further reflection revealed that many of these qualities and values were already visible throughout SciGirls media and resources in storytelling, content, and design. While developing Rule the Roost, the SciGirl identity was heavily leveraged to create an experience that builds a sense of community and collaboration, an interest in meaningful and relevant topics, and a culture of self-direction and asking questions.

<table>
<thead>
<tr>
<th>Who is a SciGirl?</th>
<th>The SciGirls Seven</th>
</tr>
</thead>
<tbody>
<tr>
<td>SciGirls work together.</td>
<td>Girls benefit from collaboration, especially when they can participate and communicate fairly.</td>
</tr>
<tr>
<td>SciGirls make a difference.</td>
<td>Girls are motivated by projects they find personally relevant and meaningful.</td>
</tr>
<tr>
<td>SciGirls ask questions and explore.</td>
<td>Girls enjoy hands-on, open-ended projects and investigations.</td>
</tr>
<tr>
<td>SciGirls aren't afraid to make mistakes.</td>
<td>Girls gain confidence and trust in their own reasoning when encouraged to think critically.</td>
</tr>
<tr>
<td>SciGirls are creative and unique.</td>
<td>Girls’ confidence and performance improves in response to specific feedback.</td>
</tr>
<tr>
<td>SciGirls motivate others.</td>
<td>Girls are motivated when they can approach projects in their own way.</td>
</tr>
</tbody>
</table>

Table 2. Who is SciGirl?

Citizen Science

In addition to promoting STEM identity, goals for the new SciGirls games included addressing the topic of citizen science, or participatory science, in a meaningful way by conveying key concepts, motivating girls to participate, and educating girls about research protocols. Based on research on the personal and social factors that motivate participants to engage in citizen science (Dickinson & Bonney, 2012), several factors became part of the design of Rule the Roost (see Table 3). In many ways, the key points are already connected to The SciGirls Seven and the SciGirl identity through the collaborative, hands-
on, relevant, and meaningful nature of citizen science. Gameplay incorporates the motivators for citizen science by rewarding participation, encouraging productivity, presenting a variety of interests, and engaging players as a community. The collaborative effort and real world focus of citizen science also overlapped with similar qualities of alternate reality games including the idea of a collective intelligence created through both an online world and the real world. This combination of online and offline play inspired the next evolution of transmedia techniques already integrated within the SciGirls approach.

<table>
<thead>
<tr>
<th>Key Citizen Science Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative in nature</td>
</tr>
<tr>
<td>Anyone can participate</td>
</tr>
<tr>
<td>Includes a protocol and requires observation skills</td>
</tr>
<tr>
<td>Contributions are compiled and used by researchers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motivators for Citizen Scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived personal benefits</td>
</tr>
<tr>
<td>Satisfaction of being productive</td>
</tr>
<tr>
<td>Alignment with personal interests</td>
</tr>
<tr>
<td>Social interaction and community collaboration</td>
</tr>
</tbody>
</table>

Table 3. Integrating Citizen Science.

Rule the Roost

From the unique connections between STEM identity and SciGirl identity, citizen science concepts and motivators, and elements of alternate reality gaming, the innovative features for the online, session-based, persistent game Rule the Roost were born. Players participate in both online and offline play on randomly assigned teams for both collaborative research challenges and self-directed projects. In each month long game session, Rule the Roost presents a “Big Question” that all players can help answer by following a simple protocol to collect and submit data. Players can review all the submitted data from the entire community in live, age-appropriate visualizations. Additionally a selection of open-ended “Questies” that vary from session to session is also available for players to complete, submitting details and photos for points. Throughout each session, players can view submitted photos and “Roost Stats” that include current team scores and recent activity by other players. While playing Rule the Roost, players are also building persistent profiles that showcase the accomplishments and skills they have accumulated across all sessions.

The Big Question

To present the Big Question, a homemade, DIY style video employs peer modeling by starring real girls who are thinking about science through meaningful topics (like nature, sleep, and weather) that are relevant to girls’ everyday lives. These diverse, curious, and confident girls introduce a question about a topic they are interested in (like whether different combinations of activities affect their ability to multitask) and ask for help from the entire community of players to answer. Similar to formal citizen science projects, the Big Question has a simple protocol for observation and collection of real world data that is outlined for players to follow. All the submitted data, including their own, is compiled together for players to view in the form of simple graphs that grow in real time as player data from all over the country is submitted. In this way, girls can see that citizen science is collaborative, all submitted data becomes part of a large collection, and their contribution is important. Anyone can participate in citizen science and any player can participate in the Big Question.
Questies

Questies are real world, open-ended projects infused with STEM and 21st century skills. These projects have a low point of entry with little to no material cost; are engaging, accessible, and relevant to girls’ everyday lives; and cover a variety of topics and interests including nature, technology, health, community and more. Players choose which Questies to complete and can complete as few or as many as they like within the available list. In this way, players are given agency to direct their efforts, exploring and developing their own interests and motivations. When selecting a Questie, players can read a brief description and, after selection, complete the project away from the online part of the game, having an authentic real world experience. Upon completion of the project, players return to the online game to answer a few simple multiple-choice questions and submit photos.

In Questies, STEM topics and 21st century skills overlap often so that girls can discover new interests by seeing connections to existing interests. For example, a girl who is interested in creating videos but has no interest in physics may show an interest in physics after creating a video to capture a levitating slinky in slow motion (the “Floating Slinky” Questie). And because people are more likely to participate in citizen science projects when they align with their own interests (Dickinson & Bonney, 2012) giving girls exposure and opportunity to engage with new interests increases their likelihood to participate in one of the variety of citizen science projects that exist. Many Questie topics also incorporate small-scale philanthropy like organizing a children’s book drive, making a school map for new students, or creating a PSA about recycling. Through completing Questies, girls can not only build interest and experience with STEM but can also see STEM as a tool for improving their own lives and the lives of others.

Questies provide starters for interest-driven, open-ended projects through a combination of descriptions that give the least amount of instruction needed and multiple-choice questions that reinforce project goals, provide opportunity for reflection, and/or add context and structure to the experience. For example, the Questie “Wing It” gives players a project goal of creating different paper airplane designs to test and compare (Figure 1). Players take ownership of the process, applying their own creativity to how they design the paper airplanes, how they test the designs, and what attributes or results they compare. There is freedom of effort in both how many designs or tests players attempt and how elaborate the designs and tests are. The multiple-choice questions reinforce comparison of the designs as part of the goal by drawing attention to speed, distance, and parts of the airplane. While the multiple choice questions require an answer and only one photo may be uploaded, the focus isn’t on giving a single “right answer” but rather on the experience itself: the player’s approach, communication of results, or opportunities for critical thinking. Players are rewarded for their efforts (regardless of their outcome, ability, or approach) with points earned for their team and experience points earned for the corresponding skill in their personal profiles.
Roost Stats

At the end of each month-long session of Rule the Roost, the team that has earned the most points is declared the ruler of the roost. A “homepage takeover” of the kids’ website features the winning mascot (one of four birds, each with their own girl-friendly and STEM/SciGirl inspired identity of being fierce, playful, clever, or heroic) until the next team triumphs. During a session, players can view live “Roost Stats” that create and reinforce a sense of community among players through a “newsfeed” of the most recent player activity, a list of popular Questies, and the session’s top players. In this way, the accomplishments of players in both an individual and team context are shared with the player base, allowing girls to find other players’ profiles to view and even “give a hoot” of approval for all to see.
Profiles

Profiles are customizable and unique to each player (see Figure 2). A player’s profile showcases all her in game activity (across all sessions), her mastery of each skill (labeled with identifiers such as “Builder”, “Designer”, “Tech Whiz” etc.), photos of her projects, her current team, and the identifier she has chosen for her “role” in the team (writer, artist, explorer, etc.). The most visible and interesting content in a profile are accomplished in the real world as part of the game (rather than creating an avatar or decorating a room), so a girl can see that it is her interests, knowledge, skills, and actions (who she is) that is important – not appearance or stereotypes. And because her own interests and choices decide everything she does within the game, both online and offline, her profile is a reflection of a part of her real self.

Post Mortem

The design and development of Rule the Roost involved finding connections between the identity of SciGirls and citizen science content to give girls the opportunity to identify with STEM. Ultimately, this meant creating both a new approach and a new kind of experience. Players’ efforts and experiences are uniquely influenced by their own imagination and context. This is most visible in the photos that players submit which showcase a variety of individual results. For example, most photo submissions for the Questie “Wing It” are simple images of the paper airplanes themselves. However, one player submitted a photo of the data from her test flights, detailing the performance of her airplanes in tables for comparison. Another player showcased each airplane with labels for which flew fastest or furthest. And yet another player showed her airplanes with sketches of each flight pattern and whether she considered the designs successful based on how long they stayed in the air. Looking at player profiles, there are casual players with a few projects and a short Questie history, but also hardcore players who have scored at the top for multiple sessions and have well over a hundred completed Questies. Many girls complete projects within each skill area while some girls focus attention on a few skills, often including “Investigator” which is leveled by completing the citizen science activity the Big Question. Thousands of girls have played Rule the Roost, developing their in-game STEM identities through the thoughtfully and creatively designed online and offline play. Because those identities are built from real world play that is influenced by their existing identities, they are likely to integrate into girls’ personal identities.
Acknowledgements

This material is based on work supported by the National Science Foundation under Grant No. 1323713. Any opinions, findings, and conclusions expressed in this material are those of the author and do not necessarily reflect the views of the NSF. Special acknowledgement to the SciGirls team and advisors.

References


Inciting Out-Of-Game Transfer

Adapting Contrast-Based Instruction For Educational Games
Catherine C. Chase (Teachers College, Columbia University), Erik Harpstead (Carnegie Mellon University), & Vincent Aleven (Carnegie Mellon University)

Abstract

We adapted a successful instructional principle – contrasting cases – to create an educational game to teach young children physical principles of stability. Our goal was to design a game that would promote transfer – extending the reach of the educational game beyond the game itself. In Study 1, we compared a “standard” version of the game to a “contrast” version that contained contrasting case levels designed to help learners notice the principles underlying game content. In Study 2, we augmented the contrast version of the game with induction levels that focused learners on abstracting general principles from sets of contrasting cases. In both studies, we found that contrast versions of the game facilitated transfer, while standard versions did not. Students found contrast versions of the game highly enjoyable, just as enjoyable as the standard game. Findings have implications for the design of educational games that are instructive yet fun.

Introduction

While research findings on the effectiveness of educational games are still somewhat mixed (Honey & Hilton, 2011), there is now mounting evidence suggesting that educational games can produce greater learning than traditional instruction (Wouters et al., 2013). But how exactly does one design an effective educational game? Some have attempted to identify design guides for educational games, but few of these guides describe specific forms of learning activities (Clark et al, 2009; Mayer, 2014). We posit that one successful approach for designing effective educational games is to adapt existing instructional principles as game mechanics (Aleven et al, 2010). Learning science research has identified several instructional principles that enhance learning and transfer in a wide variety of contexts.

We are chiefly interested in producing transfer – the application of content learned in one context to a different context. Since our focus is on how games can support classroom instruction, we explore transfer from game play to academic tasks. Many have explored this same question but with a focus on learning rather than transfer. We have chosen to adopt a transfer perspective because we see the challenge of learning from games as a transfer problem at its core; game contexts differ fundamentally from traditional academic contexts. For example, games provide rich narratives, situated representations of content, and play goals, while school contexts tend to be devoid of narrative, provide abstract representations, and invoke learning goals.
An overlooked principle that promotes deep learning and transfer is the use of “contrasting cases.” Contrasting cases are sets of examples that share many similarities but differ on key features, which are tied to deep domain principles (Bransford et al., 1989; Gibson & Gibson, 1955). There are two key processes by which contrasting cases provoke transfer. First, the contrasts help learners notice deep principles in the context of specific examples. Second, learners are pushed to form an abstract understanding of the deep principles that run throughout a set of cases, which can be flexibly adapted to novel contexts. Contrast-based instruction has been used effectively to achieve both noticing and abstraction (Gick & Patterson, 1992; Schwartz et al., 2011).

While a great deal is known about instructional principles that help people learn, it is less clear whether these same principles will work well in a game context. Unfortunately, many educational games come across as “chocolate-covered broccoli” where standard learning activities are “gamified” by the addition of simple game features like points and fancy graphics. While this kind of learning environment can enhance learning, it separates the instructional and game play elements, and in the end, may not feel like a real game. One reason we chose contrasting cases as our core pedagogy is because they share many characteristics with common games, such as being highly visual, player-controlled, intuitive tasks. We hoped that by adapting a game-like instructional technique into a game, it would make for a meaningful play experience and a strong integration of instruction with play.

In this paper, we describe our efforts to build and evaluate an educational game that pushes students to notice and abstract underlying principles through the application of contrasting cases, an often-overlooked learning science principle. We integrated contrasting cases into RumbleBlocks, a game that was designed to teach elementary-aged children about the physics of stability (Christel et al., 2012). To our knowledge, this is the first educational game that explicitly incorporates the instructional principle of contrasting cases. In Study 1, we compared a standard version of the RumbleBlocks game, with no explicit educational scaffolds, to a contrast version of the game, imbued with several contrasting case levels. In Study 2, we compared the standard version to a contrast version that was augmented with new induction levels, which encouraged learners to abstract the deep principles that ran throughout a set of cases. In both studies we investigated the following hypotheses:

1. Students who play contrast versions of the game should demonstrate greater out-of-game transfer than students who play the standard game.

2. Students who play contrast versions of the game should demonstrate similar in-game learning as students who play the standard game. Previous work has found that contrasting case-based instruction specifically aids transfer, but not always immediate learning or performance (Roll, Aleven, & Koedinger, 2011; Schwartz & Martin, 2004).

3. Students who play contrast and standard versions of the game will report similar levels of game enjoyment. We were careful to design contrasting case levels that seamlessly integrated instruction and play.

Study 1 Method

Game Design

The RumbleBlocks game is designed to teach three principles of stability. Structures tend to be more
stable when they have (1) a wide base (2) symmetrical sides and (3) a low center-of-mass. These concepts fall under PS 2.C “stability and instability in physical systems” in the National Research Council’s framework for K-12 science education (National Research Council, 2012).

![Figure 1. Example “Build” and “Contrast” Levels for Symmetry. A) Start state, B) Failed attempt, C) Successful attempt.]

*RumbleBlocks* is couched in an alien-themed narrative. An alien has been stranded on a foreign planet and separated from its spaceship. In each level, the player’s goal is to reunite the alien with its spaceship (Figure 1). The alien is located on the edge of a high cliff, with the spaceship located in a chasm below. The main mechanic of the *RumbleBlocks* game is block building. Each level varies the given set of blocks and the target height of the structure. Through the strategic placement of “energy dots” that towers must cover, levels scaffold students in building structures that have low centers of mass, wide bases, or symmetrical sides. The player’s job is to build a structure that will reach the high cliff, cover the energy dots, and place the spaceship at the top of the structure. After that, an earthquake hits, and if the structure stays standing, the alien can now reach its ship and fly home and the level is won. The game was created in the Unity game engine, which has a well-developed physics engine, allowing the game to accurately simulate the laws of two-dimensional rigid body physics. Thus, the blocks and towers behave realistically, responding to gravity, friction, and torque.

The “standard” version of the game contained only the build levels described above (see Figure 1). The “contrast” version of the game contained build levels interspersed with “contrast” levels (see Figure 1), where players predict which of two towers will stay standing in an earthquake (to help the alien spaceship find a stable place to land). The towers differ on a single feature that maps to a specific principle (e.g. towers are identical except one has a wider base or lower center-of-mass). After players predict, the earthquake knocks one of the two towers down, providing feedback (while also adding suspense to the game), and then students move on to the next level. The “contrast” levels were designed to help students attend to features of the towers that relate to principles of stability.
Participants

Study participants were 166 children in grades K-3 at two public elementary schools in Pennsylvania. The schools were high-performing (only 3% and 7% of 3rd graders were not proficient on state tests in math and reading, respectively), moderate SES (27% economically disadvantaged), and predominantly Caucasian (3% minority students).

Procedure

Students in each class were randomly assigned to either “standard” (n = 90) or “contrast” (n = 76) conditions. Conditions were implemented via two different game versions. The standard version was designed to mimic many common games, where players apply the principles of physics to achieve game goals, but those principles are never highlighted in any way. In the “standard” version, students played only “build” levels of the game. The build levels were blocked by principle, such that students played a series of build levels about symmetry, then base width, then center-of-mass. The “contrast” version of the game was identical to the “standard” version, except that it contained additional “contrast” levels, designed to focus students’ attention on a specific principle, in isolation.

Transfer beyond the game was assessed by out-of-game paper-and-pencil pre and posttests that asked students to apply knowledge of stability principles to a more traditional schoolish test (scores were converted to percent correct). Learning was measured by in-game pre and post assessment levels, which contained no scaffolding. Each structure that students built in these levels was assessed in two ways: (1) success: whether or not the structure stayed standing in an earthquake, max score=3 and (2) principle application scores: standardized Z scores reflecting the base width, degree of symmetry, and height of center-of-mass of each structure, converted so that positive scores indicate greater application of each principle. Game enjoyment was measured by a 3-point “smiley face” likert scale that asked students how much they liked the game.

The study took place over the course of four consecutive days, with 30-minute sessions each day. On Day 1, students took the out-of-game transfer pretest. On Days 2-3, students played the RumbleBlocks game on desktop computers. Total game play time averaged 52 minutes in both conditions. At the beginning and end of game play, students took the in-game learning pre (Day 2) and posttests (Day 3), which were embedded in the game. On Day 4, students completed the out-of-game transfer posttest and the survey of game enjoyment.

The study took place over the course of four consecutive days, with 30-minute sessions each day. On Day 1, students took the out-of-game transfer pretest. On Days 2-3, students played the RumbleBlocks game on desktop computers. Total game play time averaged 52 minutes in both conditions. At the beginning and end of game play, students took the in-game learning pre (Day 2) and posttests (Day 3), which were embedded in the game. On Day 4, students completed the out-of-game transfer posttest and the survey of game enjoyment.

Results

There were no pre-existing differences on out-of-game pretest scores across conditions or schools, p’s >
.11. However, there were significant differences by grade, \( F(3, 150) = 10.13, p < .001 \). To test for gains on the out-of-game transfer test, we conducted a mixed ANOVA with grade as a covariate, condition as a between-subjects factor, time as a within-subjects factor, and test score as the dependent measure. There was a strong main effect of grade, \( F(1, 163) = 58.99, p < .001 \), demonstrating that students in higher grades scored higher on both tests. There was no main effect of time, but there was a significant interaction of time by condition, \( F(1, 163) = 3.76, p = .05 \). Pairwise comparisons revealed that the contrast condition increased its score from pretest to posttest, \( p = .01, \eta^2 = .04 \), whereas no statistically significant difference between pretest and posttest was detected for the standard condition, \( p = .93 \). In other words, students who played the contrast version transferred their learnings beyond the game, while those who played the standard version did not (see Table 1).

The in-game learning pre and posttests were scored for the success of students’ structures (i.e., whether structures remained standing when the earthquake hit). To test for differential effects of condition on in-game learning, a mixed ANOVA was conducted with time as a within-subjects variable and condition as a between-subjects factor. There was a large main effect of time, \( F(1, 164) = 25.50, p < .001, \eta^2 = .14 \). This demonstrates that students across both conditions made sizeable gains in their success from pre to post build levels, with an average gain of 14% and a medium effect size. However, the interaction effect of time by condition was not significant, \( p = .57 \), indicating that both conditions got better at playing the game over time (see Table 1).

![Table 1. Adjusted mean scores (and SD) for in-game learning an out-of-game transfer.](image)

We also examined the level of principle application in pre and posttest game levels. To test for differential learning gains across conditions by principle, a mixed ANOVA with condition, time, and principle as independent factors and Z-scores as the dependent variable was conducted. The interaction of time by condition was not significant, and neither was the interaction of time by condition by principle, indicating that performance did not differ by condition. However, there was a marginally significant main effect of time \( F(1, 164) = 3.04, p = .08 \), which was largely driven by specific principles, as evidenced by the marginally significant interaction of time by principle, \( F(2, 328) = 2.85, p = .06 \). No other main effects or interactions were significant. Pairwise comparisons (with Bonferroni correction) between in-game pre and posttest scores revealed that students built structures with wider bases, \( p = .01 \), that were marginally more symmetrical, \( p = .07 \), but, the structures’ centers-of-mass did not change, \( p = .66 \). Students improved greatly at applying the base width principle, somewhat on the symmetry principle, and not at all on the center-of-mass principle (see Table 1). However, there were no significant differences between conditions.

Gain scores on the out-of-game transfer test were significantly correlated with gain scores for success on the in-game learning test \( r = .22, p = .005 \), but not with principle application scores. This suggests that
successful game play does not fully predict transfer outcomes, underscoring the need for out-of-game measures to assess whether in-game learnings transfer out of the game.

Children reported equally high levels of enjoyment for both versions of the game, and in all grades. A univariate ANOVA with condition and grade as independent variables and enjoyment ratings as the dependent variable found no significant main effects of condition or grade, nor any significant interaction, p’s > .31. Students in both conditions gave high average enjoyment ratings (Mcontrast = 2.90, SDcontrast = .39; Mstandard = 2.88, SDstandard = .38 on a scale of 1-3), and 91% of all students gave the highest rating of 3 (“I liked it!”). Children in our study greatly enjoyed playing the RumbleBlocks game, and the addition of contrasting case levels did not reduce that level of enjoyment.

### Study 2 Method

#### Game Design

In Study 2, we augmented the existing “contrast” game with new induction levels that were designed to encourage learners to abstract the principles underlying sets of contrasting cases. Typical induction prompts ask learners to explain the similarities and differences between a set of cases (Alfieri, Nokes-Malach, & Schunn, 2013), or sometimes, learners are asked to generate an equation or graph that demonstrates the pattern across a set of cases (Schwartz & Martin, 2004; Schwartz et al., 2011). However, writing and generating equations are not feasible activities for very young children, and they violated our design objective of avoiding instructional elements that “smell like school.”

Our solution was to design levels where players select visual representations or “goggles” that depict the pattern of principles imbued in a set of cases. This mechanic honors the visual nature of game tasks, and created a selection task that was intuitive and developmentally appropriate for young players. In an induction level, players were instructed to pick the goggles that “explain why some towers fell while other stood when the earthquake hit,” encouraging learners to think abstractly about what might affect stability across several different types of towers. Players could view the same set of structures through different principle-focused lenses (see Figure 2). Players were given two chances to identify the right “goggles,” and this was followed by a short movie that gave a brief explanation of the relevant principle and how it impacts stability. This general sequence of having learners attempt to induce the relevant principle shown in multiple cases followed by expository instruction on the correct principle was modeled after activities that prepare people to learn from future instruction (Schwartz & Martin, 2004; Schwartz et al., 2011).

![Figure 2. “Goggles” in introduction level. A) Base width, B) Symmetry, C) Center-of-mass, D) Number of blocks goggles (a distractor choice.)](image)
Participants

Study participants were 83 first and second graders at a public elementary school in Pennsylvania. The school was low-performing (38% and 46% of 3rd graders at the school were not proficient in reading and math respectively, on statewide tests), low SES (87% economically disadvantaged students), and predominantly African American (70% African American, 20% Caucasian).

Procedure

Students were randomly assigned within each class to either “standard” (n = 43) or “contrast + induce” (n = 40) conditions. The contrast + induce condition was essentially the same as the contrast game used in Study 1, but each block of contrast levels was followed by an additional induction level. The standard version of the game was very similar to the standard game in Study 1, with the addition of 12 more build levels, to accommodate an additional session of game play.

The procedure was roughly the same as in Study 1, with one additional day of game play and slightly longer daily sessions. The study took place over the course of five consecutive days, with 45-minute sessions each day. Measures were highly similar to the ones used in Study 1. The most significant changes were that the out-of-game transfer test was computerized and game enjoyment measures were converted to a more sensitive 5-point likert scale.

Results

There were no pre-existing differences on out-of-game pretest scores across conditions or grades, p’s > .53. To test for differential gains on our out-of-game transfer test, we conducted a mixed ANOVA with condition as the between-subjects factor, time as a within-subjects factor, and total test score as the dependent measure. There was a significant effect of time, $F(1, 81) = 10.31$, $p = .002$, which was largely driven by the significant interaction of condition by time, $F(1, 81) = 4.55$, $p = .04$, $\eta^2 = .05$. There were no other significant effects, p’s > .23. Pairwise comparisons revealed that the contrast + induce condition increased its score from pretest to posttest, $p < .001$, $\eta^2 = .15$, while the standard condition’s score remained the same over time, $p = .44$. Similar to the findings in Study 1, students who played the contrast + induce version of the game made measurable transfer gains, while those who played the standard version did not (see Table 2).

To test for differential effects of condition on in-game learning (success), a mixed ANOVA was conducted with time as a within-subjects factor and condition as a between-subjects factor. There was a marginal main effect of time, $F(1, 81) = 3.47$, $p = .07$ and a significant interaction of time by condition, $F(1, 81) = 4.39$, $p = .04$, indicating differential growth by condition. Pairwise comparisons revealed that the contrast + induce condition increased their score from pre to post, $p = .007$, $\eta^2 = .09$, while the standard condition’s score did not change over time, $p = .87$ (see Table 2).

We also explored whether students improved in their application of the targeted instructional principles on the in-game learning pre and posttest (see Table 2). To test for differential gains across conditions by principle, a mixed ANOVA with condition, time, and principle as independent factors and Z-scores as the dependent variable was conducted. There was no significant effect of time, and there was
no significant interaction of condition by time, nor were there any main effects or interactions with principle, \( p's > .18 \). Results indicate that neither condition improved in their application of the target principles from pre to posttest, and there were no differences by principle type.

As in Study 1, there was a positive relationship between the gain in success on the in-game learning test and the out-of-game transfer gain, \( r = .24, p = .03 \), but not with principle application scores on the in-game test. Again, this underscores the fact that in-game measures of learning do not fully capture the degree of transfer beyond the game.

Children reported equally high levels of enjoyment for both versions of the game, though 2nd graders liked the game better than 1st graders. A univariate ANOVA with condition and grade as independent variables and enjoyment ratings as the dependent variable found a significant effect of grade, \( F(1, 71) = 3.85, p = .05 \), (\( M_{2nd} = 4.75, SD_{2nd} = 1.02; M_{1st} = 4.28, SD_{1st} = 1.02 \)), though both grades gave very high ratings. However, there was no significant main effect of condition, nor any interaction of condition by grade, \( p's > .53 \). Students in both conditions rated the game as highly enjoyable on a scale of 1-5 (\( M_{contrast+induce} = 4.44, SD_{contrast+induce} = 1.03; M_{standard} = 4.59, SD_{standard} = 1.04 \)), and 75% of all students gave the highest rating of 5 (“I liked it a lot”). Children in our study greatly enjoyed playing the *RumbleBlocks* game, and the addition of contrast and induction levels did not reduce enjoyment.

**General Discussion**

In this paper, we have demonstrated the value of adapting contrast-based instruction for game contexts. Two studies using very different student populations demonstrated that an educational game can be enhanced by the addition of contrasting cases. The addition of contrasting case levels to a standard game led players to develop flexible understandings of stability principles that transferred beyond the game to an out-of-game test that asked learners to reason about the principles in novel contexts. In contrast, we did not find evidence that children who played a standard game transferred what they learned beyond the game context. Findings as to whether players of the standard game learned to build more stable structures in the game itself are mixed; in Study 1 we found evidence that they did, while in Study 2 they did not. Regardless, playing a standard game did not help learners to apply their knowledge outside the confines of the game. This finding also emphasizes the importance of measuring transfer in studies that assess the effectiveness of educational games. Measures of learning derived from pure gameplay metrics, such as number of levels beaten, may falsely inflate our estimates of the learning students actually take away from the game (cf. Long & Aleven, 2014).

Another important metric when considering a game’s effectiveness is how much players enjoyed playing
the game. Too often, games are implemented as “chocolate covered broccoli” where the unpleasant experience of learning is masked by the enjoyable experience of play. We explicitly chose to adapt contrasting cases as a game mechanic (out of many other successful instructional principles) because of their game-like affordances, hoping that the experience of the contrasting case activity would make learning and play one and the same. Moreover, to build RumbleBlocks, we forged a close collaboration between learning specialists and game designers from the start. Our approach paid off – in both studies, adding carefully designed contrast and induction levels did not change children’s liking of the game and may have even contributed to it.

This set of studies contains several limitations that prompt ideas for future research. First, we cannot make strong claims about the added value of the induction game levels, over and above the contrasting case levels. Future research could isolate the effects of the induction levels on transfer outcomes. Moreover, it is impossible to tell whether the “build” levels were at all instrumental in the transfer that resulted from either of the contrasting case versions of the game. Would students have transferred at the same rate had they only played the contrasting case levels? Or were the build levels necessary for helping learners to apply the principles they were noticing and reasoning about in the contrast and induction levels? Future research could explore how build and contrasting case activities mutually influence the learnings that players build in the game.

The larger message for educational game designers is to incorporate instructional methods that specifically impact transfer. Our work underscores the fact that students playing standard game levels can get better at playing the game and can effectively apply the target content in achieving game goals, without demonstrating transfer from the game to more standard school tasks. A final takeaway is that game mechanics must help players notice and reflect on the content-based principles they are applying to achieve game goals. We have illustrated one way to do this through the use of contrasting cases with prompts to induce the deep principles that underlie a set of cases.

References


through digital games and simulations: Genres, examples, and evidence. In Learning science: Computer games, simulations, and education workshop sponsored by the National Academy of Sciences, Washington, DC.


5.

Do You See What I See?

Visual Attention Patterns of Adolescents With and Without ASD to a Dynamic Videogame Stimulus

Erinn Finke (Penn State University), Benjamin Hickerson (University of North Carolina Greensboro), & Krista Wilkinson (Penn State University)

Abstract

The purpose of this study was to determine if children with and without autism spectrum disorder (ASD) fixate similarly while passively viewing a videogame play stimulus. To answer this research question, eye-tracking technology (i.e., Tobii T60) was used to gather data from typically developing children as well as children with ASD. A coding scheme was developed to determine how often all participants visually attended to various elements of the video game. This study is a first step in determining if videogame play may be an appropriate context for providing opportunities for friendship formation.

Introduction

Autism spectrum disorder is characterized by deficits in social communication and restricted, repetitive behaviors (American Psychiatric Association, 2013). Many individuals with ASD experience social isolation that negatively influences all aspects of development as well as long-term outcomes (Muller, Schuler & Yates, 2008). In particular, limitations in social skills can restrict an individual’s ability to make and maintain relationships, obtain and retain employment, live independently, and fully participate in society at large (McConnell, 2002; White, Keonig & Scahill, 2007). One important outcome that is documented to be particularly at risk in individuals with ASD is making and maintaining authentic, reciprocal friendships (Petrina, Carter & Stephenson, 2014; Rowley et al., 2012). Friendship is one of the most fundamental aspects of quality of life, and its benefits are well documented (Parker & Gottman, 1989). Many children with disabilities, including children with ASD, experience substantial difficulty in making and maintaining friends. Moreover, children with disabilities like ASD are often perceived as less socially competent and of lower social status than their typically developing peers (Orsmond et al., 2004).

Finke (2016) reviewed literature on the state of research and clinical practices designed to promote inclusion and peer relationships for individuals with ASD. As she noted, interventions to increase quality and rate of social interactions of children with ASD have primarily sought to teach very specific social skills, such as appropriate ways of entering a social group or asking partner-centered questions. Extensive research has shown children with ASD can indeed learn these targeted social skills (e.g., Odom, McConnell, & Chandler, 1994). Despite this, outcome data suggests, quite convincingly, that successful completion of social skills training does not translate to increases in the number, quality, or
duration of friendships for children with ASD (Petrina et al., 2014; Finke, 2016). It seems, based on the data available, an opportunity exists to reframe the effort to promote social outcomes for individuals with ASD by investigating how the naturally-occurring environments and activities in which friendships typically emerge may be used in intervention.

On the basis of her analysis of the construct of friendship, Finke (2016) offered a proposed framework that, together with existing programs, might serve to promote friendship outcomes in individuals with ASD. Specifically, Finke proposed three fundamental elements for friendship interventions: (a) offering a means by which both partners can enjoy equal status/contribution to the relationship (Newcomb & Bagwell, 1995) (b) structuring intervention to include mutually motivating opportunities for interaction; and (c) offering frequent opportunities for interaction in an activity context preferred by both partners. Finke (2016) also offered several potential contexts that may meet these criteria as examples and potential avenues for researchers to begin to explore her ideas empirically. One such context is videogame play. The vast majority of adolescents engage with video games as a form of leisure. Lenhart et al. (2008) reported that 99% of boys and 94% of girls under the age of 18 years old play some form of video-based games on a regular basis. Children with ASD have an interest in video games that is comparable (Hickerson, Finke & Choi, 2014) to individuals without ASD.

In addition to being popular, video games allow players to play cooperatively and as equals at whatever skill level they possess. This allows players of varying ability levels to play together without compromising the ability for either player, or the dyad together, to achieve success within the game. This will be an important factor to consider, as one barrier to the establishment of a friendship could be conflict within an interaction. Varying levels of skill and ability within an activity can cause frustration, which may cause the two children to be less interested in playing together in the future. An activity with real promise, especially when considering dyads comprised of one child with ASD and one child without ASD, would be one where the children could play together, regardless of their experiences and skills, and still achieve success through working together.

Measuring Visual Attention to Videogames as a Necessary First Step

While videogames might have promise as a context for friendship intervention, the behavioral profile associated with ASD introduces several specific and unique issues that warrant examination prior to embarking on any intervention effort using videogames as the context. One of the core features contributing to diagnosis of ASD is atypical patterns of eye gaze during actual social interactions, such as gaze aversion or limited eye contact with social partners (APA, 2013). Videogames are platforms within which game characters (the avatars within the game) enact the action and, oftentimes, interact with one another. If the visual attention atypicalities of individuals with ASD extend to attention paid to characters within videogames, then the play patterns of individuals with ASD might be quite different than those of their peers. In that event, any friendship intervention based on videogame play might be destined to fail, as it might not accommodate potential barriers of differential visual attention of players with and without ASD.

Atypicality in visual processing in individuals with ASD has formed the basis for some frequently cited models of ASD (e.g., Happe & Frith, 2006). Describing the nature of visual attention deficits in individuals with ASD has been the focus of much research (see Ames & Fletcher-Watson, 2010). Automated eye tracking technology is gaining popularity as a means of extending what is known about visual processing in social contexts, as the data collected can reveal the features that capture
visual attention a momentary marker of underlying cognitive and social processing (Gillespie-Smith & Fletcher-Watson, 2014). As a result there has been a steep increase in the number of eye tracking studies examining the visual social attention patterns and visual responses of individuals with ASD. Visual social attention “refers to the overt attentional bias to orient to and look at other people, notably their face and eyes, as well as to where they direct their attention” (Guillon et al, 2014; pp. 280).

One of the proposed core deficits experienced by individuals with ASD is decreased attention to socially relevant stimuli, particularly faces, when compared to individuals without ASD (e.g., Dawson, Webb & McPartland, 2005). Results of eye tracking studies examining this core deficit in children, adolescents, and adults with ASD have been mixed. Some studies have shown a clear difference in the visual attention patterns between individuals with and without ASD, while other studies suggest between-group performance is indistinguishable. The differences in these outcomes may be related to the differences in the stimuli used (static images vs dynamic videos) as well as the types of social demands presented within the task. To date, studies that used static images that contained a single person within the image as stimuli garnered visual social attention patterns from individuals with and without ASD that were similar (e.g., Fletcher-Watson, et al., 2009). Other studies have examined visual social attention using dynamic stimuli containing more than one person. In these contexts, individuals with typical development increased the quantity of time fixated on faces and eyes in these situations (e.g., Riby & Hancock, 2009). These results appear to suggest that as a stimulus becomes more socially complex (includes more than one person), the visual social attention patterns of individuals with ASD become more divergent compared to participants without ASD.

There is also evidence that, for individuals with ASD, relevance or salience of competing objects or events may affect their attention to faces (Sasson & Touchstone, 2013). This may vary, however, as contexts and stimuli become more naturalistic (Guillon et al., 2014). Overall, current eye tracking research of visual social attention in individuals with ASD appears to suggest individuals with ASD have most difficulty orienting to faces when there are competing non-social objects in the visual field and that individuals with ASD take longer to fixate on faces when the stimuli and display is complex (Guillon, et al., 2014).

Purpose

One major limitation of the eye tracking research involving participants with ASD to date, however, is that, with few exceptions (e.g., Gillespie-Smith & Fletcher-Watson, 2014), eye tracking technologies have rarely been used with individuals with ASD who have concomitant intellectual disabilities. This gap in the literature needs to be addressed as eyetracking technology has the power to reveal information about visual attention that is difficult or impossible to measure behaviorally, particularly in individuals with disabilities who cannot respond to conventional methods of assessment (Wilkinson & Mitchell, 2014). The current study used automated eyetracking technology, to investigate visual attention to a video game stimulus. We examined visual attention to videogame stimuli because videogames appear to offer a uniquely well-suited environment for the emergence of friendships, but it is not yet known if children with ASD attend to and play videogames like children without ASD. We believe that it is critical to examine how children with ASDs look at and interact with characters in a videogame, for two reasons: (a) unusual visual attention patterns, most particularly to human figures, is a core feature of the ASD diagnosis, so it seems possible that children with ASDs might engage differently with videogame characters than their nondisabled peers; (b) in turn, this difference of attention allocation might affect the way the individual with ASD plays the game, and, consequently, how they play with a partner.
Method

Participants

Participants were 11 individuals with ASD and 8 with typical development. Participants with ASD were recruited from a local non-public school for children with ASD. Participants without ASD were recruited through personal contacts. Only children whose parents provided signed informed consent, who also provided their own assent to participate, and who met the inclusion criteria participated in the study. Inclusion criteria for the participants with ASD were: 1) having a documented diagnosis of an autism spectrum disorder from a medical professional, as recorded on school records; 2) being between the ages of 6 and 21, inclusive; 3) having parental (or primary caregiver) permission to participate in the investigation; and 4) providing their own assent to participate (if under the age of 18) or written consent to participate (if over the age of 18). Inclusion criteria for the participants with typical development were: 1) having no reported and/or documented history of any type of disability; 2) having parental (or primary caregiver) permission to participate in the investigation; and 3) giving their own assent to participate (if under the age of 18) or written consent to participate (if over the age of 18).

Participants with ASD ranged in age from 8;11 to 17;10 years. All but one had moderate to severe limitations in receptive vocabulary, as indicated by standard scores in the range of 20-63 on the Peabody Picture Vocabulary Test – IV (PPVT-IV; Dunn & Dunn, 2007); one individual with ASD had a receptive vocabulary score within normal limits. We opted to retain this individual in the sample because visual inspection of the data indicated his eye gaze patterns were no different from the others with ASD, that is, his measures were not outliers, but rather were consistently within the range of measures. All of the participants with ASD had significant expressive limitations documented via school-based testing in their school and academic records; and used various forms of augmentative and alternative communication (AAC) as their primary form of expressive communication.

Matching across the groups of participants was based on chronological age. Chronological age matching was conducted because the study aimed to inform future interventions that might use videogame play as a context for interventions targeting friendships among same-aged peers. Therefore, it was important to determine if the visual attention of adolescents with autism to the videogames was similar or different from the attention of the peers with whom they might be playing, and making friends. There was at least one participant without ASD for every age (in years) of the participants with ASD.

Materials and Stimuli Development

One video game play clip involving the LEGO Marvel Superheroes videogame were captured using a Microsoft Xbox One. The picture-in-picture clip with the players face and the game play was captured with an additional, application, Twitch. Twitch is an application the allows video game players to broadcast their gameplay sessions using a picture-in-picture format. The viewer of the Twitch stream is able to see both the game play and the face of the game player. The Twitch stream of the game player for the current project was recorded using the screen recording feature in Apple QuickTime (see Figure 1). The QuickTime recording was then saved and uploaded into the eyetracking software for data collection.
General Procedure

Each participant engaged in one eye tracking data collection session. During this session the participant was calibrated with the eye tracking equipment using a two-point gaze fixation procedure in which the participant was directed to look to the top left and then the bottom right corner of the screen by the presence of a familiar cartoon character. Once proper calibration was achieved, each participant watched the prerecorded videogame play clip that contained the picture-in-picture video inset of the player’s reactions to the videogame. There were no additional sessions and repeated viewing of the video was not allowed.

The Tobii T60 and the software Tobii Eye Tracking Studio tracked participants’ eye movements. The Tobii T60 captures the movements via infrared light that is projected from the top strip of the monitor. The infrared light bounces off of the participant’s eyeball and these reflections are recorded by detectors along the bottom strip of the monitor. Using the participant’s distance from the monitor, the curvature of the cornea, and the location of the pupil, the system derives coordinates for the gaze location at each sample taken. The Tobii captures six samples of eye position per second (1 every 16 ms). The Tobii was connected to a Dell laptop where all of the data were stored within the Tobii software on the computer.

Data collection setting

All data were collected in a small room designated for the research activity. The room contained a table, the Tobii machine, the Dell laptop, and chairs. Participants were scheduled for 15-minute sessions, which was sufficient for watching the clips and for transition to the data collection room and back to the classroom. Each participant sat in a chair 65 cm from the Tobii T60 screen located on top of the table. The researchers sat to the side of the participant in front of the Dell computer in order to start the video, as well as observe and monitor the participant during the viewing task. For the participants...
with ASD, the data collection session occurred at their school during school hours. For the participants without ASD, data were collected in a laboratory setting on a university campus.

Data Preparation

The Tobii software program was used to create “areas of interest,” that is, to enclose the areas on the screen in which actions or events meaningful to the videogame play. Figure 2 illustrates one frame from the videogame, with the areas of interest (AOIs) illustrated. The primary research question in this study concerned whether or not participants with ASD referenced the real-time video of the videogame player during the videogame play. Therefore, one main area AOI was the square enclosing the picture-in-picture video stream in the lower right corner of the screen (labeled “face” in Figure 2). For the secondary research question, other AOIs related to other meaningful events were evaluated. These included Action Scene (the actual action being engaged in by the Lego character being controlled by the player), Big A (a large “A” shape that the character had to climb during the videogame), Dialog (the written set of instructions that scrolled along the bottom of the screen), and Life (the indicator of how much life the character had remaining). All other areas in the videogame that were not enclosed in the defined AOIs were treated as “Other”.

Dependent Measures

The dependent measure was the proportion of each participant’s own total fixation time allocated to each of the defined AOIs, and to “other”. For each participant we first derived the total time spent fixated anywhere on the videogame, and then calculated the proportion of that amount of time spent fixating on each of the AOIs. Fixations were defined as gaze that dwelled within a 35-pixel area for at least 100 milliseconds (6 or more samples), using the default filter settings on the Tobii Studio software. Data were analyzed for those participants who were calibrated and for whom more than 33% of the samples were obtained over the course of the session. Of the 13 children with ASD who participated in the eye tracking data collection sessions, usable data were collected and analyzed from 11 of them.
The proportion of time allocated to each AOI was calculated based on each participant’s own time spent fixated anywhere on the screen, rather than the total possible viewing time. The clip was 160.38 seconds in length, however, no participant showed fixations for that entire period; gaps in fixation can occur for any number of reasons, including saccades, blinks, looks away from the screen, or presence of stereotypic behaviors that momentarily occlude the infrared recording (e.g., bringing a hand to the face). Previous eyetracking research with individuals with ASD and concomitant intellectual disability indicated that the overall amount of time spent fixated, anywhere on the screen, can be significantly less for individuals with ASD than for those with typical development (Wilkinson & Light, 2014). In the current study, the individuals with ASD spent a mean of 120.12 seconds fixated on the screen, while the matched peers spent a mean of 153.78 seconds fixated on the screen. Independent samples Mann-Whitney U statistic confirmed this difference was of statistical significance (U = 70, p = .033). Logic dictates an individual with a lower overall fixation time will also spend shorter times fixated on any given element, thus potentially compromising comparison across individuals if the absolute time values are used. Proportion of attention allocation was therefore calculated to reflect the allocation of attention to different elements relative to each individual’s own total fixation time.

Results

Five separate one-way analysis of variance (ANOVA) comparisons were calculated on participants’ visual attention patterns to each of the established AOI. The analysis was significant for the AOI of Dialog, p = .023. Visual attention patterns between the groups of participants were similar (i.e., did not yield statistically significant outcomes) for the other four AOI (see Figure 3). That is, visual attention patterns were not significantly different for Action, p = .377; Big A, p = .974; Face, p = .924; or Life, p = .850.
Discussion

The current study used automated eyetracking technology, to investigate visual attention of individuals with and without ASD to a videogame stimulus. We examined visual attention to a videogame stimulus because videogames appear to offer a uniquely well-suited environment for the emergence of friendships. The results of the current study indicated the participants with and without ASD visually attended to the videogame stimulus similarly for all but one variable analyzed. The only variable with a significantly different pattern of visual attention between the groups was the text-based instructions/dialog. This could be a significant finding as text is frequently used within videogames to direct players and to provide information regarding how to move through the game and make progress. The differences between groups for this variable could be related to differences in literacy skill between the two groups. Many, if not all, of the participants with ASD were nonliterate, and all of the participants without ASD were literate. In an actual gameplay situation or intervention, this discrepancy between the groups could imply a need for careful game choice, in terms of familiarity with the game, or the need for the literate partner to read the text to the nonliterate partner.

The overall similarity in the results between the groups is very promising for the use of videogames as a context for friendship-based interventions and interactions. Overall, the participants with and without ASD attended to the same features of the game with similar levels of intensity and frequency. This appears to indicate the two groups are following the actions of the characters and the progression of the videogame story similarly. This could mean the two groups would also play videogames similarly, but this needs to be investigated further.

Important implications for individuals with ASD are related to the complexity of the videogame stimuli used in the current investigation, the chronological age matching procedures used for the comparison grout and the contrasting findings to previous eye tracking research involving participants with ASD. First, the videogame stimuli used for data collection in the current study were socially complex. The similarity of the findings in the picture-in-picture condition indicate that, in this situation, with this stimuli, individuals with ASD socially oriented and alternated their gaze between a human face and the game play scene similarly to their non-ASD peers. This is a significant finding as the face in the picture-
in-picture condition was a human, and not the human-like LEGO figures that were featured in the other stimuli clips used in this investigation. This may suggest something unique about the way individuals with ASD process and participate with people during videogame play.

Limitations and Future Directions

The current study has several recognized limitations. This study was limited to twenty individuals, twelve with ASD and eight typically developing. This study only recruited participants with ASD from one school in central Pennsylvania, leaving very similar demographic profiles, which may limit generalization. Only individuals between the ages of 6 and 21 participated, which did not permit the study of young children, or older adults. The participants only watched one video game (LEGO Marvel Superheroes), not allowing examination of visual attention patterns for other types of videogames. All participants sat in a chair facing the Tobii T60 screen located on top of the table while researchers sat to the side of the participant to reduce distractions. And lastly, only participants for whom the Tobii system had captured 50% or more of their fixations were used for the data analysis, removing some individuals from the study.

The results of the current study demonstrated individuals with ASD visually attend to videogame stimuli similarly to typically developing individuals during passive viewing of a video game play clip, however this research must be expanded to determine whether or not videogames are played similarly by children with and without ASD. Future studies should investigate how children with and without ASD physically play videogames, alone and with a play partner. Attending to, and playing video games are two different tasks and need to be studied separately. A longitudinal study that observes how children with ASD play video games together as well as interact as they play could be helpful in providing insight as to how the nature of friendship is affected by ASD and can be facilitated through a mutually motivating activity, such as videogaming.

References


Abstract
To integrate gaming and physical activity among youth (ages 13 and 14), activity monitors were used to track 42 participants’ physical activity throughout the day and in-turn integrate activity information into a virtual game world. In this analysis of Fitbit data logs, random-effects growth curve analyses were used to model the general activity trend. A two-phase model is introduced that explores how activity changes before versus after the game. This quantitative analysis of activity trends is interpreted using participant interviews. The paper concludes by making the case that game and physical data analytics necessitate complimentary qualitative analyses.

Introduction & Research Questions
A decade ago, games research diverged into two strands. In the first, scholars like James Gee focused on the positive affordances of videogames for learning and engagement (e.g., Gee, 2003; Shaffer, 2006; Squire & Jenkins, 2003). In the second, health and human development scientists explored the possible negative effects of videogames (e.g., Tremblay & Willms, 2003; Vandewater, Shim, & Caplovitz, 2004). Today this divide remains largely intact, with researchers from these different approaches evaluating different questions: How do games affect kids minds? How do games affect kids health? In this research study, we reunite these research perspectives. Instead of asking how games can be more active, like exergames for Wii Fit, or focusing on the games that “sneakily” introduce health information, the current project designed an engaging exploration game called Terra that incorporates students’ daily physical activity — collected through wearable physical activity monitors — into a game.

This work fills a current gap in research and game design, as almost all exergames encourage players to move, but do not require players to consider how, when, or why they exercise and move actively. In order to integrate gaming and physical activity, activity monitors were used to track participants’ physical activity throughout the day and in-turn integrate activity information into a virtual game world. In the sense that our design allows users to keep track of physical activity, this study is not unique. We are drawing on the growing approach known as “Quantified Self” in which individuals track intensive personal data (Lee, 2013). Research on the “Quantified Self” promotes the use of wearable devices to track myriad health metrics that provide the user with a slew of data that can be employed in daily decision-making and long-term planning (Swan, 2009).

However, the Quantified Self approach alone is not necessarily enough to change behavior, at least
among children (Swan 2006). In contrast, games and video games can be a robust mechanism for transformative individual change (Bogost, 2011; McGonigal, 2011). This program integrates the activity data stream format Quantified Self into the transformative landscape of game play.

Evaluating the efficacy of this combination is an urgent concern. Since 1980s, childhood obesity has doubled from 7% to 18%, while the adolescent obesity rate has tripled, growing from 5% to 18% (Ogden, et al, 2012). This issue creates far-reaching consequences in light of the predictive relationship between obesity and dangerous metabolic and lifestyle-driven diseases later in life. Such diseases currently account for nearly 70% of deaths in the United States (Kung et al., 2008; Reilly & Kelly, 2011). This study will not directly evaluate interventions on childhood health. But, by exploring how something youth already do — play games — can better promote what youth should do more — move and get active — we offer insight into one avenue for change.

In the analyses below we explore general trends in the activity patterns among and between participants. This analysis builds on established growth curve modeling techniques for longitudinal data (Singer & Willet, 2003). These analyses were informed by analyses of interviews and focus groups with participants and learning ecology analyses (Stewart, Hagood, & Carter Ching, in press). We address the following research questions about general use trends and the impact of introducing a physical activity monitor game:

1. What is the general trend of activity among participants?
2. How does activity rate (i.e. steps taken) change after the introduction of the accompanying game?

Research Design

Sample

This study included a sample of 42 middle school students. Participants comprised middle school students at an average sized public school located in a small Northern California town near a large research university. The participants were equally split between two periods of an educational technologies elective course taught by the same instructor (Period 1 = 22, Period 2 = 20).

The individuals’ age, gender, and ethnicity are reported here. Participants’ ages were ages 13 and 14 (Mage = 13.7, SD = .55). Both classes enrolled mostly male students; thus participants include mostly boys, with boys making up 83% (N = 35) and girls 17% (N = 7). The self-reported ethnicity of the participants was 48% Caucasian, 17% Latino/a, 12% Asian, 5% Native American, and 2% African American, with 11% of the students not reporting their ethnicity. Note that 2% of this sample is equal to one participant.

Data Collection

In this project participants utilized activity monitors that tracked the number of steps taken and activity intensity (the latter was deemed unreliable). As the dashed boxes in Figure 1 show, participants wore the activity monitors for 30 days before the introduction of Terra, a tile-turning, planetary exploration
game. The participants then continued wearing activity monitors for another 60 days while playing *Terra* several times each week. During the period of data collection students participated in the game development process, giving feedback and suggestions to the game designers. Play took place as an in-class activity, students were encouraged but not obligated to play. All activity and game data were collected passively as log data. Other personal information about the participants was collected through surveys and interviews.

![Timeline of Fitbit use, game introduction, and duration.](image)

Figure 1. Timeline of Fitbit use, game introduction, and duration.

Figure 2 shows *Terra*, the online browser-based game we designed. Players of *Terra* are space explorers who have landed on a desolate planet. They set up individual domed bases, with the goal of completely “terraforming” the planet so that more of their people can come live there. *Terra* downloads information from the Fitbit online database each time a player logs in. The game displays an “Energy” window that details how many game moves are possible each game day based on in-game metrics and steps. For example, for each 1,000 steps a player has taken the previous “real-world” day, they get one extra move in the game when they log on. The timescale of the game is compressed so that players get seven “*Terra*-days” for each real-world day, while playing a week’s worth of time in the game at each daily login activities like exploring terrain, planting and harvesting crops, building their base, or caring for creatures. As the game progresses, the landscape of the world that players create becomes an aggregate visual representation of their synced activity over the variable time frame of the game campaign, with each player’s landscape reflecting not only strategic in-game decisions but also the extent of their daily fitness.
Measures

Quantitative data were captured as passive measures through activity monitors and game logs. Since these are not psychological measures, we do not report psychometric properties like reliability and validity. A survey including several scales was used to collect additional participant data, especially demographic data. Below we introduce the variables of interest.

The primary outcome measure of interest is activity, measured the number of steps an individual takes. Steps were measured at an hourly level, then aggregated to the week level. Each weekly step observations represents the average steps a participant took each day that week, taking into account how frequently they used the device. The average number of daily steps (across weeks) is 6415 (SD = 3738).

Data Analysis Plan

Following established model building practice (Singer & Willet, 2003), we first fit several unconditional models. This process requires iteratively fitting and evaluating each model to identify the model that best describes game play over time (see Table 1). Model 1, the unconditional means model, allows us to partition the variance within and between individuals. Model 2, the unconditional growth model, provides a base rate of change over time. We also explored non-linear rates of change. Model 3 is like the unconditional growth model (Model 2), but adds quadratic time effects. This model explores how the introduction of the game mid-study could impact the number of steps taken.

Based on Models 1–3, and on interview reports, we next explored if two-phase models better described the patterns of activity throughout the study. Model 4A provides the two-phase growth model with linear
rates of change. While Model 4B fits the two-phase growth model with quadratic rates of change. In both Model 4A and Model 4B, separate coefficients were calculated for before the game was introduced (“BG”) and after the game play started (“AG”).

<table>
<thead>
<tr>
<th>Model</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>$\text{average steps}<em>{ij} = \gamma</em>{00} + \zeta_{0i} + \epsilon_{ij}$</td>
</tr>
<tr>
<td>Model 2</td>
<td>$\text{average steps}<em>{ij} = \gamma</em>{00} + \gamma_{10}\text{WEEK}<em>{ij} + (\zeta</em>{0i} + \zeta_{1i}\text{WEEK}<em>{ij} + \epsilon</em>{ij})$</td>
</tr>
<tr>
<td>Model 3</td>
<td>$\text{average steps}<em>{ij} = \gamma</em>{00} + \gamma_{10}\text{WEEK}<em>{ij} + \gamma</em>{20}\text{WEEK}^2_{ij} + (\zeta_{0i} + \zeta_{1i}\text{WEEK}<em>{ij} + \zeta</em>{2i}\text{WEEK}^2_{ij} + \epsilon_{ij})$</td>
</tr>
<tr>
<td>Model 4A</td>
<td>$\text{average steps}<em>{ij} = \gamma</em>{00} + \gamma_{10}\text{BG.WEEK}<em>{ij} + \gamma</em>{20}\text{AG.WEEK}<em>{ij} + (\zeta</em>{0i} + \zeta_{1i}\text{BG.WEEK}<em>{ij} + \zeta</em>{2i}\text{AG.WEEK}<em>{ij} + \epsilon</em>{ij})$</td>
</tr>
<tr>
<td>Model 4B</td>
<td>$\text{average steps}<em>{ij} = \gamma</em>{00} + \gamma_{10}\text{BG.WEEK}<em>{ij} + \gamma</em>{20}\text{AG.WEEK}<em>{ij} + \gamma</em>{30}\text{AG.WEEK}^2_{ij} + (\zeta_{0i} + \zeta_{1i}\text{BG.WEEK}<em>{ij} + \zeta</em>{2i}\text{AG.WEEK}^2_{ij} + \epsilon_{ij})$</td>
</tr>
</tbody>
</table>

Table 1. Taxonomy of models followed to identify best fit.

Missing Data

The outcome variable of interest, steps, has missing values. Based on interview data we can conceptualize missingness for the steps, when 0 is recorded for steps, as made up of two parts. First a zero might be recorded when the participants chose not to use their fitbits. The second is when the fitbit deleted records because it was not syncing frequently enough. Based on our interviews we believe the latter case is missing completely at random. However, the former, missing step data based on disuse is likely related to engagement. At best, some other predictors in our model may predict this type of randomness. At worst, these data are not missing at random.

To improve this situation, we created a use frequency variable which creates a binary variable noting when daily steps as is zero and non-zero. This variable also includes missing data, but they are missing due to technical errors. We also evaluated multiple imputation techniques for dealing with missingness in other predictor variables, however, more than 5% of the survey data that would be used for multiple imputation was also missing. Since the amount of missing data exceeds the is a recommended threshold for imputing values (Graham, 2009), we did not complete multiple imputation. Later in the discussion we return to the concept of missingness, and explore how missing data in game and physical data analytics necessitates companion qualitative data.

Results & Interpretation

The first research question explores the general trend of activity among participants. To address this question we compare the models to determine best fit. It is important to note that Model 1 outlines the unconditional means model, which describes the initial variation among participants. This model is useful in that it partitions the variation among and between individuals, using the intraclass correlation coefficient (ICC). The ICC in this case is .65, meaning that 65% of the total variation in average daily steps is attributable to differences among participants. Model 1 also sets a baseline AIC and BIC our goodness-of-fit indices to compare among the Models (lower AIC and BIC are preferred).
Next, as shown in Table 2, it is unclear if Model 2 or Model 3 best represents the general trend in activity. Based on descriptive data visualization we suspected a non-linear model would fit best. However, neither Model 2 (linear change) nor Model 3 (quadratic change) offered meaningfully lower AIC or BIC. Thus, we moved to evaluating a two-phase model. In the two-phase model BG coefficients indicate coefficients for weeks occurring before the game was introduced, while AG coefficients indicate second phase weeks occurring after participants started playing the game. In both Model 4A and Model 4B the intercept and AG linear change are significant. However, the addition of quadratic effects reduces (i.e. improves) the AIC in Model 4B, but not BIC. Thus, either of the Model 4s could arguably be interpret as best fitting our data. One note is that Model 4B does not converge when including a random-effect for the after-game quadratic effect (AG Week^2), thus this term is not included in the model.

So, regarding the first hypothesis—what is the general trend of activity among participants—a two-phase model separating before- and after-game effects is better than a single phase model. But, among two-phase models, modeling time as linear or quadratic offers similar results. Figure 3 shows the average trend line in the two-phase model.

![Figure 3. Two-phase model: average steps over time.](image)

The two-phase models (Modes l4A and 4B) address the second research question—how activity relates to the introduction of the game. Since a two-phase model better describes the trends than a one-phase model, this indicates that something is different before- and after-game. Considering Model 4B, we see that the average number of daily steps taken in the first week of the study is 6787. In the weeks of the before-game phase, individuals took less steps each week. The decrease in steps became less sever in each subsequent week. Then, after the game is introduced, participants took 6082 steps daily and this average declined by 1131 daily steps each subsequent week. So overall, we found that each phase of the study began with interest and then declined. But the weekly decline was smaller each subsequent week. Figure 3 shows the predicted trend of average daily steps by week.
Table 2. Hierarchical growth curve results.

### One Phase Models

<table>
<thead>
<tr>
<th>Term</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4A</th>
<th>Model 4A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8028**</td>
<td>7228**</td>
<td>6555**</td>
<td>6686**</td>
<td>6787**</td>
</tr>
<tr>
<td>(368)</td>
<td>(490)</td>
<td>(509)</td>
<td></td>
<td>(467)</td>
<td>(5484)</td>
</tr>
<tr>
<td>Week (Linear)</td>
<td>-141*</td>
<td>238</td>
<td></td>
<td>-426</td>
<td>-705*</td>
</tr>
<tr>
<td>(63)</td>
<td></td>
<td>(154)</td>
<td></td>
<td>(375)</td>
<td>(223)</td>
</tr>
<tr>
<td>Week (Quadratic)</td>
<td>33*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(12)</td>
<td></td>
<td></td>
<td></td>
<td>(27)</td>
</tr>
</tbody>
</table>

### Two Phase Models

<table>
<thead>
<tr>
<th>Term</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4A</th>
<th>Model 4A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td></td>
<td>6555**</td>
<td>6787**</td>
</tr>
<tr>
<td>(368)</td>
<td></td>
<td></td>
<td></td>
<td>(467)</td>
<td>(5484)</td>
</tr>
<tr>
<td>BG Week (Linear)</td>
<td>117</td>
<td></td>
<td>-426</td>
<td>-426</td>
<td>-705*</td>
</tr>
<tr>
<td>(119)</td>
<td></td>
<td></td>
<td>(375)</td>
<td>(375)</td>
<td>(223)</td>
</tr>
<tr>
<td>BG Week (Quadratic)</td>
<td>12</td>
<td></td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(74)</td>
<td></td>
</tr>
<tr>
<td>AG Week (Linear)</td>
<td>-403**</td>
<td></td>
<td></td>
<td>-403**</td>
<td>-705*</td>
</tr>
<tr>
<td>(101)</td>
<td></td>
<td></td>
<td></td>
<td>(101)</td>
<td>(223)</td>
</tr>
<tr>
<td>AG Week (Quadratic)</td>
<td>37</td>
<td></td>
<td></td>
<td>37</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(27)</td>
<td></td>
</tr>
</tbody>
</table>

### Variance

<table>
<thead>
<tr>
<th>Term</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4A</th>
<th>Model 4A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within-person</td>
<td>4.62E6</td>
<td>6.83E6</td>
<td>6.18E6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In initial status</td>
<td>8.42E6</td>
<td>7.52E6</td>
<td>6.99E6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear Slope</td>
<td>9.79E4</td>
<td>4.33E5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadratic Slope</td>
<td>2.09E3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariance</td>
<td>-6.56E5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariance</td>
<td>9.67E3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariance</td>
<td>-2.62E4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Goodness-of-fit

<table>
<thead>
<tr>
<th>Term</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4A</th>
<th>Model 4A</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIC</td>
<td>8028</td>
<td>7994</td>
<td>7983</td>
<td>7972</td>
<td>7968</td>
</tr>
<tr>
<td>BIC</td>
<td>8040</td>
<td>8018</td>
<td>8023</td>
<td>8013</td>
<td>8033</td>
</tr>
</tbody>
</table>

** p < .001; * p < .05

Discussion

Answering the Research Questions

The answer to the first research question: What is the general trend of activity among participants? Is that there are two distinguishable phases in activity rates, one before the game is introduced and one after the game is introduced (see Models 4A, 4B and Figure 3). Regarding the second research question: How does the activity rate (i.e. steps taken) change after the introduction of the game Terra? As Figure 3 shows, before the game the youth record less steps on their fitbits over time. However, there is a resurgence of step activity during the week when the game is introduced, but this peak return quickly to the pre-game level of activity and subsequently decreases more.

One major concern for these analyses are that the data are not necessarily missing at random. This
was discussed previously, but it should be noted that future iterations of this project should keep this issue in mind in the design process. Especially because the missing data due to technical problems adds measurement error to “use rate.” Future models including should include the use-rate variable to account for missing at random data.

The activity level measured by steps in this study varies greatly between individuals (see Figure 5). This observation is confirmed by the ICC value that of the total variation in average daily steps, 65% is attributable to differences among participants. Future work with these data should explore between-participant variables to explain this difference. Further extensions of the present study will evaluate within-participant and time-varying predictors that better predict the number of steps taken. Currently, we have only evaluated uncontrolled models, but a controlled effects model could answer future research questions like: What predicts the rate of change before the game is introduced versus after the game is introduced?

The Argument for Companion Qualitative Analyses

Toward the end of the study we also conducted individual interviews and focus groups with a subset of students (see Figure 1 for timeline); approximately 50% of students participated in both classes. In these conversations we asked students to recollect and describe their experiences wearing the Fitbits and playing Terra throughout the duration of the project: at the beginning (when they first received the devices), when we introduced Terra, and what researchers conducting the conversations referred to as “now” (i.e., in the fourth month, when focus groups and interviews took place). Students described diachronic reflections, comparing experiences across time between “then” and “now,” which we can then examine relative to the quantitative model depicted in Figure 3.

What emerged from that analysis (which we do not have the space to delve into fully, beyond general themes), is that while many students describe an initial surge of interest followed by a decrease in game engagement and device wear, both of which correspond to the spike and subsequent decrease in steps and patterns of “missingness” in the latter portions of the quantitative model, there were some fairly different categories of reasons students described for their disengagement in particular. In the following excerpt Gabriel suggests that anxiety around having to be responsible for the device resulted in his decreased interest:

Sara: At first, how often were you wearing it?

Gabriel: At first I was wearing it all the time.

Sara: And now how often would you say you’re wearing it?

Gabriel: I don’t really wear it at all anymore.

Sara: So what changed for you?

Gabriel: Well, I would be always like losing it, or I’m thinking it’s lost and then it’s not, and I didn’t want to break it…(pause). I have it somewhere.

Students also described a decrease in social motivation to wear the Fitbit at school, wherein at first it was a symbol of “specialness” that generated peer interest but ultimately became mundane and unnoticed.
Other students described frustration with occasional bugs in the game that prevented syncing their devices, or frustration with inaccuracies in how the device measured movement, or frustrations with poor alignment between their chosen physical activity (e.g., swimming) and the form factor of the device. Still others became bored with various aspects of the game over time.

What these different themes show is that “missing data” or “decreased engagement” are not all the same, and it is dangerous to ascribe the same meanings to similar data patterns across individuals. Studies of pedometer interventions in health research tend to explain missing data as “non-compliance” or “failure of fidelity,” but few deeply examine participant meanings around their devices and their data. Our ongoing goal is to find ways of combining quantitative and qualitative data to provide a better picture of what we can see in this study of physical activity monitor gaming.

Acknowledgments

This research is funded by grants from the National Science Foundation IIS-1451446 and IIS-1217317.

References


7.

Game-Based Learning for Identity Change

Aroutis Foster (Drexel University), Mamta Shah (Drexel University), & Amanda Barany (Drexel University)

Abstract

This study examined the extent to which a game, Land Science (LS), afforded identity change opportunities as defined by Projective Reflection (PR). PR served as a theoretical lens to analyze the design of LS and existing logged and intact data for 16 high school participants. Preliminary analyses indicated that LS met the intended design goals of supporting students’ knowledge gain for urban science and scientific modeling. Identity change was partially met as impacting students’ content knowledge. LS did not afford opportunities for learners to explore multiple science identities, set personal goals within the learning environment, or establish personal relevance to game experiences. Hence, it was unclear whether participants valued the experience and content as personally significant to their future goals. Implications are discussed for advancing knowledge in the field about educational gaming for changing students’ science identities.

Learning in the 21st Century and Identity Change

The context of learning in the 21st century heightens the need for educators and designers to develop curricula and learning environments that facilitate students’ foundational knowledge, meta knowledge, and humanistic knowledge (Kereluik et al, 2013). It also requires that learners develop trans-disciplinary skills such as abstracting, patterning, and synthesizing (Mishra, Koehler, & Henriksen, 2011). Additionally, discussions of 21st century knowledge and skills emphasize the importance of reflexive self-reconstruction strategies to meet the needs of an increasingly globalized and technological society. As such, a focus on facilitating students’ abilities to explore and form identities (e.g. exploring who they are or who they want to become) has gained prevalence in the 21st century (Kaplan & Flum, 2012). Guiding students in trying out different identities as they engage in learning, and simultaneously promoting student agency, may be a crucial educational goal for facilitating student engagement with academic material and the development of aforementioned knowledge and skills. Furthermore, curricula designed to enable identity exploration in students may prove useful, especially in light of the new and developing careers of the 21st century for which student preparation and mentorship may be limited or unavailable.
Game-based learning and Identity Change

As immersive digital environments, games have the potential to further the development of students’ long-term interests in educational content. Games can influence players’ identity exploration and change processes by illuminating the personal relevance and utility of information beyond school settings (Foster, 2008). For instance, a study of engineering virtual internships Nephrotex and Rescushell by Chesler and colleagues (2015), demonstrates how games can offer authentic virtual environments that emulate professional settings, thereby facilitating player acquisition of situated content knowledge and exploration of domain-related identities. Such affordances might serve as motivators for students to consider career domains with limited acquisition rates, or those lacking positive social status among youth (i.e. careers in science, technology, engineering, and mathematics domains). Nonetheless, research examining identity exploration and change in a game-based learning context is still in its infancy.

Game-based learning research has explored the process of identity change as (a) the process by which individual learning develops within and across games (“the what of learning”), and (b) the ways in which learning is influenced by learner characteristics along biological, cognitive, experiential, and affective lines (“the who of learning”) (Foster, 2014). For example, Statecraft X is a game-based curriculum designed to develop the connection between citizenship and governance by encouraging players to act as citizens with a sense of national identity (via agency and social cohesion) (San Chee, 2013). Though research exists to illuminate some elements of identity change in game contexts, few studies have explored (c) the ecological context of learning (“the where of learning”), or (d) the inevitable shift in the frame of learning as a player changes (however inconspicuously) over time (“the when of learning”) (Alexander, Schallert, & Reynolds, 2009). Given the clear affordances of games as contexts for identity exploration, some research exists to explore the effects of games on player identity change, though examples of this line of research are less prevalent. Notably, Chesler and colleagues’ (2013) study of epistemic games offers insight into players’ developing epistemic frames as ways of thinking, valuing, and knowing about professional engineering praxis.

Existing research on identity exploration focuses primarily on projective identities, defined as identities that stem from the comingling of real self and virtual self in a game space. Theoretical discussions of projective identities depict identity as both a singular and temporary development (Gee, 2007). Other identity researchers expand on this concept, positing that identity and context are continually in flux, subject to construction or reconstruction as the situational context (i.e. game play) evolves and develops (Sinai, Kaplan, & Flum, 2012). As a learner engages in identity exploration over a significant period of time, the temporary nature of projective identities fades as learners experience what Markus & Nurius (1986) call possible selves. Possible selves comprise of the desired selves we would like to become and/or the feared selves we wish to avoid. The development of possible selves in a game context is influenced by (a) students’ prior knowledge and perceived competence, (b) students’ social networks, which can influence interest development as a given domain gains acceptance among peers (Oyserman & James, 2011), and (c) opportunities to identify with available domain examples to see themselves in a given role and develop knowledge in the domain (Foster, 2008). The facilitation of long-term identity change also necessitates intentional student reflection on a starting self, through possible selves, and on the new self that emerges at the end of a game experience, which must be measured across long periods of time (Foster, 2014).

Given the emergent landscape of identity research in a game-based learning context, we argue for the
need for a unified approach for examining how games facilitate identity change. We propose the use of Projective Reflection as a theoretical framework for analysis (Foster, 2014; Foster & Shah, 2016).

Theoretical Framework

Projective Reflection is a theory and a process of identity change in immersive virtual environments (Foster, 2012; 2014). Projective Reflection is defined as “the process by which a person engaging in digital gameplay or in a virtual environment constructs and/or enacts an identity in the game/virtual environment that has the potential to modify the person’s possible/future self and lead to a new sense of identity in a domain” (Foster, 2012; 2014). We are examining Projective Reflection as a process to facilitate identity exploration in an intentional way. To do this, we built on the modified the Dynamic Systems Model of Role Identity (DSMRI) developed by Kaplan, Sinai & Flum (2014) that focuses on identity exploration using four constructs: a) ontological and epistemological beliefs, b) action possibilities, c) purpose goals, and d) self-perception and definition of self. The Projective Reflection model operationalizes the DSMRI constructs in a game-based learning experience as a) content knowledge and game and technical literacy, b) regulated action, c) interest and valuing, and d) self-perception and definition of self, respectively, thus serving as a comprehensive lens to frame identity exploration, the precursor to identity change.

To develop a more fine-grained understanding of identity change along these four constructs, we consider changes over time in a) what the learner knows – current knowledge, b) what the learner cares about – self and interest/valuing, c) what/who the learner expects to be throughout the virtual experience and long term- future self, d) what the learners wants to be – possible self, e) how the learner thinks – self and interest, and f) how the learner sees him/herself – self-perception and self definition. We map these questions to the four modified DSMRI constructs described above, resulting in detailed descriptive player cases that can track how an individual changes in relation to content knowledge, game and technical literacy, regulated action, self-perception and definition of self, and interests and valuing, as a result of engagement in the learning environment. It is this tracking of identity exploration as incremental changes in these constructs over time, culminating at a particular end point typically defined by teacher or learning goals, that we refer to as identity change. Thus, Projective Reflection helps us describe learning as identity change in terms of opportunities for identity exploration, and changes in learners’ knowledge, attitudes, regulation of actions, self-perceptions, interests, and valuing in relation to specific/targeted domains and in an intentional manner. Projective Reflection is facilitated by an instructor through the play-based pedagogical model Play Curricular activity Reflection Discussion (PCaRD) (See Foster & Shah (2015) for more information). In this paper, we examined the following research question: “To what extent does the design of a virtual learning environment/game, namely Land Science, facilitate identity change?”

Methods

This investigation is part of a larger 5-year NSF project that aims to develop and test a process of supporting intentional identity exploration and change for students using immersive learning environments to learn science, and provide implications for designing and teaching in technological environments for learning as identity change (Foster, 2014). This paper reports initial findings from years 1 and 2 of the project. Years 1-2 involved investigating and characterizing the processes of identity change in known exemplary science games/virtual learning environments (EcoMUVE, Land Science,
and River City) that aims to facilitate a science identity for users. We used intact complete existing data from these environments in our studies. The process involved (1) analyzing the design of Land Science for identity change affordances, and (2) examining existing data from completed studies of participants using the game to learn science and explore science identities. A known limitation of using existing data is that we did not have access to the all elements of the play context or the conditions under which players were playing, thus some information relating to identity change maybe missing. The existing raw data we analyzed was obtained through partnerships with the host institutions for each environment. This paper reports preliminary findings for data shared by the Epistemic Games Group for the game Land Science.

Description of Land Science and Participants

The game Land Science was designed to offer players the opportunity to explore an urban science epistemic frame: the skills, knowledge, values, identity, and epistemology that an urban planner takes on as a part of the community of practice (Bagley & Shaffer, 2009). Players role-play as urban planning interns within a fictional firm, Regional Design Associates (RDA). Land Science is played in two phases, with each phase engaging learners in individual and group activities. Players obtain information and get familiarized with cognitive (e.g. proposal writing) and technical (e.g. iPlan) tools that will help them create a zoning map for the city of Lowell. In phase one, players learn about the city’s need for a new zoning plan. Four groups of players meet with a unique stakeholder group to learn about their concerns. They also perform virtual site visits and preference surveys, and create practice zoning maps in order to understand the extent to which the needs of the stakeholders they satisfied with could be reasonably addressed in proposing a new plan. In phase two, players are assigned new groups in which members come with knowledge of different stakeholders needs. In this phase, members of a team work together to meet the needs of all possible groups. They work together in team meetings to discuss how the stakeholders’ interests can be integrated to propose a well-rounded re-zoning proposal.

Participants consisted of 16 high-school students (8 female and 8 male) in northeastern United States. They completed Land Science over three days in April 2014 in an out-of-school setting. Prior to the start of the study, participants reported engaging in online activities such as watching videos, playing video games, and chatting on social networking platforms for about 4 hours a day.

Data Sources

The design of Land Science was analyzed to identify features that afforded identity change. Existing logged data from 16 students was collected from the game experience, consisting of intake and exit interviews, chat archives, notebook entries, and iPlan map images. Intake and exit interviews consisted of written responses to in-game survey questions pertaining to players’ technical and gaming literacy (i.e. online and game activities), knowledge of urban science, and the tools and skills required to act as an urban scientist. The chat feature archived all communication between participants, as well as conversations between participants and mentors during in-game team meetings. Notebook entry documents contained student responses to assigned tasks as part of the apprenticeship experience. Finally, iPlan map images were captured from the iPlan tool in Land Science, which allowed players to manipulate city zoning in the process of developing a re-zoning plan. Figure 2 depicts a screenshot of the Land Science interface.
Data analysis

Overall, game design features and participant data were coded using combined deductive (i.e., theory-guided) and inductive (i.e., data-guided) analyses for examining features the game that impact identity exploration in the content area. Deductive coding followed the theoretical definitions of the constructs of current selves, possible selves, regulated action, interest/valuing, and science knowledge. Inductive analysis involved the use of discourse analysis (Gee, 2011), and quantitative content analysis (Riffe, Lacy, & Fico, 2014) for characterizing design principles. A computer algorithm was created that made it possible to streamline the large datasets of participant responses from the pre-post data and worksheets into a single table to simplify the discourse analysis process.

Existing data was examined for all 16 participants in terms of the changes in what they know, what they care about, what they expect to be, how they think, how they see themselves and what they want or would like to be in terms of science related identities, before, during, and after playing the game. The changes were triangulated along the aforementioned parameters with the designed characteristics of the game. For instance, in order to understand the extent to which the game supported a participant’s knowledge (what they know), existing data from all sources were examined chronologically and as they occurred in the game (in-take interview, notebook entries, iPlan maps, chat archives, and exit interview). The changes in participants’ knowledge of urban science and scientific modeling (a complex process that allows urban scientists to assess how multiple factors within a system impact one another) before and after the game intervention was examined in relation to changes in a) procedural, declarative, and contextual knowledge, b) game and technical literacy, c) interest in science, d) valuing of science, and e) regulated action. This was repeated for understanding changes in a) how participants’ think, b) how participants’ see themselves, c) what participants’ expected to be, d) what participants’ care about, and e) what participants’ would like or want to be in terms of science related identities before and after playing the game. Statistical analysis was not possible due to the nature of data obtained from Land Science. Therefore, in-depth interpretive analysis was performed for all the participants. Together, this
analysis allowed us to track the extent to which LS afforded opportunities for identity change as defined by Projective Reflection (Foster, 2014).

Results

We report results for the extent to which the design of Land Science facilitated identity change. First, we report changes in participants’ learning for the whole group followed by a case that illustrates identity change based on the current game design.

Whole group findings

Overall, participants began the LS experience with some knowledge of urban science, often manifesting with a limited degree of specificity and with little awareness of declarative terms. For instance, student responses to intake questions revealed varying degrees of baseline interest in science and urban planning, with some students reporting no interest (i.e. “None”), and some reporting general interests (i.e. “I am interested in making cities as environmentally friendly as possible”). Though not explicitly prompted to do so, some students acknowledged the real-world importance of urban science topics in their in-game writing: “…All of these indicators are important to take into consideration because they are common impacts/aspects that come with a city.” Furthermore, all participants demonstrated implicit valuing of game content as they worked to empathize with stakeholders and address their needs. Throughout the LS experience, students demonstrated increasing knowledge and confidence in their communications using the discourse of urban science, particularly with regards to meeting stakeholder needs. Students were able to articulate and demonstrate nuanced understandings of stakeholders’ perspectives, discuss stakeholder conflicts and possible solutions with peers, and use game tools appropriately to assess and address those needs. Interpretive analysis also revealed that participants became increasingly confident in using their emerging knowledge to support peers and justify their own decisions, thus reinforcing our finding that LS offered a safe environment for learners. Nonetheless, despite the changes in participants’ knowledge of urban science, it was not clear if participants who completed Land Science experienced changes in their personal interest in science, what they wanted to be in terms of science related careers in the future, or if they valued the experience and the content as personally significant to their future goals.

Descriptive case: Anna (pseudonym)

Changes in what the participant knew and thought. Examples of changes in what Anna knew and thought manifested in terms of her science and content knowledge and game literacy, which are discussed below.

Science and content knowledge. Anna began the Land Science experience by demonstrating a general understanding of urban planning as a science career: “Urban planners use information such as data involving environment, housing, and population.” Anna’s responses demonstrated initial confidence in her understanding of the relationships between the variables in the scenario, and her ability to identify key information based on these relationships. For example, Anna recognized that toxic algae would influence the farms, and that information that can further detail the cause and effect of that relationship would further the development of a solution. However, Anna’s response at the outset involved the use
of non-specific terms to conceptualize a solution, such as damage, information, data, amounts, etc., indicating a lack of detailed knowledge on the subject. Anna’s understanding of science and urban planning concepts expanded in detail to include more elements of declarative knowledge as the play experience progressed. Summarizing her developing understanding of algae blooms after a virtual site visit, Anna wrote, “these algae blooms can cause a decline in different types of fish, and create invasive species,” showing increased understanding of the relationships between algae blooms and other specific environmental variables.

Anna’s written final plan in LS demonstrated a synthesis of her increasingly detailed knowledge of the relationships between specific urban science variables and her increasingly detailed declarative knowledge of science terms. Anna identified specific units of measurement (i.e. nesting sites) when discussing urban science variables, and recognized specific local species when discussing environmental interactions. After completing LS, Anna expressed enjoyment for the heightened understanding “about cities and how they’re constructed” that the game facilitated.

**Game/technical literacy.** As part of her intake survey, Anna indicated experience with social media platforms and online chat programs (i.e. Google chat), as well as music and video streaming sites. However, Anna stated that she did not engage in either video gaming or programming activities at the outset of the experience, suggesting a potentially limited level of technical and game literacy. Anna’s potential for limited technical literacy did not manifest in artifacts of her gameplay data, as she was able to leverage game tools with little exhibited difficulty to build detail into her existing understanding of urban science processes as gameplay progressed. Anna’s reflection on her use of the mapping tool (iPlan) further highlighted her ability to manipulate in-game elements to meet game goals:

> I came up with 9,200 for housing, which was near the target-goal for one of the stakeholder groups, as well as 52,000 jobs, which was also near another target number… I also needed to make sure that for my stakeholder group, the “unacceptable” values were not displayed, so I managed to stay below 36,000 for runoff, above 2,000 for birds, under 0.3 for CO, and under 0.4 for phosphorus.

Anna completed the Land Science activity with confident opinions about enjoyable elements of gameplay and ways to improve game design. She affirmed a desire for the game experience to facilitate “more interaction with other stakeholder groups instead of mainly focusing on one” as a way to improve her experience.

**Changes in what the participant cared about.** Examples of changes in what Anna cared about throughout the Land Science experience manifested in terms of her developing interest, valuing for urban science. As part of the intake interview, Anna responded to questions designed to explore her understanding of urban science topics. However, these questions did not prompt her to comment on her initial interest in the content or her perceived personal relevance of urban science. However, during the Land Science experience, the development of Anna’s relationship with the content often manifested through stated empathy with the needs of the fictional stakeholders (or the “clients” whose needs players must address). For example, when asked to describe the needs of her stakeholders in the group chat, Anna aligned her perspective with theirs:

> I was with the Lowell-Concord River Watershed Council: We basically only care about the environment: we want lower runoff, Carbon monoxide, phosphorus, and especially want to increase the number of Baltimore Orioles (birds) in the region.
In some instances, Anna affirmed the real-world utility of her activities. When discussing the competing variables that urban planners must manage in Land Science, Anna explained, “All of these indicators are important to take into consideration because they are common impacts/aspects that come with a city.” However, other examples of valuing primarily manifested when Anna emphasized the importance of pleasing stakeholders. Anna regularly used in-game content with potential value connections in her notebook entries and chats, but she did not explicitly affirm the real-world value of urban science content or connect urban science to her own values beyond the above statement. After completing Land Science, Anna stated, “I enjoy learning more about cities and how they’re constructed. I have a little interest in the environment.” Nonetheless, Anna was not guided in to conduct reflections about the personal relevance of her experience with Land Science.

**Changes in how the participant saw herself.** The intake interview, gameplay, and exit interview similarly did not prompt reflection on how Anna might have seen herself pursuing a career in science (urban science, environmental science and related fields). Hence, it is difficult to ascertain how Anna shifted in her perception of herself after her experience as an urban planning intern in Land Science. However, Anna made action-oriented and experiential statements that were self-referential as gameplay progressed. Examples include her use of, “I realized…” I felt that it was unrealistic…” “I faced the risk…” and “I found a way…” when describing her struggle to meet complex stakeholder needs. Anna’s self-referential statements suggest she viewed herself as active participant whose realizations, opinions, struggles, and successes have a role in shaping the game experience. Data from chat archives and notebook entries also revealed that Anna identified herself as a member of an urban planning team whose goal is to best represent the needs of stakeholders.

**Changes in what the participant expected to be and wanted to be.** We were unable to ascertain a shift in this aspect because information on participants’ career and future aspirations were not solicited before, during or after playing Land Science.

**Projective Significance**

Projective Reflection was used as the analytical lens to examine existing Land Science data. The Projective Reflection model was not used to inform the design of the game, curricular context, or data collection methods. As a science learning game, Land Science supports identity exploration in relation to some aspects of Projective Reflection by providing players with opportunities to model how urban planners work and think (Bagley & Shaffer, 2015). Our research question explored how the game facilitated the development of urban science identities as well as examining the extent to which elements of our theoretical framework for identity change are reflected in the data. This study is exploratory and the first of its kind given the emerging state of research examining identity change in games (Ecenbarger, 2014). Preliminary findings revealed that the current game design supported the development of declarative content knowledge and game/technical literacy. Participants also demonstrated engagement in the Land Science experience as learners invested in science. They developed empathy with stakeholders and an understanding of their needs. This can be attributed to designed features of LS for individual and social learning (peer and mentor support) throughout the experience. Through one participant’s responses, it became evident that the players may be able to identify with the role of an urban planning intern. However, the current design of the game did not afford opportunities for intentional role identification. Thus, such reflection appeared only spontaneously or implicitly. The participants also did not have opportunities to set and pursue personal goals given the game’s focus on urban science content. While inconsistent examples of intentional self-reflection exist,
the game design may have limited manifestations of player reflections on their self-perceptions and self-definations about developing science identities both in and beyond the game experience. By using the PR model to inform design, future games could connect with in game content to support systematic role identification beyond the game experience. Though Land Science was effective at triggering interest in game content, the extent to which players could see future selves investing further time in learning about urban science careers was not assessed. This could be attributed to the design of Land Science, which limited the number of possible selves participants could explore in relation to urban science (Markus & Nurius, 1986). The duration of Land Science may have further impacted findings for identity change among participants as suggested by researchers (Beier et al., 2012; Sinai et al., 2012). The findings of this study inform the design of games for supporting identity change in an intentional manner.

Acknowledgements

The project is supported by a National Science Foundation CAREER Award, titled CAREER: Projective Reflection: Learning as Identity Exploration within Games for Science. The primary investigator is Aroutis Foster, recipient of the NSF Faculty Early Career Development (CAREER) Program: DRL-1350707. All opinions and results are by the researchers and do not reflect the views of the National Science Foundation.

We extend a debt of gratitude to David Williamson Shaffer and his colleagues at the Epistemic Games Group for their partnership and support. It is through this partnership with the Epistemic Games Group at the University of Wisconsin-Madison that we were granted access to the game Land Science and existing raw game data. Land Science work at UW-Madison was funded in part by the National Science Foundation (DRL-0918409, DRL-0946372, DRL-1247262, DRL-1418288, DUE-0919347, DUE-1225885, EEC-1232656, EEC-1340402, REC-0347000), the MacArthur Foundation, the Spencer Foundation, the Wisconsin Alumni Research Foundation, and the Office of the Vice Chancellor for Research and Graduate Education at the University of Wisconsin-Madison. The opinions, findings, and conclusions do not reflect the views of the funding agencies, cooperating institutions, or other individuals.

References


How Music Affects Learning in a 3D Gaming Environment

An Experiment
Ryan L. Sittler (California University of Pennsylvania)

Abstract

This study examined the effects of music, in a 3D gaming environment, on educational achievement as measured by a series of criterion-referenced tests (identification, terminology, and comprehension). A sample of 81 undergraduate students, from a medium-sized public institution in western Pennsylvania, were recruited to take part in the experiment and then randomly assigned to one of three groups that each played a short educational game module about the human heart. Each group played an identical module save for the fact that one contained no music, one module included music by Mozart, and another allowed participants to self-select the music they would like to receive. They then each took a series of identical tests to ascertain performance. Results are discussed herein.

Introduction

The study of games as educational tools rarely examines the role, if any, that audio plays in the learning process. Specifically, music in game environments is even more rarely studied and little empirical evidence exists as to whether or not it affects learning outcomes (Zehnder & Lipscomb, 2006; Fassbender et al, 2012). Some researchers, however, have put forth ideas about how music may influence a learner while playing an educational game. In some instances these concepts are based on broader educational media research.

Gredler (2002) suggested that music may act as a distractor—this would interfere with information processing and negatively affect learning performance. Clark and Mayer (2008; 2012) support this notion by suggesting that extraneous auditory information reduces performance and therefore should be limited or eliminated. This may be due to overloading the system that deals with auditory information in working memory—this is referred to as the phonological loop. Working from the theoretical position of information processing—that humans have limited mental resources (Miller, 1956; Atkinson & Shiffrin, 1968; Lang, 2000)—it does make sense that music could interfere with learning. Other authors suggest that the research is not clear in this area and background music could positively affect a learners’ performance and improve learning outcomes (Bishop, Amankwatia, & Cates, 2008; Brown & Green, 2011).

Despite the dearth of empirical research on this topic specifically, there is evidence that music can be harnessed for positive learning effects. The colloquially named Mozart Effect, for example, showed that subjects listening to 10 minutes of Mozart’s Sonata for Two Pianos in D Major exhibited short
term improvement in performance of abstract and spatial reasoning tests (Rauscher, Shaw, & Ky, 1993). Other studies have since extended the research in this area and have determined that while music alone may not provide a desired outcome, specific types of music may work better than others in improving performance—particularly if the listener enjoys the musical selection (Nantais & Schellenberg, 1999; Ilie & Thompson, 2011). In short, certain songs in certain educational applications (such as a virtual game environment) can improve learning outcomes (Richards et al., 2008; Fassbender et al., 2012). Further, listening to music that a person enjoys—self-selecting per their own tastes—may lead to increased improvement.

This paper describes an experiment in which undergraduate students were taught about the human heart, in a 3D gaming environment, and then tested on different educational objectives that included facts, concepts, procedures, and principles (Merrill, 1983; Ragan & Smith, 2004). It utilized, with permission, a modified version of an existing instructional script and criterion-referenced tests based on the work of Dwyer & Lamberski (1977).

The overarching research question this study addresses is: what are the effects of audio, within a 3D gaming environment, on the achievement of different educational objectives? Based on theoretical knowledge of the subject, and information contained in the review of literature, this then leads to two hypotheses:

1. Participants that listen to Mozart’s *Sonata for Two Pianos in D Major* during their treatment will perform better on criterion-referenced tests than those that listen to silence.

2. Participants that listen to self-selected music during their treatment will perform better on criterion-referenced tests than those that listen to Mozart’s *Sonata for Two Pianos in D Major*.

**Method**

This study utilized a 1 X 3 factorial post-test only control experimental design (Cresswell, 2009). A pre-test was not used because the author did not want to provide the students with any leading information about the questions in the post-test. The independent variable was music at three levels: none, Mozart, and Self-Selected. Participants (*N* = 81) were recruited from undergraduate classes in the Department of Communications Media at Indiana University of Pennsylvania via an in-class presentation by the author. This included 43 males (53.1%) and 38 females (46.9%) aged 18 or older. 32 (39.5%) self-identified as gamers whereas 49 (60.5%) did not. Three participants (3.7%), all female, self-identified that they had more than three previous college level classes that taught information about the human heart—this question was asked to identify those with prior knowledge on the subject. Involvement was voluntary and food was offered as compensation for their time. Each subject was randomly placed into one of three separate groups: Control (*n* = 27), Mozart (*n* = 27), and Self-Selected (*n* = 27).

The members of each group worked in a computer lab that was equipped with a series of identical computers, software, and Encore AE-06 disposable stereo headphones. They each answered a series of demographic questions and then played a functionally identical short educational module, in a 3D gaming environment, which taught them facts, concepts, procedures, and principles of the human heart and its functions (see Figure 1).
The module opened with a brief introduction, from an NPC named Professor Hart, explaining that participants needed to wear headphones and adjust volume as needed, within a prescribed range, regardless of whether or not they were receiving music in their treatment. This was required to account for the sensory experience of wearing headphones as it could be a confounding variable—subjects were to be kept under similar conditions as much as possible. They were then familiarized with the interface and how to control it by pointing and clicking with the mouse. Some brief narrative action was included to help draw participants into the environment; they got to see some other NPC students in the virtual classroom, were instructed to take a seat, and some humor was used in the text to lighten the mood. The instructional script, which was broken into three sections (the parts of the heart, the circulation of blood through the heart, and the cycle of blood pressure in the heart), was delivered via the Professor Hart NPC and included facts, concepts, procedures, and principles of the human heart and its functions.

Participants had the option to repeat each section of the instructional script until they felt comfortable with the content. They then each took an identical battery of three criterion-referenced tests—identification, terminology, and comprehension. Each test contained 20 multiple-choice questions. The identification and terminology tests each included five potential answers for each question. The comprehension test included four potential answers for each question. The instructional script and tests were based on the work of Dwyer & Lamberski (1977).

Participants in the Control group wore headphones but received no audio treatment during their experience working through the module. Conversely, participants in the Mozart group listened to Mozart’s Sonata for Two Pianos in D Major and those in the Self-Selected group picked the music of their choice from Spotify. Subjects were not given a time limit but generally completed the module in 30 minutes or less. The study took place over three days as the lab was not big enough to include all participants at one time. Data were collected via the Qualtrics platform and analyzed using IBM SPSS.
version 22. Eight questions were eliminated post hoc—resulting in a 52 question test set—due to a Cronbach alpha coefficient of $\alpha = .64$. Items with negative inter-item correlation were dropped from each test. The resulting Cronbach alpha coefficient for the composite of tests was acceptable at $\alpha = .71$ (Pallant, 2013).

Results

Taking the three test sets as a composite score, the subjects in both the Control ($M = 14.59, SD = 5.37$) and Mozart ($M = 15.74, SD = 6.65$) groups performed better than those subjects in Self-Selected ($M = 11.67, SD = 4.04$). Mozart participants were the most successful overall. This was true of both the aggregate scores and the scores on the three individual identification, terminology, and comprehension tests (see Table 1).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>$\bar{x}$</th>
<th>SD</th>
<th>$\bar{x}$</th>
<th>SD</th>
<th>$\bar{x}$</th>
<th>SD</th>
<th>$\bar{x}$</th>
<th>SD</th>
<th>$\bar{x}$</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>27</td>
<td>5.70</td>
<td>2.83</td>
<td>4.44</td>
<td>2.76</td>
<td>4.44</td>
<td>2.45</td>
<td>14.59</td>
<td>5.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mozart</td>
<td>27</td>
<td>5.59</td>
<td>3.30</td>
<td>5.30</td>
<td>3.16</td>
<td>4.85</td>
<td>2.93</td>
<td>15.74</td>
<td>6.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Selected</td>
<td>27</td>
<td>3.85</td>
<td>2.27</td>
<td>3.64</td>
<td>1.66</td>
<td>4.19</td>
<td>1.84</td>
<td>11.67</td>
<td>4.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>81</td>
<td>5.05</td>
<td>2.92</td>
<td>4.46</td>
<td>2.67</td>
<td>4.49</td>
<td>2.43</td>
<td>14.00</td>
<td>5.66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 18 Items  
* 17 Items  
* 52 Items

Table 1. Subjects’ scores by test and aggregate.

A one-way between groups analysis of variance (ANOVA) was used to further examine the data. There was a statistically significant difference at the *$p < .05$ level on scores for the three groups: $F(2, 78) = 4.00, p = .02$. The effect size, calculated using eta squared, was .09. However, the difference in mean scores between each group was small (see Table 2).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>$\bar{x}$</th>
<th>SD</th>
<th>SE</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>27</td>
<td>14.59</td>
<td>5.37</td>
<td>1.03398</td>
<td>12.4672</td>
<td>16.7180</td>
<td>6.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Mozart</td>
<td>27</td>
<td>15.75</td>
<td>6.65</td>
<td>1.28057</td>
<td>13.1085</td>
<td>18.3730</td>
<td>7.00</td>
<td>39.00</td>
</tr>
<tr>
<td>Self-Selected</td>
<td>27</td>
<td>11.67</td>
<td>4.04</td>
<td>.77717</td>
<td>10.0692</td>
<td>13.2642</td>
<td>6.00</td>
<td>23.00</td>
</tr>
<tr>
<td>Total</td>
<td>81</td>
<td>14.00</td>
<td>5.66</td>
<td>.62903</td>
<td>12.7482</td>
<td>15.2518</td>
<td>6.00</td>
<td>39.00</td>
</tr>
</tbody>
</table>

Table 2. Scores in aggregate.

Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the Control ($M = 14.59, SD = 5.37$) was not significantly different from either the Mozart ($M = 15.75, SD = 6.65$) or Self-Selected ($M = 11.67, SD = 4.04$) groups. However, Mozart and Self-Selected did differ significantly at the *$p < .05$ level (see Table 3).
Table 3. Post-hoc comparisons.

Though not the main focus of this study, prior knowledge was assessed via a question in the demographic survey that each participant completed. In it, they were asked to self-identify if they had at least three prior college level courses that taught information about the human heart. Three female subjects indicated that they had. No males met this criterion. Taking the three test sets as a composite score, two females outperformed the average of others in their gender group (see Table 4). Likewise, though not a focus of this study, aggregate scores showed that females ($M = 15.21$, $SD = 6.71$) outperformed males ($M = 12.93$, $SD = 4.34$).

Table 4. Scores by participants self-identifying as having had more than three prior college classes that taught about the human heart.

Discussion

The overarching research question this study addresses is: what are the effects of audio, within a 3D gaming environment, on the achievement of different educational objectives? Specifically, two hypotheses were to be tested:

1. Participants that listen to Mozart’s Sonata for Two Pianos in D Major during their treatment will perform better on criterion-referenced tests than those that listen to silence.

2. Participants that listen to self-selected music during their treatment will perform better on
As evidenced by the data presented in this paper, there was not a statistically significant difference in participants’ achievement on criterion-referenced tests between the Control group (which received no music) and the Self-Selected group which listened to Mozart. Hypotheses 1 is not supported. Further, there was a statistically significant difference in participants’ achievement on criterion-referenced tests when comparing participants in the Mozart group and those in the Self-Selected group. However, the hypotheses predicted that Self-Selected would be more successful and that is not the case. Therefore, hypothesis 2 is not supported. Overall, the subjects that listened to Mozart had the highest mean score $\bar{x} = 15.74$ out of 52 questions (30.3%).

Limitations & Future Research

Overall, subjects performed poorly on each of the tests. This leads the author to believe that there was a fundamental problem with the design of the instructional module since it was the delivery—and not the assessments—that largely deviated from the original work on which this study was based. The highest performing group listened to Mozart and scored just 30.3% and the lowest performing group, Self-Selected, scored 22.4% ($\bar{x} = 11.67$ out of 52 questions). These scores are generally better than random guessing but still not impressive. A different pedagogical approach may have been more successful.

Prior knowledge was only assessed from the perspective of whether or not participants had extensive previous coursework on the human heart. A pre-test would have also been able to help better understand prior knowledge on the subject and is another avenue worth exploring in future research. Further, it is possible that the instructional approach used in this study would work better as a review activity as opposed to a way of introducing content. This is slightly hinted at in the data collected, but the sample size is too small to make any strong statements without further research being conducted.

Past research has suggested that as long as participants are listening to music that they enjoy, they should perform better on certain types of mental tests and exercises. The evidence here stands in opposition to that concept. One possible explanation for this is that subjects had to expend extra mental resources while choosing and selecting their music from Spotify. This is typically called decision fatigue. This could have caused more cognitive load for participants which ultimately interfered with their information processing abilities (Kalyuga, 2009). Additionally, as participants in the Self-Selected group were free to listen to the music of their choice, they may have inadvertently made a selection that impeded their ability to perform. This is due to the fact that they likely did not have a concept of what music may or may not help them in studying (e.g., choosing music with too much singing versus instrumentation, tempo, music they are familiar with versus something new). Indeed, some participants commented after the experiment that they did not enjoy the music they self-selected. When pressed as to why, they stated that the Spotify playlist was not as good as they anticipated. All of these problems may be avoided in the future by having subjects select music ahead of time, and ensuring that it is ready to play when they arrive for the experiment.

There were other confounds in this study that made it difficult to strike a balance between a pure lab setting and something that participants might experience in the real world. Noise-cancelling headphones, for example, may have mitigated the opportunity for background noise to interfere with information processing. Similarly, white noise could have been used—instead of silence—to establish baseline scores. All of these possibilities can be addressed in future research.

criterion-referenced tests than those that listen to Mozart’s *Sonata for Two Pianos in D Major*.
Acknowledgments

The author offers sincere thanks and appreciation to Dr. F.M. Dwyer for granting me permission to adapt his research for use in this context.

References


Gamification, Digital Game-Based Learning and Serious Games a Critical Literature Review

Rebecca Ly (University of Sydney)

Abstract

Over the last two decades gamification, digital game-based learning and serious games are areas that have been widely researched. And yet, in spite of this, the literature on gamification, serious games and digital game-based learning indicates a high degree of disagreement on the definitions for these aforementioned terms. This paper aims to tackle this issue by placing such terms on a continuum which illustrates the degree of overlap which exists between gamification, serious games and entertainment games. Following this, the researcher will observe how the continuum works in practice. More specifically, previously existing research conducted by Humberstone & Ly (2016) on browser and native applications for the Bring your own Device (BYOD) classroom will be applied to the continuum. Such applications will be assessed for their “gamefulness”, thereby confirming the relevance of this continuum.

Introduction

Scholastic research in “gamification”, “serious games” and “digital game-based learning” (DGBL) has accelerated over the course of the last decade (Hamari, Koivisto, & Sarsa, 2014). Since these terms are relatively new, there has been a level of disagreement over the usage and definitions of such terms (Derterding et al, 2011; Kapp, 2012). In addition to this, Bring Your Own Device (BYOD) is an approach to integrating ICT. This approach has begun to gain popularity in educational institutions today (Kobayashi; Kong & Song, 2015). As the name suggests, it is a solution which allows all students to bring their own device (or a device that they have access to) into the classroom to use in their learning. This sort of arrangement allows students to learn with any digital technology they bring to school (Kobayashi; Kong & Song, 2015), instead of prescribing a limited number of devices that the institution will support. The following paper will review the currently existing literature which attempts to define the terms gamification, serious games and DGBL. The author has synthesized and balanced the definitions of the terms found in the literature and will outline them, as a way to state the axioms. These definitions will then be problematized in relation to one another, and for the purposes of clarity a solution will offered by situating such terms on a newly defined Reality, Gamification, Serious and Entertainment Games (RGSEG) continuum. This paper is informed by existing research conducted by Humberstone &
Ly (2016) which assessed the compatibility of browser and native applications for institutions adopting BYOD in music education through software content analysis. Software applications identified in the prior research will be positioned on the RGSEG continuum, following an inventory which measured to show the relevance of gamification, serious games and DGBL to browser and native applications designed for music education.

Defining the Terms

**Defining Game and the Magic Circle**

Huizinga (1955) proposes that games exist within a game space or an environment known as the “magic circle” (p. 10) Certain conditions exist inside this particular space which have been listed below:

- Role playing (for example, the player could be a goal-keeper or a potion maker)
- rules
- voluntary participation
- rituals with special meaning (for example, in the realm of reality, kicking a ball into a goal does not have much meaning, however in a game of soccer, or within the “magic circle”, such activity is rewarded with a point)
- non-seriousness, in other words, the accomplishments or rewards gained from participating inside the magic circle do not translate to acquiring financial, social or cultural capital outside of the game space

In Huizinga’s writings, the magic circle is very often juxtaposed against the realm of reality.

**Defining “Gamification”**

“Gamification” refers to the placement of game elements (badges, points, levels and leaderboards) into non-game related contexts (Deterding et al., 2011; Kapp, 2012; Robson et al, 2015). Gamification has been used in education and training, marketing, management, leadership and health and fitness (Hamari et al., 2014). Very often, tasks and activities are gamified due to the assumption that everyday activity such as checking emails, completing coursework, exercising or attending staff meetings are mundane, arduous and boring (Hamari, 2015). Thus, it can be difficult to motivate oneself to engage in such activity. In contrast, it is easy to find the motivation to play games, thus game elements are implemented, and gamification emerges to motivate the player to want to engage in the aforementioned activities (Buckley & Doyle, 2014; Deterding, 2012; Hamari, 2015; Seaborn & Fels, 2015). Gamifying something does not make it a game. A very common example of gamification exists in retail loyalty-based reward systems. Loyalty-based systems operate by rewarding the consumer (or in gamification terms “the player”) with points for purchasing particular goods and/or services. When enough points are acquired, the player may redeem a reward, which may be a free coffee or a holiday. In the realm of music education, gamification has been utilised to improve formative and summative assessment, as well as to increase engagement and motivation inside the classroom (Hein, 2014). This is evident in the fact that a
great number of drilling applications exist to enforce basic concepts related to music theory: examples of this will be provided later in the paper.

**Defining Serious Games, Commercial Games and Digital Game-Based Learning**

“Serious games” refer to digital games which have non-entertainment outcomes. To this end, games designed for education and training or health and fitness are serious games. Thus, *Where in the World is Carmen San Diego* (Nates, 1985) and *Darfur is Dying* (Ruiz, 2006) are all examples of serious games. Converse to serious games are commercial entertainment games, which are games made for entertainment purposes. The term Digital Game-Based Learning (DGBL) was first coined by Prensky (2001) and it refers to learning *through* games. Curiously, the term DGBL has often been used in conjunction with both serious and entertainment games.

**Issues with Terminologies: Situating the terms on a Continuum**

In the previous section the terms gamification, serious games, entertainment games and DGBL were defined in a way that was concise and succinct – as a way to state the axioms. In practice, the definitions of these terms are not always clear. In recent scholarship, it has been acknowledged that it can be difficult to distinguish the difference between serious games and gamification. In his book, Kapp (2012) overcame this issue by referring to all serious games as gamification, and he asserted that serious games are ultimately a category that fall under the umbrella term “gamification”. Conversely, McGonigal (2012) avoids the term gamification, asserting that it trivialises the idea of using game-thinking to enhance reality. Instead, she prefers to use to term “Alternate Reality Games (ARGs)” referring to them as “games that you play in real life” (p.10). Ian Bogost uses the derogatory term “exploitationware” (2011) to describe gamification, arguing that it is ultimately a gimmick designed to extrinsically motivate users to click or purchase products. His criticism, though, appears to be directed at the commercial usage of gamification. He does not criticise or mention gamification’s use in education and training contexts. Critics of the term gamification further describe the term to be frivolous, arguing that gamification already exists in traditional school or work environments (Kirk & Harris, 2011). For example, in the classroom, it can be argued that assessments are ultimately “quests,” marks are “points” and that ranking systems are essentially “leaderboards” – thus one can argue that school is already gamified, prompting the question: Where does reality end and where does gamification begin? At times, commercial games designed for entertainment have been used in “serious” contexts (Ferdig & Pytash, 2014; Squire, 2007). For example, the game *Minecraft* (Persson & Bergensten, 2015) was designed for entertainment purposes, but it has been used to teach a great variety of subject areas such as architecture, construction, design, mathematics, and archaeology (Short, 2012).

As previously stated, there are contradictions that arise in regard to the terms “gamification”, “serious games” and “entertainment games”: rather than categorising games and applications under those three distinct categories, a continuum can be applied to illustrate the blurred boundaries that exist between them. On one end of the continuum is the realm of lived reality, and on the other end of the continuum are commercial entertainment games. As shown in Figure 2, next to reality is gamification and adjacent to gamification are serious games.
The more a user (or player) moves to the right of the RGSEG continuum, the closer he or she is to the Huizingarian idea of the aforementioned “magic circle” (1955, p. 10). In fact, it can be argued that at the extreme right end of the continuum, the player is completely immersed in the magic circle. Contrary to this, if the player was closer to the reality/gamification end of the continuum, then he or she would experience reality with particular game-like elements. This can be exemplified in the case of loyalty cards, because in many instances loyalty programs do not make spending a game, however the gameful mechanics of points, rewards and levels make the activity of shopping game-like (Werbach & Hunter, 2012; Zichermann & Linder, 2013). Moreover, the player does not assume another role and the outcomes are in fact “serious.” As stated above, previously existing research differentiates DGBL from gamification. In practice, this can lead to confusion as gamified applications are at times referred to as games (Birch, 2014). This continuum offers a new way to understand gamification, serious games and entertainment games.

**Bring Your Own Device, Bring a Browser and Native Applications**

In schools, BYOD refers to the educational policy that allows students to bring any digital mobile device into the classroom (Stavert, 2013; Thomas, O’Bannon, & Bolton, 2013). Prior to the growth of BYOD, it was not uncommon for students to use school-owned devices for the duration of the lesson, which in turn limited the students’ opportunities to develop their technological skills outside of the classroom (Wong & Looi, 2011). BYOD mitigates this issue as it allows the student to use their own device (Wong, 2012). Although a great number of digital devices exist in today’s modern world, the technologies are by no means homogenous (Nykvist, 2012). “Bring a Browser” (BaB) was a term coined by Steven Heppell
(2012) and it attempts to mitigate the issue of hardware and operating system diversity in the BYOD classroom. BaB, as the title suggests, ensures that learning happens exclusively on a browser, on any operating system and native applications refer to applications which work on any operating system.

Methodology

In earlier research, Humberstone & Ly examined the compatibility of various browser-based and native applications for BYOD programs in music education. The information was coded against particular sub-categories (learning experiences) relevant to music education, namely composition, performance and musicianship. More importantly, the research categorised the how compatible each application was on a variety of different operating systems, along with the compatibility of various hardware devices (MIDI keyboard and audio input) on such operating systems.

The prior research did not assess the relevance of gamification, serious games and DGBL in the tested browser and native applications, but it is important to consider gamification and DGBL in reference to those published results: Marc Prensky (2001), the technologist who coined the term “DGBL” emphasised this importance by acknowledging that “(DGBL) meets the needs and learning styles of today’s and the future generation of learners” (p.10). A high number of music video games and gamified music applications exist in the market today but there is little research that delves into the use of gamification or DGBL in music education (Birch, 2014; Gower & McDowall, 2012; Hein, 2013, 2014; Williams, 2012). This article attempts to bridge this gap in the literature.

Employing quantitative content analysis (Rourke & Anderson, 2004), an inventory containing four questions which reflected the aforementioned Huizingarian definition of gaming was created:

1. Is the outcome of the game:
   1.1. Serious
   1.2. Non-serious
   1.3. Serious and non-serious
   1.4. Other

2. Does the program contain rituals with special meaning?

3. Does the player (or user) assume another role?

4. Are there rules on how the program is to be used?

The same inventory featured a list containing a wide number of game elements which were based off Karl M. Kapp’s list of game elements (2012). The elements were listed as follows:

- Goals
- Rules
- Competition
- Time Constraints
- Reward structures
- Feedback
- Levels
- Narrative
- Avatars and game-like aesthetics
- Re-playability
This checklist assesses the degree to which an application is gamified. The inventory was designed to instil confirmability (Bresler & Stake, 2006) in the theory of the aforementioned continuum. One point was given to each “yes” answer in the questions section (this refers to only questions two, three and four), and similarly, one point was to every checked item in the checklist. Both authors of the previously mentioned research (Humberstone & Ly, 2016) filled out the inventory (one inventory per application, each researcher assessed each application). Once all the inventories were completed, the authors discussed the results, noting discrepancies, however, the scores indicated that the researchers mostly agreed on factors related to the gamefulness of each application. The points that were acquired from the completion of each inventory were summed then averaged to produce a score which numerically represented where the application(s) would best be placed on the continuum. The placement of such applications would thus be contingent on the aforementioned Huizingarian list of factors which defined a “game”. An application traverses the continuum by answering “yes” to the three aforementioned questions as well as acquiring items from the gamification checklist (e.g. reward structures, competition/cooperation, re-playability), the numerical scores worked to measure where the application was best placed on the continuum.

Findings – How the continuum is applicable to browser and native apps for music education

As shown in the figure, Noteflight (2016), Chromatik (2016), Quicktab (2016) and Salsa Beat Machine (2016) feature playback options and they are ideal for the BYOD classroom since they are compatible across a high number of operating systems. However, they are by no means gamified – the user does not assume another role, the outcomes are serious and there are no rituals with special meaning. Thus, these applications would be best placed on the “reality” end of the continuum. Software titles which scored a low (0.25) rating included: Soundtrap (2016), Drumbit (Santos, 2016), Flat (2016) and FL Studio Groove (“FL Studio Groove,” 2016). In the prior research (Humberstone & Ly, 2016), these were categorised as “productivity software” (software used to assist a person in arranging, composing or producing music). Again, these software titles feature playback options which can be argued to be a form of “feedback” – although, unlike a game, this kind of feedback is neutral in the sense that it does not indicate to the user whether their actions were “right” or “wrong”.

Music Delta (2016) is a browser application which features information on music composers and musical instruments. It is targeted to younger primary school (elementary) aged students and features informative videos and quizzes which serve to assess the students’ retention of the content. The quizzes give students the ability to acquire points as they structure the students’ learning and they offer students the opportunity to try again after failing. Sight Reading Factory (2016) is another music drilling application and as the name of suggests, it is aimed at improving a learner’s sight reading (ability to read and play or sing music notation accurately). On Sight Reading Factory, examples are featured and levelled according to their difficulty. MusicTheory.net (2016) is an application designed to enforce music theory skills to users. The player can drill themselves in note identification and such drills also feature a timer and keep score of the user’s correct answers. Feedback is provided, informing the user of their correct and incorrect answers. However, there are no win or lose states and the player does not assume a role and the activities do not have “special meaning”. Both Sight Reading Factory and Music Delta scored a rating of 0.5 whilst MusicTheory.net scored a rating of 1.25. Morton Subotnick’s Music Academy (2016), which scored a rating of 1.75, is unlike the aforementioned applications in that it is a browser based application designed to teach composition to younger, primary school aged children. It
provides the user with feedback, and many of the activities are levelled, with a user interface design that features game-like aesthetics.

*MusicFirst* (2016) is an online Learning Management System (LMS) designed specifically for music education, and also a conduit to a range of other integrated browser-based software titles. The application in itself is not gamified, so it sits on the reality side of the continuum. *Practicia* (2016), which scored a RSEG rating of 3.25 is also a music LMS, designed more specifically for private instrumental teachers and their students. Unlike *MusicFirst*, gamification features are included in the application, as students can log their practice hours, complete tasks, and accept rewards. Statistics are included, which serve to motivate the students and further provide them with a sense of progress.

The native instrumental performance teaching applications *Synthesia* (Czikszentmihalyi, 1990) and *Yousician* (Chris & Kaipainen, 2015) are placed closer to the serious games end of the continuum. *Synthesia* scored a rating of 3.25 whilst *Yousician* scored a rating of 4.25. The game is very similar to music rhythm games such as *Guitar Hero* (Harmonix, Neversoft, Creations, Visions, & FreeStyleGames, 2015) and contains a wide range of gamified elements such as levels, points, win-states, rules, progress bars which show the player’s progression, instant feedback, and the ability to try again for an infinite number of times after failing. The aim of the game is to improve the player’s piano or guitar playing ability – thus the intention of the game is a “serious” one.

The numerical scores indicate that the majority of the applications appropriate for music education in institutions with BYOD technology policies were closer to the reality end of the continuum. Curiously, the applications that were specifically designed for educational purposes (such as: *Sight Reading Factory, Mort Subotnick’s Music Academy, Music Delta, Focus on Sound* and *Practicia*) rated higher scores on the inventory, placing themselves towards the gamification/serious games end of the RGSEG continuum.

**Conclusions**

This paper does not recommend or advocate for gamification, DGBL or any specific application to be used in the music classroom but it puts forward a model in which educators, scholars and developers can think about DGBL, gamification and serious games. This paper also contextualises browser and/or native applications which are suitable for the BYOD classroom, thereby assessing how relevant gamification, serious games and DGBL might be to music education – it is clear, after analysis of the data that more and more software programs designed for music education purposes are becoming gamified, although the majority of the applications were not gamified. From the list of browser and native applications that were analysed, there were fewer applications closer to the entertainment games end of the continuum. Clarification to the terms gamification, DGBL and serious games have been established through the development of the RGSEG continuum which seeks to mitigate issues with regard to defining the aforementioned terms. There is currently a very scarce amount of music educational research that examines the relevance of gamification, serious games and DGBL in ICT supported learning. The continuum establishes a model that can be used in future music educational research and general gamification and DGBL research. Finally, such research encourages educators, scholars and developers to also take a more active approach as designers of their lessons, research and technological development.
References


Children's conceptions of stories in educational games

Osvaldo Jiménez (University of the Pacific)

Abstract

The GLS community at large have extolled on the necessity that a story/fantasy has in its relation to educational games. This study is a report on interviews done with 16 children after playing two educational games that were deemed to have high and low amounts of stories by the author and story grammar frameworks found in the research literature. The findings and interviews with the children tend to suggest that characters are of principal importance to children and that game mechanics can be leveraged by children to drive a story when none is present.

Introduction

Much has been made by researchers outside (Habgood, Ainsworth, & Benford, 2005) as well as those currently active in games and learning community about the importance of story and its important relation to games and learning (Barab et al, 2007; Jiménez, 2014, Slota, Young, & Travis, 2015). While some of these studies have been largely experimental and aimed at looking at the types of story and more specifically how fantasy has helped increase student scores (Malone, 1981; Parker & Lepper, 1992; Habgood & Ainsworth, 2011) others have noted the relative importance of story to games (Reeves & Read, 2009) and how it helps to promote inquiry (Barab et al, 2007) as well as shape player’s conversations and goals (Slota et al, 2015). Story’s link to learning and play has also been evident in other areas as well, as researchers have argued for the benefits that acting out stories can have in helping students better understand those stories (Pellegrini & Galda, 1982; Williamson & Silvern, 1991). The link between role-playing, play and learning connects directly to educational games, as one could argue that the work done in placing students in role-playing scenarios is leveraged in games, particularly in epistemic games (Shaffer, 2006) where students can learn to play the role of a doctor, scientist or other professional worker.

With so many proponents arguing for the usefulness of stories in both learning and in games for a variety of reasons, I wanted to explore this link further. What is it about stories that children tend to find so powerful and how are those stories leveraged when they decide to play games? One argument made by one proponent of story is that stories can provide vivid images (Simmons, 2006), which could be a factor in helping people remember those stories in the long term. To explore this question, I wanted to focus on the simple premise that we need to know more about how children understand stories and how that
knowledge relates to games. To help answer this question, I interviewed children to investigate what aspects of stories children remember in educational games. Based on pre-existing literature and research that argues for the beneficial effects that all types of stories have on comprehension and memory (Black & Bower, 1980, Bower, 1978; Kintsch & Van Dijk, 1978; Mandler & Johnson, 1977; Rumelhart, 1975; Thorndyke, 1977), I would hypothesize that children who played games that lacked story would not be able to remember a game as well as children who played games that had a deeper story.

To investigate this claim, I needed to find two games that had differing amounts of story, which I think would be best operationalized by applying them to the aforementioned story frameworks. After researching the variety of frameworks meant to categorize and classify relatively small stories, I chose the Thorndyke framework based on its flexibility (see Figure 1), which would be useful for games that have very little to no story. With story and narrative having very broad interpretations in the games and learning community, it may be helpful to define how the word story will be used in relation to games. I am going to use the term story mostly as an expanded form of the word fantasy used by Parker & Lepper (1992) in which they operationalized fantasy as a way to establish a context for a particular game. Rather than use term fantasy, I would like to use the term story because other researchers have argued that fantasy does not encompass stories because situations involving day-to-day occurrences may not be considered as fantasy (Saltz, Dixon, & Johnson, 1977). Thus, the term story here is meant as a context that can be used or leveraged as part of a game. In the Thorndyke framework, stories are broken down in setting, theme, plot, and resolution, with each category being broken down still further. For example, setting consists of characters, location and time, while plot is composed mainly of sub-goals and outcomes. With the framework chosen I needed to choose two games that had stories that fit this framework in different ways. In looking for a game which I believed to have a “stronger story”, I chose a game called Tug-of-War based on how it applied to the Thorndyke framework (Figure 1: right) as well as because of my close knowledge of the game. Tug-of-War is a card game that helps students with taking fractional components of whole numbers and has a story about two teams of people trying to recruit as many people to their side as possible to win a tug of war (Jiménez, Arena, & Acholonu, 2011).
After examining a number of factors in looking for another game that did not adhere as closely to the framework, I arrived at using Number Eaters, a clone of a classic edutainment game, Number Munchers (Ito, 2007). The goal of Number Eaters is to control a Green Monster who has been tasked with eating all of the numbers that correspond to a specific equation given in the upper right corner. While the Green Monster moves around, it also has to avoid landing on the same square as the Purple Monster while finding the numbers. Once it finds all of the squares that have the correct answer to the equation, the player then moves on to the next level. The next level presents the player with a new grid of numbers and a new equation for the player to calculate.

Number Eaters’ story has many limitations when applied to the Thorndyke framework. My conceptualization of Number Eaters (Figure 2, below) as it applies to the Thorndyke framework may help one understand the game’s limitations. In the figure, areas marked as clouds are areas where there was little information provided. For instance, the setting’s location for Number Eaters is very abstract, to the level that it could be considered non-existent, which is why I labeled it in the framework as “Grid”. There is also no mention of the time at which this game is occurring, and there are no episodes or events that lead up to the theme for the game. The areas marked as ovals are areas where I think non-story game elements better fit with the application of the Thorndyke framework for the games.

Number Eaters became the prime choice for comparison because of the similarities and differences it had with Tug-of-War. The two games are similar in that they both integrate math into the main game mechanics (Habgood, Ainsworth, & Benford, 2005; Hunicke, LeBlanc, & Zubek, 2004). Nonetheless, Number Eaters differs from Tug-of-War in that it does not provide any story-based reason for doing the math problems that it presents and calculating the number does not advance the story aspect of Number Eaters. Number Eaters also stood out because it could cover fractions content; it is seen as a classic
educational game, and served as a nice contrast because it has a minimal story, yet may still appeal to children. I also chose *Number Eaters* over the classic *Number Munchers* because of the former’s free availability on the Internet, making it easy to access via different computers. With both games chosen, I began the study described below.

*Figure 2. Number Eaters game applied to the Thorndyke framework.*

**Interview Study**

**Participants**

Sixteen students participated in the study – ten females and six males. Five of the students were incoming third graders, six were incoming fourth graders, and the remaining five were incoming fifth graders. All participants were part of an after-school club; the club’s mission implies that the club seeks to meet the needs of children in communities where they are not met effectively. The after-school club is located in a suburban area of Northern California.
Method

First, children played both educational games for approximately one hour each. The order in which participants played the games was counter-balanced, so that half of the students played Tug-of-War first, while the other group played Number Eaters. Each student was introduced to the two games by a researcher. A researcher introduced and explained to each of the students how to play the game, but did not mention anything about the story. While the students played the games, the researcher was present only to assist the child or answer any questions they may have, staying mostly out of their way.

After playing both games, the children were then interviewed. The length of time between when the children finished playing the game and when they were interviewed ranged from one to three days. For the interview, the children were invited to meet with a researcher individually. Next, the researcher followed an interview protocol during the meeting. Fourteen out of the sixteen interviews were recorded using a video camera. In the other two interviews, a video camera was not used based on the privacy choices outlined by the parents. In those two interviews, the researcher took field notes of their responses.

Materials

Children played both Tug-of-War and Number Eaters on a laptop computer. While I initially wanted children to play solely the fractions sub-game of Number Eaters, children played any version of Number Eaters they wanted, which included children playing games where they worked with basic arithmetic. This decision was made because the participants did not have the requisite knowledge to solve the fractions problems in Number Eaters. Most of the participants decided to play the Addition version of the Number Eaters game, which meant their goal in the game was to look for spaces that had an addition problem equal to the target number provided to them in the game.

Interview Questions

Each interview lasted approximately 20-30 minutes and involved a one-on-one session between an interviewer and the interviewee. The protocol followed a semi-structured interview, with a set of initial questions and sets of questions used to prompt students to elaborate on their answers to those initial questions. The interview was broken up into two phases. The first phase had questions that were meant to “break the ice” for children to talk about stories in general. Children were asked to discuss their favorite cartoon show and were prompted to provide in detail what happened in either their favorite episode or the last episode they watched. Follow-up questions were asked to ensure that the children were finished with their description of the show. This first phase served to gauge their storytelling capabilities, to help make visible what matters to them, and to understand what they recount as part of their stories. This phase also informed me of their ability to understand stories in traditional media (television/film), which places a large emphasis on story. While both Tug-of-War and Number Eaters have a semblance of a story, the story is not the central component of either game, so having a source of comparison to another medium where story is central was important.

The second phase of the interview concerned the two games the children played. The children were
asked approximately the same set of questions for both games. The questions were: “Tell us what the game was about” and “Did the game have a story? Children were then asked to elaborate on their responses. Finally, they were asked questions that addressed the differences between the games, which were to discuss why they thought the math was present in the game and why performing the math equation was important. To understand how they conceptualized the calculations with respect to the game, children were also asked what happens after they calculate the answer and its significance. To help the children in answering these questions, the interviewers presented the children with relevant screenshots of the game. These screenshots were shown at the end of the interview in order to not influence what participants told us initially about the game and the story. The interview study was piloted with two children, and a few questions were modified. Similarly, a few questions were introduced to the protocol, most notably to ask children specifically about the characters in the game and their responsibility or interaction with those characters.

Description of the Analysis

All of the playtime and interviews were done with the children over the course of two weeks, with most students taking one or two days to finish the study. All interviews were uninterrupted and took 20-30 minutes to complete. Some of the playtime had to be split for some of the students due to having to leave early for the day.

Shortly after finishing all interviews, tapes were watched, and an open-coding indexing scheme was employed. In open-coding, I wrote down surprises and general themes (such as creative interpretations) that I noticed from looking at their responses. Each videotape was then transcribed. These transcriptions were done at the conversational level and did not include non-lexical utterances, except long pauses. The transcripts were recorded into a web-based form that I created. With regard to the two non-taped interviews, I decided that my field notes looked close enough to the transcriptions that I could place the notes into the form as well. The transcriptions enabled me to analyze and more quickly look up information from each interview.

After transcribing the interviews, the Thorndyke grammar was applied to each child’s conceptualization of each game. After practicing my application of the grammar and validating it with the knowledge that I had of the Thorndyke grammar, I understood more of the limitations of the grammar. More specifically this grammar was meant to be used in stories with a single protagonist or character. With a deeper appreciation for the grammar, I then applied the Thorndyke grammar to both Tug-of-War and Number Eaters (Figures 1 and 2). From those applications, I then developed a set of codes that I used to count and structure children’s interpretations of the two games. The result of that analysis caused me to generate two major findings, which are discussed below.

Results

One theme that came about early on in the interviews was the importance of the characters to the children. In relating to the first interview questions, fifteen out of the sixteen subjects were able to recount a show or movie that they had mentioned as being their favorite. In relation to the first interview questions, after the children would mention their favorite show, the other researcher and I would ask them to describe the show to us, and thirteen out of the fifteen children started their description by naming one of the main characters, or a few main characters and how they were related to each other.
For some students who would mention the same show the same characters would often be the only consistent information. For example, two of the participants mentioned that their favorite television program was called the Regular Show, which is an animated show on Comedy Central. When both were asked to describe the show, their responses were:

“It’s about like a blue jay and a raccoon start working at a job, but then they start slacking off too much so their boss Benson pressures them to work harder” (Response #1 – Incoming 5th grader, Male)

“Basically about this blue jay and squirrel and they like in the commercials. It’s anything but a regular show, like everything new happens in episodes” (Response #2 – Incoming 5th grader, Male)

While both have come up with different explanations to the question, “What is this show about?”, what one can infer from each description is that both children recognize that the show is about a blue jay and a furry mammal. Both children described the characters first, rather than describing the setting or other details about the show, which reflects the general pattern shown by the thirteen students who mentioned characters. Of the two students who did not mention characters initially, one started off by mentioning that they did not know how to speak English very well, and the other mentioned that the show was fun but hard to explain. Nonetheless, the fact that students mentioned characters first suggests their importance to the children.

The importance of the characters to a story was also demonstrated in the Number Eaters game. Because Number Eaters had two monsters that children could find appealing, I found children generated many facts to help them explain the game that were based on the characters. Although not all were immediately forthright with mentioning the monsters, all of the students did identify when prompted that there were two characters on the screen, a “protagonist green” monster that they control, and an “evil purple” monster that they must stay away from. Students then generated scenarios that used the characters and the game’s rules to explain their encounters in the game. For example, one student mentioned that a character would become sick if they ate the wrong number, and a majority of the students would say that the purple monster would eat the green monster (nine out of 16) if they ever came into contact with each other, although this is something that was never explicitly mentioned in the game.

Students who did not mention the purple monster’s responsibilities would also mention other facets that were not part of the game. For example, two children mentioned that the purple monster tries to block the green monster from getting the numbers, and another two mentioned more accurately that the monster could get the green monster, rather than eat it. The remaining children gave erroneous statements, but even some of those were invented, such as one student who stated that the purple monster was there to protect the green one. Whether correct or inaccurate, the children’s statements about the role that the purple monster has in the game, provides evidence that the children are remembering the characters. I would propose that the children are then using the characters and their experience in the game, to generate reasons that align to their own stories about the game.

This conjecture falls in line with previous literature done by Bower (1978) about characters and their motives, where they showed that when characters had a motive, subjects would add more detail to the story depending on the character’s motive. In line with this research, I believe that students use their knowledge of characters and game mechanics to infer actions for those characters that align to both the story and the game. The difference here is that rather than the children knowing the motives of the characters beforehand, the children are filling in the goals of those characters by observing the
actions that they perceive those characters to be taking during the course of the game. I would argue that children are using the game’s mechanics to determine motives for the characters in the game. This finding is important because it makes it salient to me that in game design, the characters are a central focus for children who play a game.

Nevertheless, children do not always need characters to memorize the game’s rules. Characters could serve as an anchor point around which students could organize their information. However, students could also use the general game process to store most of the information they needed about the game. In contrast to Number Eaters, Tug-of-War did not have much of a mention about characters. Nonetheless, they did refer to other elements in the game, namely stink bombs and air fresheners, which are two components in the game. It could be that the stink bombs and air fresheners in Tug-of-War served as surrogates for the characters that children used to anchor their initial responses about the story. 11 out of the 16 children mentioned stink bombs and air fresheners when they were asked “What is Tug-of-War about?” in some capacity in their first sentence. Only two of the sixteen children failed to mention the air freshener or stink bomb directly. The representations that the students gave and their anchoring around the stink bombs and air fresheners almost makes it analogous to the purple and green monster or other characters that are present in stories. The lack of mentioning characters also could be because in the Tug-of-War game, the protagonist that they follow is themselves, but there is no direct mention of that in the game.

Before conducing this study, I thought that children who played Number Eaters would not have a good recollection of the game’s rules because they did not have a good story to use as a basis on which to organize the game’s information. My analysis of their interviews demonstrates that they do use the story as reasoning for the game’s rules. However, contrary to my hypothesis, children still had a good understanding of the game and its rules. For Number Eaters, it seems that students use the game’s traditional mechanics and their experience with the game to conceptualize a story. Contrary to enjoying the game and story together – like in Tug-of-War – Students are using their experience in Number Eaters to come up with a story for the game.

For instance, the theme of the game, according to Thorndyke, would be to win the game, but there is no reason to win the game, other than a person’s innate desire to win. You win Number Eaters by clearing the correct spaces, solving math equations along the way, and moving to the next level. These lines of reasoning mirrored what I found in the interviews. While only three children mentioned the overall goal of winning the game, the majority did mention that they were out to eat numbers (13), and that the goal of eating a number and calculating the number was to clear the numbers from the board (13). Moreover, half of the children mentioned the reason for clearing the board was to move on to the next level: a classic game mechanic. This last statement provides evidence for the argument that for many of the children, the goals of the game provided enough of a context for doing the activities. When no story was present, it seems children anchor to mechanics and characters and when appropriate, apply stories to that mechanic. This type of anchoring and then generating story could explain the aforementioned finding that the majority of children would make up answers about how the purple and green monsters would interact in Number Eaters.

In truth, this theory about leveraging game mechanics to fill in holes in the story was also evident in Tug-of-War, based on another interview where a child explains his version of the Tug-of-War story:

“The story is that you have [to] pass all the levels from pulling the rope, and there’s the math you have to do the
math, so the story is you have to do everything so you have to get 20 points so you can be passing the levels.”

(Incoming 4th Grader, Male)

The last part of their sentence is interesting because this student ended up incorporating a common game mechanic, the mechanic of a game having many levels, and their desire to pass the level by gaining a certain amount of points. From their speech, one could infer that the reason this student believed they needed to get the 20 points in the tug of war matches was to move on to the next level. Therefore, they used a common game mechanic of moving on to the next level in order to justify why they were trying to achieve a certain amount of points. Tug-of-War has no reason for having 20 points as a goal, nor does it have a good system of tying the matches together, so it looks like the student used this to generate a scenario that fit with their understanding of the game and its story.

Conclusion

This study was meant to explore more deeply what elements of story children remember in the context of playing an educational game, in the hopes of leveraging that knowledge to make better educational games in the future. While it was hypothesized that deeper stories would cause students to better remember stories, it was found that children tend to remember characters and possibly game mechanics and place them as a focal point in what they remember. From this they tend to generate and build their notion of what the story would be. It is my hope that this study provides some insight to future game developers on how children perceive story so that the educational games community can leverage it to the advantage of its users.

References


When is a Game Not a Game?

Considering Player Perceptions of An Educational Game Through Reality, Meaning, and Play

Jackie Barnes (Northeastern University) & Casper Harteveld (Northeastern University)

Abstract

Educational games are designed with playful affordances, yet have the serious purpose of supporting players’ learning. Given this, how players perceive these activities may influence how they interact with them, and therefore, whether they actually learn from them. We present player perception of an educational game through the triadic game design framework. Selected cases are presented here from one educational game teaching Newtonian physics to better understand the relationships between player perceptions and the nature of their game experiences, in terms of reality, meaning, and play. The findings we present indicate that players’ perceptions of educational game affordances as school-like or game-like contribute to divergent experiences with the same design.

Introduction

Serious games are designed for a purpose beyond play (Harteveld, 2011). Games are designed to promote empathy, values, or in the case of educational games, learning. Despite this simple definition, there has been an extensive discussion about what constitutes a “serious game” (Deterding et al, 2011), also in relation to what is defined as a “game” (Juul, 2005; Salen & Zimmerman, 2004), considering that some games are repurposed entertainment games, others are more like gamified experiences, and then various games are considered borderline cases because they are more like “simulations” or “virtual environments.” The aim of this paper is not to contribute to this discussion. Rather, the aim is to investigate in the context of educational games how the players themselves perceive the games they play and what effect this has on the impact the game attempts to achieve.

Inspired by the triadic game design framework (Harteveld, 2011), we posit that given players’ perception of what they are doing, the interactions with the design may differ widely. In other words, the game is more than the designed affordances intended by the designers—the enacted design is, in fact, the interactions players have with that game in a particular context. This means that games can be taken up in ways that their designers may not have intended: “the meaning that people attribute to games is not necessarily intended by the designers” (Harteveld, 2011, p. 56). In fact, game design is considered a “second-order problem” (Salen & Zimmerman, 2004) because designers can only indirectly influence how players experience their game.

Within educational game experiences specifically, the goal of supporting players to learn something
cannot be considered separate from the meaning attributed to the game by those players. How players attribute meaning is influenced by their previous attunements to affordances (Gibson, 1986) that are represented in the game they are playing: “Players are first real people in the world” (Harteveld, 2011) and their real life experiences will impact both how they make sense of game play and the meaning they draw from it (Dervin, Foreman-Wernet, & Lauterbach, 2003). Players have goals, intentions, and perceptions related to the act of playing games, and a particular game. Therefore, in evaluating educational games it is of importance to consider the idiosyncrasies of players, and not treat the game as a universal artifact that is experienced similarly to all of its users.

In short, we see games as ecologies (Salen, 2008), which can be redefined by the experiences of players and the context in which they are played. The initial perception of a game may impact the meaning players attribute to game affordances and their game interactions. This paper investigates an implementation of SURGE: Fuzzy Chronicles, a simulation game that teaches Newtonian mechanics (Clark et al., 2011), to see how player perception affects player experience. In this exploratory analysis we present player talk of several cases as they interact with SURGE. Below we discuss some relevant literature, our analytical framework, details of SURGE, and then the cases that illuminate reality, meaning, and play within student talk before discussing our conclusions and future work.

Background

While the literature on games, serious games, and game design is growing substantially, there is limited work investigating players, the diversity of player experience, and, specifically, how players perceive educational or serious games. Nacke et al. (2009) describe this as a difference between playability research (focusing on a game design) and player experience research (focusing on the player and their perceptions and experience before and during game play). The lack of understanding of how users perceive educational games is a main driver for this paper and the discussion it prompts. A sample of relevant findings are included here to support our discussion.

One factor that might influence player experience is their previous game play. For example, Christou (2013) found that game experience impacted perceptions of usability. Essentially, more frequent gamers saw games as more usable, more accessible, and more appealing. Given this, things like perception of learning how to play a game and the difficulty or enjoyment of an initial game experience might be impacted by previous game experience. This is supported by findings that suggest navigation and other game play dynamics are tougher for those who are not used to playing games (Tawfik, He, & Vo, 2009). Players’ personal histories (Mayra, 2007) may be important through other measures than game experience. Player understanding must “take into account the historical perspective, as well as the public and private contexts of digital play” (p. 814) For example, through taking personal histories of players into consideration, it is clear that playing with a friend is different from playing with a stranger.

Further, the physical context in which a game is played matters. One might imagine that placing a game within a classroom context might necessarily communicate to players that what they are doing is educational. Similarly, Verdercruyssse et al. (2013) found that many players saw what they were doing as educational despite the activity being described as “a game.” In their study, they called the task a “game” for some players and an “instructional activity” to others, and they found that those who were in the “game” group reported higher interest, enjoyment, and perceived competence after playing. While player perception of a game can differ, the framing of a game-like task also matters. In fact, Lieberoth (2014) compared environmental discussions through a list of questions, a competitive discussion board
game, or through a discussion using the game pieces but not game mechanics. They observed that simply framing an educational activity as a “game” (in both game conditions) and use of game artifacts increased interest and engagement, whether or not the activity actually had game mechanics.

Despite the potential of games for learning (Gee, 2003), previous research has suggested that educational videogames do not work as an ideal instructional method for all users. For example, Squire (2005) found students who were traditionally successful in school tended to dismiss the potential value of their success in playing educational games, while academic underachievers in particular, or the students who resisted mandated traditional school curricula, were more enthusiastic about game play and developed better conceptual understandings of the content. Similarly, those who self-identified as “gamers” had trouble connecting that identity to their play within an “educational game.” Failure within the genre of educational gaming upset and frustrated these students. Squire suggests that these users “may be inclined to reject educational games out of hand if such games challenge or compromise their identities as gamers” (p.4).

The triadic game design framework (Harteveld, 2011) helps to explain these experiences in the context of playing serious games. This framework posits that the successful design of a serious game requires the consideration of three different paradigms: reality (e.g., domain, subject-matter experts), meaning (e.g., outcome, learning scientists), and play (e.g., activity, game designers). Each paradigm consists of specific people, disciplines, aspects, and criteria that need to be considered as part of the design process. A game will be applied successfully only by carefully considering and balancing each paradigm (much like any other technology in the classroom, see (Mishra & Koehler, 2006). In practice this means that the game’s educational setting, goals and challenges, and content will have to match and reinforce each other. This triadic framework is not only useful for designers, it can also be used to characterize players and understand their play experiences. Using this framework, players can be identified as people (Reality), as meaning makers or learners (Meaning), and as players (Play). Each player has a particular personal background that may shape their experience in addition to how they are inclined to learn about the world and what games they prefer to play. During their interactions, players might be attuned to affordances (Gibson, 1986) related to school (reality) or a game (play), resulting in different learning (meaning).

Methods

The design used within the study was a Newtonian mechanics simulation game called SURGE: Fuzzy Chronicles (Clark et al., 2011). Players navigate their ship safely to reach the exit portal in each level by dragging forces onto their spaceship with a chosen direction and amount of force (in Newtons). The trajectory may require passing through green speed gates of a certain magnitude (e.g., 3 m/s), picking up “fuzzies” along the way, or passing through purple mass gates (which require the ship to have a fuzzy as cargo). If the player uses too much or too little force to propel themselves through a speed gate, their ship will explode, and the player will be required to try again to pass the level.
Players progress through red levels, blue levels, and green levels, which each emphasize a particular concept of Newtonian mechanics (e.g., the relationship between force and speed, the relationships between mass, force, and speed, and the concept of opposing forces). The level pictured in Figure 1 is in the blue set of levels. At the end of each set of levels are “warp levels” which require a minimum score of 80 to be earned to pass onto the next set. Both level performance (reaching the goal) and response to a multiple-choice question count toward the warp score. The questions that pop out for players (Figure 2) ask about an action they took in that particular level, or what they might do in a similar hypothetical situation.
The fuzzy on the bottom right reacts to the player’s response and if players choose an incorrect answer, they are prompted to try again. Each attempt makes the warp score decrease. At the end of the question, they are shown their total warp score for that level. We verbally instructed students in the classroom that they needed a score of 80 to move on, and that the score was impacted by the number of attempts and whether they answered the question correctly.

**SURGE** was taken to and examined within a 7th grade STEM class. The players were 97 students, across four class periods. Researchers were present in the approximately 75 minute classes for a period of five days. Case studies, whose talk is included in this paper, were selected among the participants on the basis of whom had their consent form turned in the first day, as the priority was to document the trajectory of learning over the course of all days of implementation, with the aim of keeping even distribution across classes and gender. The activity was introduced as a playtesting session in which the students were encouraged to give feedback about the game for its improvement. In this way, they are positioned as “experts in the use of their own media culture” (Marsh, 2011, p. 105). Students were encouraged to share game strategies. They were told that they would not be given a class grade on the activity, but were asked to try their best because their participation would help us improve the game.

All participants were given a pre and posttest of 21 questions that assessed physics content presented in a way similar to game dynamics but in a more traditional format. For example, a question might ask how much force is required to push an alien weighing 1kg at a velocity of 2 m/s (no friction). Participants also completed an engagement survey at the end of the study. Lastly, screencaptures recorded the screen and talk of the 20 case studies each day, including their interviews. In this paper, we focus on the interview
data and player talk, but reference other data where appropriate. A complete description of the data and results is described in Barnes (2015).

Findings

In the discussion of the selected cases we illuminate players’ perception of game affordances (Gibson, 1986) according to the three paradigms of triadic game design. Considering reality, or the content being represented in the game, players perceived the physics content as structured and unfamiliar. Considering meaning, or the educational nature of the game, one player elaborated extensively that SURGE is a “learning game” and what qualified it as such. Considering play, we consider whether SURGE, in this context, counted as a game at all, reporting players’ perceptions of game affordances as “academic” or “playful.”

Reality

Some students verbalized perceptions of the physics content in the game, either describing it as a “physics game” or to indicate that they are unfamiliar, or have not learned, physics. Here we present two cases who had relatively successful experiences, as measured by their game engagement survey and posttest. Steven was within the top 4 pretest scorers (71%) and top 4 posttest scorers (95%), and rated himself as a gamer (5 to 7 hrs/wk). At the start of a conversation with Steven on the second full day of game play, he was prompted “Tell me about the game so far.” He responded by describing how he thinks the physics content in the game is hidden from players: “It’s pretty good, but uh, I think it will help people, like, not recognize that it’s actually physics. Because usually it will say ‘PHYSICS GAME’, or something, and people won’t try it, because they know it’s going to be something where they have to learn.” Here Steven articulates what counts as physics as something that people are tentative to enter into, and something that will require the uncomfortable experience of learning.

Another player, Cal, who has a similar profile to Steven, with relatively high pre (57%) and post (90%) test scores and game experience (5 to 7 hrs/wk), did not seem to connect his achievement or progress in the game to knowledge about “physics and stuff like that.” Cal separates what he is doing from “physics” but also points out that the content of the game was totally new to him. When asked whether he’s seen any of the words and symbols in the game previously, he says, “The force, not as much. Not really… We haven’t really learned much about the physics and stuff like that.” Despite being very successful in the game, in terms of game progress and learning, Cal doesn’t appear to consider what he is doing as “physics.” He also states that the physics is something he hasn’t learned previously. However, Cal did quite well on the pretest. Understanding of the content the game doesn’t appear to map to Cal’s perception of it as physics, perhaps through the interactive nature of the experience.

Meaning

A second conjecture of this paper is that it is consequential whether a player perceives the educational nature of SURGE, or whether they treat it as they would any other game. Here we present a less successful case, respective to engagement and learning, to understand the player’s experience and perception of the “learning game.” Lamia had a pretest score slightly below average (29%) and a
relatively low posttest score (43%). She did not get very far in the game—5 levels before the average level all cases reached. Lamia rated herself as a heavy gamer, playing more than 10 hours per week. She frequently told researchers about her skill with The Sims and other games. However, she described SURGE as a “learning game” rather than a “for real game.” When Lamia was asked to think about the game critically, asking what she would change as the designer, she suggested two solutions for her frustration: “What I would change is, if you lose, after one time you lose, there’s a superguide to do the whole thing for you! Or… I’d make, when you complete a level, there’d be a non learning game, so somebody would look forward to completing it.” When asked by a researcher what makes it a learning game, to her, she responds, “The questions it tells you at the end of the level. The QUIZ questions!”

Even here, she used academic language, calling the review questions “quiz” questions. When her friend suggested that it must be a learning game because they are required to do it, she agreed by saying, “Yes! Because school doesn’t let us play any for real games. Plus, if I’m at home, and I can’t pass a level, of ANYTHING, videogames or any game in particular, Google is always helpful. Google. Type in the game, and cheat, and done. I’m awesome.”

Lamia considers herself an avid gamer, yet she contrasts what she is doing to “for real games” that would not be allowed in school. She reported playing The Sims and “killing games” in conversation with researchers. So, for this gamer, who has a lot of strategies for getting through games on her own terms, this game was very saliently a “learning game.”

Lamia also participated in social talk about grades and demarcation of “geek,” “nerd,” and “dork” categories with her friends while playing. They made a chart indicating the differences in these groups. During the conversation, Lamia put herself squarely into the category of “geek,” because “that just means you’re not good at school but like sci-fi.” The self perception of being not so great at school, coupled with Lamia’s perception of SURGE as not a “real game” may have increased her frustration when trying to understand the Newtonian mechanics within SURGE.

For Lamia, the SURGE experience shows her complicated relationship to both games and school. When she encountered trouble, she elaborated her usual gaming strategies of quitting, wishing she could use cheats. Conversely, she also expressed that she gets frustrated when she is unable to complete a game. She labeled SURGE as a learning game multiple times, and described that it was because players cannot quit or cheat. When she completed the level again and saw score of 58, she growled “AGH. I’m going to do with every game I don’t like. Quit. Hey, there ain’t nothing wrong with quittin’!”

**Play**

Typically, players of games act with some basic assumptions, influenced by their previous experience with and attunement to, game affordances. However, whether or not players perceive what they are actually doing as game play is important. In particular, the context of play—taking place within a classroom, for example—might impact players’ perception of playfulness in the activity. During interviews on the 3rd day of game play, case study participants were asked if what they were doing felt more like a game, or school. Some of the qualities that attune players to the game-like nature of SURGE are the platform (i.e., being on a computer rather than a workbook) and its interactive nature. Those who saw it as a game described how the task was sort of like a puzzle they had to figure out. One stated, “It kind of felt like a pattern. That’s what it kind of feels like. It’s like a pattern, when you
know the number, you know what comes next.” Another said it was game-like because if it was school, “it would have a bunch of math problems and you would have to imagine stuff.” For this student, the virtual simulation they could interact with was different than prompts to imagine situations common to traditional STEM assessments, and for him, signalled that he was playing a game. Similar to this, multiple students reported the physical context as an indicator that they were playing a game, saying “the fact that it’s on a computer and we’re interacting with stuff” and “because you are on a laptop and not like in a workbook” made it feel more like a game to them.

Players described SURGE as like school because it told them information, but also because it included intellectual work. One student said “I think the school part of it is that you have to guess at which size or speed and which direction it’s going, so that makes you think.” Another echoed this description, saying “it’s sort of like school, in that you have to figure it out.” One player pointed out the “questions that it asks of me” as making it feel like school, to her.

Players could pick out specific game affordances related to either play or academics. Here, we see that the games genre was signaled through specific affordances, but not universally. Given this, question of whether or how SURGE counts within the traditional categories of a game, and specifically how an educational game is conceptualized, is one for further discussion.

Discussion

This paper asked how educational game players perceive the games they play and what effect this has on the impact the game attempts to achieve. We aimed to understand these dynamics through looking at reality, meaning, and play in the talk of players of SURGE. Our findings show that the physics content of SURGE was something unfamiliar to most players, but also was something that signaled to players that the game was educational. Conversely, a heavy gamer, who may have been attuned to typical game affordances in first person shooter or simulation games, labeled SURGE as a “learning game.” These instances, and the specific affordances which players categorized as academic or playful prompt additional questions that we plan to explore further.

Overall, we conjectured that when games are played within classroom contexts, it is consequential whether a player perceives them as academic or playful. Also, the way researchers framed the game, as “a game” and encouraged sharing strategies, as well as the inclusion of a pretest, may have influenced players’ perceptions related to games or academics, or both, and their personal moment-to-moment goals for playing each day. Contextual factors can influence the play or meaning components of an educational game experience when perception of a task is altered. Similarly, if a player thinks SURGE is about spaceships and aliens that is something quite different than a player who assumes the content (reality) of the game is physics.

The implications of using games in classrooms requires more reflection on how these games are both designed and framed when introduced to students. Whether considered students or players, educational game users form relationships between themselves and the affordances of a game, given their gamer or academic identities. While educational games have been shown to be beneficial for learning when compared to non-game alternatives, it is yet to be understood whether those findings are due to the interactive nature of the task, the playful perception of players, or another reason. Future work will address these questions while investigating the diversity of player perceptions and experience in educational games. Specifically, it will explore relationships between players previous attunement and
perception of the task in terms of four general quadrants: those who are highly attuned to school, those who are highly attuned to games (and the opposing cases) and looking at how those groups perceive an educational game as “game” or “school.”

Lastly, additional work in progress is looking into comparisons of why designers, researchers, and educators, respectfully, define and evaluate educational games. We feel that these investigations will both contribute to a comparison of rubrics of quality, but also illuminate differences in how these different audiences decide what truly counts as a game.

References


Implementing Evolution in Video Games

Barrie Robison (University of Idaho), Terence Soule (University of Idaho), Christopher Mirabzadeh (University of Idaho), David Streett (University of Idaho), & Nicholas Wood (University of Idaho)

Abstract

Instruction of evolutionary biology at the state and national K-12 level is fraught with challenges. We need new methods to teach and engage students, teachers, and the public in evolutionary education. We are therefore developing video games that feature explicit models of biological evolution. Our premise is that adding biological evolution to video games makes the games better for the game player and facilitates player comprehension of complex concepts that are hard to teach. Traditional video games are usually scripted, featuring “waves” of enemies that have defined and predictable characteristics. A player’s success in such games is based on learning the predictable, rote script necessary to advance to subsequent levels. By integrating principles of evolutionary biology, we argue that video games can be made more compelling. One of the reasons why evolution has not been correctly implemented in video games is the perception that evolution is an inherently slow and gradual process – to slow to add much value to a video game. In this paper, we describe two simple video games in which generations of enemies undergo adaptation through natural selection. The enemies with the traits that best counter the player’s strategies survive to reproduce, and their offspring feature prominently in the next generation (analogous to a game level or wave). In both cases, we demonstrate significant phenotypic evolution of enemy populations over time scales that are amenable to game play.

Background

Instruction of evolutionary biology at the state and national K-12 level is fraught with challenges. Understanding of evolution relies on comprehension and integration of a dizzying array of other fields, from genetics to geology (Miller, Scott, & Okamoto, 2006). Fundamental misconceptions about science and evolutionary biology, and rampant anti-intellectualism and opposition from creationist groups further complicate essential scientific education in our public schools. Thus, we often face a battle as to whether we can teach evolution, let alone confronting the complexities of teaching it well.

We argue that evolutionary education could be enhanced by developing video games based on models of biological evolution. Not only do we argue that evolution can make better video games, but also that playing these games could demonstrate and teach difficult concepts.
Evolution in Commercial Games

There are numerous cases in which evolution is being used to market video games. Many of these titles simple use the word “evolution” in their title, such as “Halo – Combat Evolved”, or “FIFA Pro Soccer Evolution”. The choice to use evolution in these titles likely stems from the linkage between evolution and the perception of improvement, advancement, or optimality. This is, unfortunately, reinforcing a misconception that biological evolution is directed force leading to optimality.

While these examples of evolution in video games are unfortunate, there are other titles that profess (ether implicitly or explicitly) to demonstrate biological evolution. While it is nice that evolution is being used to make a more compelling game, the reality is that all of these titles are deeply flawed, and reinforce fundamental misconceptions about evolution. In the following section, we will consider three typical misconceptions regarding evolutionary biology (Alters & Nelson, 2002), and provide examples for each.

Misconception 1: Individuals evolve

A very common implementation of evolution in video games is one in which an individual character “evolves” by acquiring new traits or abilities. Examples abound, but the recent title “Evolve” by Turtle Rock Studios (2015) serves as a particularly compelling case. In Evolve, four players battle against a gigantic monster controlled by a fifth player. This creature can acquire energy by eating other (smaller) creatures or players. Once enough energy is acquired, the player is asked to press a button or key to “evolve”. Once this ability is activated, the creature appears to burrow into a cocoon like structure, and then the player can choose to evolve one of several new abilities. Evolve is admittedly a very fun game that has met with commercial success, but the process described above is not evolution. Rather, biologists would likely refer to this process as metamorphosis.

Unfortunately, the conflation of individual metamorphosis with evolution is very common in video games. Other examples include the Pokemon series, and any game in which “upgrades” are cast as evolution (a recent redeployment of space invaders – Space Invaders Infinity Gene is an example).

Were “Evolve” to actually feature evolution, it would require a population of giant monsters with variation in their traits. If this variation could be inherited, then the monsters best able to survive against the four player team or to kill and eat the other creatures would reproduce and those traits would increase in frequency in the next generation. Given the high quality art and design necessary to create the creatures, a game such as this would likely run into significant performance issues.

Misconception 2: Evolution involves agency

Another common game trope involving evolution is the conference of agency over evolution to the player. In this case, the player is allowed to choose the direction of evolution, usually by selecting options in a tech or upgrade tree. While Evolve also employs this mechanism, we will use a different game to demonstrate this misconception. Spore (released by Maxis in 2008) is a game that professes to be about evolution. Indeed, the supporting text on the Steam site for spore states “Single Cell to Galactic God, evolve your creature in a universe of your own creations. Play through Spore’s five
evolutionary stages: Cell, Creature, Tribe, Civilization, and Space.” The problem is that as the player progresses through the game, they are given choices about which traits to evolve (Bohannon, 2008). Another example is Plauge: Evolved. In this game, the player chooses the mutations to evolve so that their pathogen (a virus, bacterium, fungus, or other such things) can infect and kill the world population. In both cases, the games are tremendously fun but badly misrepresent biological evolution.

Misconception 3: Evolution implies progression, optimality, or perfection

This misconception is typically reinforced by games that use evolution in their title to imply quality or improvement. The aforementioned Halo Combat Evolved, and FIFA Pro Soccer Evolution can be placed alongside Ark, survival evolved, and a host of others. In reality, evolution is a process driven by probabilities and usually does not arrive at the “perfect” solution.

Collectively, we argue that to date video games have used the idea of evolution for marketing purposes, but implementation of evolution has been deeply flawed at best. Our premise is that evolution CAN be implemented in a video game, and that doing so will make the game better and enable the game to be used for educational purposes. In this paper, we test whether evolution can be implemented in a game and demonstrated on a time scale appropriate to casual game play.

Examples of two evolutionary video games

Here, we present two examples of evolutionary video games that demonstrate phenotypic evolution over time scales consistent with video game play. In each of our games, a population of enemies is pitted against the player. This population is comprised of reproducing individuals whose genome is encoded by an “infinite alleles” quantitative trait model. That is to say, each allele at a locus is a number drawn from a Gaussian distribution of mutational effects scaled to the phenotype produced by that locus. In the simulations presented here, we generate standing genetic variation in the initial population by drawing mutations at each locus.

Fitness of each individual in the population varies by game, but is typically determined by how long the individuals survive, how much damage they inflict on the player, and how many resource items they consume. At the end of each generation, each individual generates gametes at a rate proportional to its fitness. Gametes are then randomly selected from the gamete pool to generate a number of offspring equal to the desired population size.

Traits of each individual are calculated using a function particular to that trait. For example health may be calculated by summing the individual’s genome values, applying a sigmoid function to map the variation to an appropriate range, and then adding an intercept representing the minimum health.

Example 1: Evolution of color in The Ladybug Game

The Ladybug game is a simple demonstration of evolution developed by Author using the Processing programming language. In this game, the player controls a ladybug and attempts to eat aphids. The aphids’ color is controlled by a digital genome with three genes. These genes determine the value of red, blue, and green using an RGB color scale (see Figure 1 for a screenshot).
game is a specific color, and the aphids that most closely match that color are more difficult to detect. The longer the aphids survive, the more likely they are to reproduce. Generations are continuous, and reproduction is asexual.

Population size is fixed at 10. When one aphid is caught one of the other nine is randomly selected to reproduce. When an aphid reproduces all three genes (red, green, and blue) are copied from the parent and then mutated. The mutation effects are drawn from a uniform distribution with a range of -30 to 30. Thus, the mutation rates in this game are artificially high. In this example, we set the ladybug to autonomous mode (not controlled by a player), in which the ladybug “sees” all aphids in a 180 degree arc in front of it. It chases the aphid whose color is most different from the background, where the difference is the sum of the absolute differences in the red, green, and blue channels. In the case of no selection the ladybug chases the closest aphid in front of it. If there are no aphids in front of the ladybug, it travels in a straight line until it hits a wall and then it turns around. The aphids can wrap around the screen, which gives them a way to escape the ladybug – although they aren’t “smart enough” to do that intentionally.

In this example, we ran 5 replicate games in which selection was active, and 4 replicate games in which selection was turned off. Our hypothesis was that selection on color can be realized over a time frame typical of a “casual game” – in our case one minute. We tested whether the genetic value for color at each “gene” was under selection by using an ANOVA with replicate nested within treatment.

<table>
<thead>
<tr>
<th>Experiments:</th>
<th>Regular evolution</th>
<th>User control</th>
<th>No Inheritance</th>
<th>No Variation</th>
<th>No Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Go Change Environment Reset</td>
<td>Go Change Environment Reset</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variation</td>
<td>Inheritance</td>
<td>Selection</td>
<td>User Control</td>
<td>Variation</td>
<td>Inheritance</td>
</tr>
</tbody>
</table>

Figure 1: A screenshot of The Ladybug Game at the end of a replicate.
We analyzed the genetic values of each population at the end of the experiment using an ANOVA in which replicate was nested within treatment (Selection or No Selection). For all three color genes, we observed a significant difference (p<0.001) between the games played with selection and the games in which selection was deactivated (Figure 2. Thus, over the course of one minute, a player could witness the rapid evolution of color in response to player controlled or autonomous predation.

![Figure 2: The evolution of color genes under selection for matching a red background (left) and with selection deactivated (right). Each line of a specific color represents the population mean genetic value for that locus in a particular replicate.](image)

**Example 2: Evolution of speed and armor in “Project Hydra”**

In the second example, we present evidence that evolution can be demonstrated using a more advanced game engine and player experience. In this case, we use a prototype (codenamed Project Hydra) being developed by one of our graduate classes (CS 504 – Video Games and Evolution). In this game, the player controls a tank, and must navigate a map to rescue planetary colonists housed in mining pods (see Figure 3 for a screenshot). The player and the colonists are being preyed upon by alien creatures that are a sexually reproducing population (fixed at 100 individuals) with a diploid genome. The genome uses an infinite alleles model to generate genetic variation that controls their morphology, armor, health, speed, etc.
In this case, we again set the player element to autonomous mode, in which the tank was stationary and protecting resources nearby. A population of 100 creatures per generation was then allowed to attempt to damage the tank and collect resources. We replicated this condition three times, and then ran three replicates in which the tank did not fire. We observed significantly different evolutionary patterns between these two treatments. In the case of autonomous fire mode, we observed rapid evolution of armor, allowing the creatures to resist damage at the cost of reduced speed. In the control treatment (with no tank fire), we observed the evolution of high speed creatures with reduced armor (Figure 4). We used an ANOVA of the generation 5 data to test whether the outcomes for each trait were significantly different. The ANOVA indicates that after only 5 generations the two treatments differed significantly for both speed and armor value (p<0.001).
Figure 4: Rapid evolution of speed (left) and armor (right) phenotypes when the player tank can damage and kill the enemies (blue lines) and when damage is turned off (red lines).

Conclusion

We have demonstrated that accurate models of evolution need not undermine game play, and can be experienced over intervals commensurate with typical play times (less than two minutes of game play or over several “waves”). Our model does not reinforce the typical misconceptions regarding evolutionary biology that typify the current cohort of video games that profess to portray evolution. By having the enemy population evolve, we remove agency over evolution from the player. Our model also clearly demonstrates that individuals do not evolve, but populations do. Finally, the stochastic nature of our model, in which mutations are randomly drawn from a distribution and population sizes are small enough to allow genetic drift, allows demonstration that evolution does not result in a perfect solution in every case. One caveat is necessary to emphasize, however. These examples use artificially high mutation rates to generate the genetic variation upon which the player selects. Caveats such as this should be made explicit to the players of evolutionary games.

Future Work

While we have shown that evolution CAN be implemented in video games, we must now test whether these games can effectively teach evolutionary concepts (Corredor, Gaydos, & Squire, 2014). We are now collaborating with education professionals to test the educational value of our games, and refine them to make them more effective (Squire, DeVane, & Durga, 2008). In addition, we are keenly interested in whether evolution can actually IMPROVE game play.

Acknowledgements

The authors would like to acknowledge the work of T. Devault, M. Zeigler, A. Ambriz, and J. Aurajo on Project Hydra. Components of this work were supported by BEACON – an NSF Science and Technology Center.
References


How'd That Happen?!

Failure in Game Spaces to Prepare Students for Future Learning

Alison Lee (Teachers College, Columbia University), Connie Liu (Teachers College, Columbia University), Mathurada Jullamon (Teachers College, Columbia University), & John Black (Teachers College, Columbia University)

Abstract

Educational games can be used effectively in the classroom, because exploration and responses to failure in game spaces can afford productive metacognition that better prepares students for future learning (PFL). In our study, we explored how the role of failure-induced metacognitive appraisal and strategy selection while playing a physics game better prepares students for learning from formal content after gameplay. Our results indicate that experiencing failure to prepare students for future learning can elicit more complex and robust mental representations of a complicated science system. However, experiencing failure unto itself isn’t sufficient for improving general conceptual understanding – a good metacognitive response is required. Further investigation identified response to failure with info-seeking, then fixing one’s answer was found significantly related to learning because it entails an appraisal of knowledge gaps, resolving such gaps through info-seeking, and apply newly acquired information to address prior misconceptions.

Theoretical Background

Games have been investigated for a variety of educational purposes, and despite mixed reporting, meta-analyses indicate that they can be good for learning under specific conditions (Wouters et al., 2013). Generally, games are purported to be good for learning because of (but not exclusive to) the following reasons: games can be highly motivating and intrinsically interesting to students because of mechanics such as narratives, reward systems, agency, and competition (Malone, 1981; Yee, 2006); games can provide the optimization of difficulty and scaffolding that naturally promotes persistence (Gee, 2005; Juul, 2013); games can provide clear-cut goal states, feedback, and opportunities for revision/multiple attempts (Shute et al., 2009); and games provide a “low-stakes” environment through which players can explore and fail without heavy repercussions (Juul, 2013). Furthermore, games and simulations can provide constrained environments that highlight key concepts and interactions within a system, which can be particularly useful for science content that can be abstract and difficult to understand (Honey & Hilton, 2011). However, games alone are not a panacea or replacement for explicit instruction. One of the most effective ways of using games for education identified by Wouters et al.’s (2013) meta-analysis is combining serious games with instructional content, because game experience provide students with “well-structured prior knowledge” that they can then access and build on during later learning. It is in
this premise – that games can provide grounded exploration and interactions with abstract content that can inform later formal learning – that is the subject of investigation in this paper.

Transfer, or the ability to take what is learned or experienced in one context to use in another, is a fundamental goal of learning. However, a century of investigations and epistemological debate has yielded ambivalent conclusions about precisely what constitutes and yields transfer of knowledge (Barnett & Ceci, 2002; Chen & Klahr, 2008; Detterman & Sternberg, 1993; Singley & Anderson, 1989; Thorndike & Woodworth, 1901). Recently, investigations in the field of the learning sciences have led to novel approaches in the instruction, definition, and utility of transfer for learning and skill development. In the Preparation for Future Learning paradigm, transfer is defined as the use of prior experiences to inform and improve later learning (Bransford & Schwartz, 1999). The idea is that oftentimes we use prior knowledge to notice and frame new information, and that these “knowing with” kinds of prior experiences can greatly shape and improve understanding of the new context. Having relevant, familiar prior experiences can prepare you to ask the right questions, notice the important components, and therefore lead to deeper, more robust conceptual models of the learned material. While PFL may seem to be a common-sense approach to education, PFL as a framework for pedagogy is a relatively new approach.

PFL studies highlight the utility of activities where students explore and grapple with relevant content. Oftentimes, these activities are explicitly designed such that students are thrust into a problem-solving environment that compels them to wrestle with underlying principles of the concepts. Schwartz et al.’s (2011) work on inventing with contrasting cases as PFL demonstrated that even when students were not always ultimately successful in their inventions prior to learning, their invention experiences before instruction led to better transfer outcomes on two dimensions: better conceptual understanding of ratio structures in physics, and better application of this ratio structure to other domains. This finding demonstrates that students who explored the underlying principles of ratios through invention learned, abstracted, and applied these concepts better than those who took the traditional route of learning first and then practicing (“tell and practice”). Their conclusions suggest that a critical mechanism of this PFL activity is fostering an “appreciation of the deep structure” of the concept such that students readily called upon their experiences with this deep structure when learning about the formal concept later on. As such, we can look at transfer as a process, where accessing prior experiences and information is a skill to be cultivated for more effective learning, rather than only looking at transfer as an indicator that learning has occurred. However, they do not discuss what specific mechanisms of invention-with-contrasting-cases led to greater noticing of the deep structure. Thus, there are some questions not yet answered: what is the role of iteration, failure, strategy, and realizations about insufficient solutions in noticing these deep structures?

Manu Kapur’s (2008) work with PFL attempted to address some of these questions by isolating failure as a vital component of preparing students for future learning. Kapur used the PFL framework to design an intervention using either well-structured (and scaffolded) problems or ill-structured problems prior to formal learning. His work revealed that despite students in the ill-structured condition struggling with defining, analyzing, and solving their problems (in other words, failing to generate explicit understanding of the concepts or effective solutions), these experiences were more conducive to learning later on. This phenomenon, which he coined “productive failure”, demonstrated that success in the traditional sense (that is, success in clearly defining concepts and generating effective solutions) may not necessarily lead to greater learning; in fact, designing problem solving tasks that scaffolds and directs learning towards “success” may unwittingly undermine the effortful cognition that could benefit formal
learning later on. Instead, environments and tasks that permits for students to initially fail and grapple with concepts rather than “succeed” can be more beneficial to future learning. However, Kapur also did not elucidate what specifically in the productive failure space led to greater learning. Does failure in itself call attention to deep features? Or does failure afford opportunities to engage in cognition that then leads to deep feature noticing? How much failure is sufficient for PFL? What makes the failure productive? Are there ways of designing tasks that promote productive failure, rather than just plain failure (that is, if there is even in fact a difference between regular failure and productive failure)?

Loibl & Rummel (2014) addressed some of these questions by asserting that productive failure improves learning by calling students’ attention to the gaps in understanding when they confront a failure. In their work, they demonstrated that attempting to solve problems before formal learning can lead to a global awareness of knowledge gaps – that is, acknowledging that some component of their understanding is incomplete without specification. This awareness is a kind of global cognitive appraisal that arises from students’ inability to solve the problems (a failure), that are then fully specified and addressed in teacher instruction. However, while they discuss global knowledge gaps (global metacognitive awareness) as a mediator for failure to positively impact learning, they do not explicitly discuss moment-to-moment metacognitive behaviors that happen in response to the failure that can also be productive for learning.

Much of the work surrounding failure in educational research entails demonstrating the importance of resilience in the face of failure, with advocates from pop culture like JK Rowling and Steve Jobs, to the seminal works on mindset by Carol Dweck (2006) and grit by Angela Duckworth (2007), who largely emphasize affective resilience in response to failure (that is, how we can encourage people to persist in the face of failure, given that failure is often the pathway to success). However, little has been done to identify when and how failure can be useful – that is, what are the kinds of “necessary and sufficient” conditions of the task, the learner, and the instructional method such that failure is productive? For example, are there certain kinds of reflection that should be happening in the failure space, or does productive failure entail the capacity to select the appropriate consequent actions in response to failure? What about the role of acknowledging and pinpointing what caused the failure, presumably a vital part of noticing the deep features of a concept?

These components are encapsulated by metacognition, or the ability to judge and monitor one’s own states of knowing, and employ strategies to improve understanding. Metacognition is a critical part of learning because it permits learners to identify, more deeply understand and effectively address gaps in knowing (Flavell, 1979). Metacognitive processes are commonly discussed as a critical component of teaching students to transfer because the act of self-monitoring helps facilitate the recognition of when the information or strategy might be relevant in other contexts (Perkins & Salomon, 1992; Belmont, Butterfield, & Ferretti, 1982; Adey & Shayer, 1993). Each moment of failure affords an opportunity to make a metacognitive judgment about what knowledge component is lacking. In addition, environments like games that afford opportunities to address those gaps (through revision, hint-seeking, and scaffolds) can also mediate deeper conceptual understanding later on. We argue that students who act in more reflective ways during the PFL activity, whether those metacognitive behaviors are enacted by natural predilection or provoked by the environment, would attend more carefully to deep features and therefore will be more prepared to learn from future learning activities. Furthermore, metacognition is especially valuable in failure spaces, because the most “productive” affordance of failure is to address head-on what those gaps between expected and actual outcomes are, and what actions should be taken to resolve them. Presumably, what makes productive failure good for preparing students for future learning is contingent on students’ abilities to reflect on their incorrect solutions,
address gaps in knowledge, and select strategies and actions in response to these appraisals. It is through these metacognitive mechanisms that cue students to identify and engage with deep features of the concepts. However, getting students to engage in these metacognitive behaviors is an arduous task – students are often intimidated by failure, particularly in school tasks where failure often involves high-stakes consequences, such as failing a quiz or getting a low score on your homework. Furthermore, these common school tasks do not often permit or encourage efforts to respond to those failures – that is, they don’t provide the tools, encouragement or opportunities for students to review their incorrect solutions, appraise where knowledge gaps occur, seek to close such gaps, and fix their solutions. What curricular tools might provide low-stakes, engaging problem-solving environments that encourage student iteration, permit for metacognitive behaviors, and allow for exploration of academic content in meaningful, goal directed ways? Games fit all of these criteria.

Failure is a critical component of games, where the process of failing (a level, a fight, a boss, a puzzle) is inherent in the game design in order for it to be compelling and entertaining. People appear to be incredibly productive when encountering failure in games, where they use the failure experience to inform future decision-making and understanding of the problem space. These kinds of metacognitive behaviors – reflecting, judging the goodness of one’s performance, coordinating strategies, planning next actions to address what went wrong previously – are ones we strive for students to employ, but are enacted so naturally in game environments. Furthermore, game spaces seem to promote resilient behaviors in the face of failure – perhaps because the failures do not have high stakes (outside of the game), and therefore does not negatively impact motivation. On the contrary, despite deliberate designs for inducing failure, games seem to encourage engagement and persistence, even (and perhaps especially) when the player is frustrated and confused (Juul, 2013; Csikszentmihalyi & Larsen, 1980). Games are a natural fit as a PFL activity, as they provide a space for exploring real systems, especially those that would otherwise be impossible to interact with in real life, and are goal directed and constrained to cue learners to key concepts and system structures (Malone, 1981; Garris, Ahlers, & Driskell, 2002; Black, Khan, & Huang, 2014; Reese, 2007). Situating exploration, problem-solving, and systems manipulation in a game can be a powerful method for generating intuitions about a particular concept or system (Garris et al., 2002; Honey & Hilton, 2011). These grounding experiences can prepare students to better learn from formal content later on (Hammer & Black, 2009). Therefore, the game space is essential for us to investigate what cognitive mechanisms are at play in failure that are good for future learning, while alleviating the concerns about motivation and the high-stakes nature of failure in school tasks.

Given these threads of research on games, preparation for future learning, productive failure, and metacognition, we seek to investigate what role metacognitive responses to failure in a physics game play in preparing students for future learning. Thus, the broad scope of this research is to ask the following questions:

Q1: Does the affordance for responding to failure elicit deeper conceptual understanding?

Q2: Are there particular metacognitive responses to failure that are better for learning?

Study Design

36 adult subjects were recruited from a NYC university. 83% were pursuing a graduate degree, and all of them held at least a bachelor’s degree. All subjects reported reported low prior knowledge of
the concepts covered in the study. Subjects learned about basic principles of direct current circuits by playing a game called Electropocalypse (the PFL activity) and by watching Khan Academy videos about direct current circuits. Electropocalypse, a puzzle game, takes players through a narrative where they act as electrical engineers who must reconfigure electrical circuits to meet level goals, each involving another physics principle. Subjects played a subset of levels (1-13) covering content like closed/open loops, short-circuiting, and resistors in series and parallel. All subjects played the game, watched four Khan Academy videos, responded to surveys, and completed three Open-Ended Worksheets (OEs) and a Post-Test. Subjects were randomly assigned to three study conditions: Tell-and-Practice (Tell), Full PFL (Full), and No Failure Response PFL (NFR). The Tell served as the control condition where students first watched the video, followed by the game (See Figure 1). In the Full condition, students played the game, followed by watching the videos. In the NFR condition, students followed the same order as the Full condition, but played a version of the game where if they submitted an incorrect solution (failure), they were not permitted to view or fix their solution, but instead received an explanation and screenshot of the correct solution (see Figure 2). This NFR condition was created so that we could isolate the effect of metacognitive responses to failure without manipulating the naturally-occurring amount of failure subjects experienced when playing each level for the first time. Furthermore, this condition mimics the structure of many common classroom activities, where students complete a set of problems (like homework), receive their grade indicating whether their solution was correct or not, but do not have the opportunity to fix or engage in metacognitive behaviors in response to those solutions.

![Figure 1: Study Design](image1)

![Figure 2: Normal Feedback Screen (left) vs. NFR Feedback Screen (right)](image2)

Learning and behavioral measures evaluated each subject’s learning of physics principles, complexity
of his/her her conceptual model, and his/her metacognitive response to failure. Learning measures were assessed through three OE Worksheets and a Post-Test. The OEs contained the following prompt: “Draw and explain a parallel circuit. Be sure to label all relevant parts of the circuit system, explain what a parallel circuit is, and how it differs from a serial circuit.” OE responses were coded on two dimensions: correctness and complexity. The OEs were given at three time points: TP1 (pre-measure), TP2 (after first activity), TP3 (post-measure). The Post-Test comprised of four sections: three multiple choice questions about Ohm’s Law, three questions on reasoning about a diagram, two transfer questions that asked subjects to reason about water pipes based off of direct current circuit concepts and relating concepts/components of the water pipe system to direct current circuits (a common analogous reasoning prompt used to measure transfer), and two PFL questions on Voltmeters and Ammeters. Post-Test responses were also coded based on content, transfer, and complexity. Behavioral measures were assessed through log data from the game. The log data generated a list of subjects’ actions over the duration of the gameplay. Analysis of the log data identified action sequences in response to failure, duration of time spent on a particular action or level, and how subjects navigates throughout the game.

Results

Learning Outcomes

There were no significant findings in Post-Test content ($p=.227$), transfer($p=.774$), or complexity scores ($p=.814$). A repeated measures ANOVA on OE correctness scores also indicated that there were no significant differences in OE correctness scores by OE3 ($p=.238$). However, while learning of the physics concepts equally occurred across all of the conditions, subjects in the Full Condition produced more complex explanations of direct current circuits in parallel and series. A RM ANOVA on OE complexity scores revealed that the Full condition provided more robust explanations ($F[4,64]=6.213, p<.001$) of electrical circuits at TP3 than the other two groups (See Figure 3).

![Figure 3. OE complexity score.](image-url)
Behavioral Outcomes

Game log analysis also identified eight distinct responses to failure. Behavioral responses to failure included “Info-seeking, restarting the level”, “Info-seeking, fixing current solution”, “Fixing current solution”, “Quick Resubmit (did not change solution)”, “Restarted Level”, “Skipped backwards”, “Skipped forward”, and “Skipped to next level.” Of the eight responses to failure identified, “Info-seeking, then fixing your answer” was positively correlated to Post-Test complexity. ($r$[13]=.694, $p$=.009).

General Discussion

Our findings suggest that engaging with failure in game spaces before formal learning can elicit more nuanced mental representations of a complicated science system. While there were no condition differences in Post-Test and OE3 conceptual understanding measures, we found that students in the Full condition produced more complex and robust explanations of parallel and serial circuits in the last open-ended worksheet. This suggests that while the various methods of using games for learning across these three conditions can produce benefits to conceptual understanding, the affordance of experiencing failure can better prepare you to learn from formal content later on, thereby producing more nuanced and rich conceptual models. However, our expected finding that the Full condition would also perform better on the Post-Test analogous reasoning transfer and PFL measures was not confirmed, nor were the complexity of their responses on the post-test any better or worse than the other two conditions. One possible explanation for this is that our particular population – adult graduate students at a reputable institution of higher learning – already possessed the intuitive and grounded prior knowledge that would be required to make the analogy between electrical circuit and water pipe systems, thus negating any benefits that using games as preparation for future learning would otherwise yield. Another possibility is that our study did not provide enough of a treatment to have a significant effect on these other dimensions – after all, the game session only lasted 45 minutes and occurred only once. This is supported by Wouters et al.’s (2013) meta-analysis, which suggests that games are better for learning when there are multiple sessions of gameplay. Another possibility is that the measures of transfer used – the analogous reasoning and PFL questions – were not sensitive enough to detect significant differences between groups, or that they were not the right kind of transfer assessment to use for this kind of learning.

These results suggest that simply engaging in failure unto itself is insufficient for improving general conceptual understanding more than just playing the game with learning, even though failure can benefit the complexity of one’s conceptual model. However, our results did demonstrate that there are effortful metacognitive behaviors that are related to better learning. We found that of all the responses that one can take in response to failure in our game environment, the response of “info-seeking, then fixing one’s answer” was significantly positively related to learning. When considered within the framework of metacognition, this is beneficial because it required subjects to appraise and become aware of knowledge gaps, resolve identified gaps through info-seeking, and then apply the newly acquired information to adjust prior misconceptions. All three of these components – the appraisal (or the awareness of knowledge gaps), the resolution (or “filling-in”), and the application – are equally critical to learning. This is in contrast to Loibl & Rummel’s (2014) conclusion that the awareness of knowledge gaps alone account for the benefits of productive failure for learning – we see that a general awareness is not as important here (as evidenced by our nonsignificant differences in Post-Test conceptual questions) so
much as the specified appraisals of what one does not know in the moment of failure. Furthermore, we see the importance of the “application” component when contrasting “info-seeking, fixing” with “info-seeking, restarting” – if resolving knowledge gaps alone (through info-seeking) were sufficient for productive failure, then we should have seen that both of these strategies would be statistically significantly related to learning. However, seeing that fixing one’s solution after info-seeking may have been the key component suggests that the metacognitive actions taken after metacognitive judgments made are just as important as the judgments themselves – knowing that this newly acquired information must be used to address previous failures is a vital part of the learning process. This may be related to the “appreciation for the deep structures” Schwartz et al. (2011) referred to in their own PFL activity – that is, info-seeking and fixing one’s solution may have led to greater intuitions about the underlying concepts and structures of parallel and serial circuits that then led to more complex conceptual models. An alternative explanation is that these other behaviors may also be significantly related to learning, but that our sample size for these correlations are too small and therefore not detectable.

To conclude, using failure spaces in games for learning can be an effective way of improving the complexity of students’ conceptual model, but have tenuous impact on more general conceptual learning and transfer. Furthermore, the most effective metacognitive response to failure in our game was to fill in knowledge gaps through information seeking, then applying this new information towards fixing one’s prior incorrect solution. However, we are limited in our conclusions about the degree to which games in general can be an effective PFL activity, because our population may have already possessed the appropriate prior intuitions about the system, or because our transfer measures were insufficient, or our treatment duration was insufficient. To address these limitations, future studies should examine whether this game can be used as an effective PFL activity for younger students with little or no exposure to the content, using alternative transfer measures such as delayed assessments, and using multiple game sessions for the treatment. Above all, future studies should compare whether the addition of metacognitive prompts after failure that provoke students to appraise, info-seek, and apply information to fix solutions in the game can produce better learning outcomes in both conceptual learning and conceptual complexity.

References


Belmont, J. M., Butterfield, E. C., & Ferretti, R. P. (1982). To secure transfer of training instruct self-management skills. How and how much can intelligence be increased, 147-154


Loibl, K., & Rummel, N. (2014). Knowing what you don’t know makes failure productive. Learning and Instruction, 34, 74-85.


Making Design Activities Gameful Using a Role-Playing Card Game

Beaumie Kim (University of Calgary) & Diali Gupta (University of Calgary)

Abstract

This paper presents our attempt at making a master’s level course on Digital Game-Based Learning (DGBL) gameful. The students were expected to propose design concepts for educational games at the end of the course while collaborating in groups. In our effort to make the design activities gameful, we created a role-playing card game for designing DGBL, which challenged the players to use various learning and design principles. Adopting Holden and colleagues’ (2014) conceptualization of gamefulness, we observed that learners showed a lusory attitude in designing DGBL when playing this card game. In this paper, we discuss our design of the course and the role-playing card game. We also argue that engaging in such a card game supports learners’ gameful learning based on preliminary findings from using the game in the classroom.

Introduction

Educators are increasingly attempting to incorporate games and game dynamics for student motivation and performance at various levels of education (Johnson et al., 2014; Sheldon, 2011). The approach of changing classroom dynamics similar to that of games is often called gamification, which uses game design elements within a non-game context. Within educational contexts, it could be the productive interaction generated through simple game play for learners and educators (Rughinis, 2013; Leech et al., 2014). Gamification has gained popularity in higher education specifically in science and engineering-based disciplines (e.g., Barata et al., 2013). In the field of Education, there have been consistent efforts to make the courses on game-based learning more game-like by the instructors of in-service and pre-service teachers (e.g., Fishman & Aguilar, 2012). These efforts found that game scoring mechanics mapped to course assessment does not necessarily engage students (Fishman & Aguilar, 2012; Sheldon, 2011). We concur that an assessment-focused gamification of a course may not promote students’ gameful engagement. Hence we focused on how course activities could be more gameful. The term ‘gameful’ was used by McGonigal (2011) to emphasize goal-driven and serious efforts in gameplay. Recent research on university course designs with gameful grading systems revealed that students not only perceived the grading system positively but it made them work harder and feel more control over their learning (Aguilar, Holman & Fishman, 2014).

As facilitators and researchers of a master’s level course on Digital Game-Based Learning (DGBL) at
a Western Canadian university, we advocate engaging pre-service and in-service teachers in gameful learning activities (Kim, 2015). The course used game concepts and dynamics (e.g., experience points and multiple battles) (Sheldon, 2011), while exploring various forms of games, and their design and learning principles for their potential use for classrooms (Kim, 2014, 2015; Kim, Gupta, & Clyde, 2015). Building on the gameful experience framework proposed by Holden and colleagues (2014), we explicitly communicated with students that being gameful was an important element of the course. Considering how card-based games as a pedagogy foster collaborative learning and essential 21st century thinking skills (Reese & Wells, 2007), we incorporated a role-playing card game to support students’ design of a DGBL environment. Gressick & Langston (2015) similarly designed and implemented card games to scaffold student recognition of fallacies in thinking and avoiding them through social negotiation. Our role-playing card game was designed to play in groups of 3-5 students where each player drew from a selection of cards from three categories – disciplinary, interdisciplinary, and multidisciplinary that determined their expertise in approaches, and encouraged collaboration on a game design using sound principles. In the following, we briefly discuss the multiple iterations of the course and our approach to gameful participation, including the role-playing card game. We then present the preliminary findings from using the game in the classroom.

Gamefulness in the Classroom

Players or learners who are gameful make efforts to understand the rules or constraints to accomplish game goals, negotiate their identities within and around the game, and cultivate curiosity and inquiry to overcome their ignorance (Holden et al., 2014; Kim, 2015; Salen, 2011). These three dynamic elements, namely ‘ludory attitude’ (Suits, 2005), identity, and ignorance, help experience gamefulness (Holden et al, 2014). The gameful experience through these dynamic elements also supports learners’ cognitive, social, and emotional engagement in learning. Cognitively, players engaged in non-linear repetitive tasks, progressively discover overt or hidden game rules and gain expertise in both the content and rules of the game (Domínguez et al., 2013; Lee & Hammer, 2011). This requires them to cognitively identify their area of ignorance and actively seek solutions. In this process, they project and conceptualize multiple identities that are pertinent to the game as well as their social worlds beyond the game environment (Holden et al, 2014). The players’ ludory attitude of addressing these challenges is socially stimulated, especially when players identify varying expertise (i.e., identities) as well as weaknesses while seeking solutions (i.e., ignorance) within the collaborative game settings. Similarly, gameful engagement accompanies and is intensified by a range of emotions. Emotions, from curiosity to frustration to joy, can be powerful source for deeper engagement (Kim & Kim, 2010; Lazzaro, 2004). Mild frustration for failing a seemingly achievable goal, joy of figuring out a solution with co-players, and curiosity toward what solutions competing players may come up with are some of the examples that could motivate players for deeper engagement. The design activities of a game or a course can support gameful learning, but these dynamic elements come into play when learners start interacting with the design. In this section, we discuss the design of course activities that may support learners’ gameful engagement.

Supporting gameful participation

Every activity in a two-week summer intensive course on DGBL was positioned as meaningful experience, and participants could score experience points (XP) every day (for more details, see Kim,
The instructor conducted this course for three years (2013, 2014, 2015), in which students participated in online (Google+) and in-class conversations and activities. There were a number of changes in subsequent iterations. For example, after receiving varying reactions to the leaderboard of XP in 2013, we started having participants create avatars for Google+ community for anonymity in their online activities and XP for the leaderboard (Kim, Gupta, & Clyde, 2015). This also reframed online conversations as a gaming experience (McGonigal, 2015; Ramirez & Squire, 2015). Students tried to figure out their peers and to hide their identities at the beginning but became less concerned about avatars and anonymity as the course progressed and they were more focused on their group work. Some students expressed their concerns during the second iteration over posting on Google+ during class time instead of participating in discussions. Hence the third iteration focused on exploring gameful participation during the class discussions and group design in addition to improving various existing elements of the course. For XP, “Gameful Participation” was introduced to put more emphasis on in-class activities with the guidelines in Table 1.

<table>
<thead>
<tr>
<th>Gamefulness</th>
<th>On-going leadership</th>
<th>Contribution to the guild</th>
</tr>
</thead>
<tbody>
<tr>
<td>You will be rewarded by being fully immersed into the new rules of this course and contributing to everyone’s (including facilitators) learning experience.</td>
<td>Your leadership can be in many different forms and are essential for our learning. Share your expertise as teachers, gamers, designers, parents, experienced learners, etc. with us!</td>
<td>Contributing productively to your guild is also the process of finding and developing expertise. Exercise distributed leadership within your guild.</td>
</tr>
<tr>
<td>Warning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engaging in other activities, such as checking your emails or social media, would distract you from being fully immersed.</td>
<td>Having no voice or dominating the conversation may not give you the full experience of the class.</td>
<td>Again, simply following or dominating your guild's decisions may not give you the full experience of the collaboration.</td>
</tr>
<tr>
<td>Tweeting or microblogging on social media, including our Google+ community, may help you only when the content is immediately relevant to the on-going activities/topics.</td>
<td>Asking good questions to those who have different expertise will also give you a better learning experience.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Guidelines for Gameful Participation XP

Gamefulness as the first guideline encourages lusory attitude. On-going leadership part of the guideline emphasizes developing their existing and other multiple identities. The third guideline, Contribution to the guild, focuses on the ignorance element by encouraging their development and identification of varying expertise of the group (i.e., guild) members. All three guidelines draw attention to their social and cognitive influence on other participants.

Students’ gameful participation was put into test from the first day of the class. At the beginning of the class, the students had to play an icebreaker game by preparing clues (i.e., questions and drawings) about themselves based on how they wanted to introduce themselves in class. Out of the seven students, one team comprised of four students and another the remaining three. Each team received the opponents’ clues (2 or 3 items, 8 total for each team), shuffled and drew them, and guess who the clues referred to. One group appeared more competitive based on their difficult questions. This gameplay led to a display of lusory attitude as the students engaged in conversations on why games are engaging,
the value of games, how games draw people together and help with problem solving. The students’ multiple identities began to emerge as their clues highlighted not only their personal experiences (e.g., their hobbies, family) but also their relevant experiences such as expertise at gaming, exposure to digital games, experience at using games in their classrooms. Starting with this game, sparked students’ identification of their areas of ignorance as they began taking a deeper interest in the types of games they would play for the course, while familiarizing themselves with game terms such as “battles”, “avatars” and how that would play out in the course.

Making design activities more gameful

This course used the concept of game “battles” for different levels of tasks and their goals (Sheldon, 2011; Fishman et al., 2012), especially for their DGBL design project. In digital games, a boss battle is the most challenging part at the end of a level, which would require players to use varying skills and knowledge (about the enemies) they acquired. In this course, students needed to fight three battles, including forming and introducing the teams, sharing on the project with in-class playable components, and producing the DGBL project document. In the course of completing first two battles, students shared parts of their prototypes on Google+ and received feedback from other students and the instructor. To make their preparation for the final battle a more gameful effort, we created a role-playing card game for the group’s DGBL design activity. The goal was to design and pitch a game with sound learning and design principles while developing their design expertise. We would like to highlight three main features of this card game: game content, role-play, and progression.

![Figure 1: A Deck of Cards](image)

Game content

The students were given a deck of cards with key design principles for DGBL (See, Figure 1), drawn from the previous course discussions on readings. They were categorized as Game Structure, Learning Principles, Game-Based Learning, and Game Aesthetics. Categories were written on the card, and also
indicated by different colours. They started this game during the second week (Day 6, 13th of July) of the course, so they played it with their preliminary game ideas from the first five days. The players were expected to use the cards to elaborate upon the design principles for their game design. Each card had assigned points (1 to 9), considering its expected complexity of addressing them. They were also required to fill out scoring sheets, with which they could record the evidence of using design principles (i.e., describing relevant existing or modified design). The competitions were implicit in the game in varying levels, including developing their personal design expertise, better addressing design principles (within and across groups), and creating more sound educational game designs (between groups). Both their scores and design products represented their achievements.

**Role-play**

Based on the four categories of design principle cards, each player was asked to take on a disciplinary, interdisciplinary or multidisciplinary expert role, by focusing on one, two, or more than two categories. This was an opportunity for participants to think about their own design expertise, and at the same time, to strategize how they could productively design together, rationalize their design choices, and score better for the game. The participants were provided with character sheets to record their individual information about their roles.

**Progression**

Students played this game and with their game designs for three days. The progression for three days was for both game content and role-play. On the first day (Day 6, 13th of July), students received the first three categories, as they were relevant to the readings and activities from the first week. To focus on understanding the cards and initial gameplay, they took turns with different cards without assigning any role. On the second day (Day 7, 14th of July), the fourth (Game Aesthetics) category was added as it was relevant to the readings and activities of the day, and students were introduced to the three expert roles. On the last day of the role-playing card game (Day 8, 15th of July), they had a chance to create their own cards (up to 15 points within 2-3 cards) for the categories they chose. They could also change their roles with the new cards. Through this structured progression, students were expected to increase the complexity in their game design and the way they played this card game.

**Preliminary Findings**

For their design activities or multiple battles, they formed two groups. They named their teams with their game titles, *The Castaways* (CA) and *The Sorcerer’s Apprentices* (SA). We observed that using the role-playing card game was effective in students’ deeper appreciation for DGBL literature and relevant design principles and gameful engagement in their design of DGBL for both groups. CA team consisted of three female teachers of Western Canadian schools whereas SA team had two female and two male teachers with diverse teaching assignments across the world.
Lusory attitude toward playing and designing

The CAs decided to design a science game for elementary students (Grade 2) involving concepts from boats and buoyancy (see Figure 2a). They decided that their students would learn this content well through experimentation in the game. From our observation, the CA members carefully followed the game rules, including taking turns to read the card and identify the evidence of using the principle in their game, and deciding if each of them scored the assigned XP in each card. In the effort of better playing this card game and finding their design evidence, they chose fewer cards but of higher point values. On Day 6, this group also chose to incorporate features from games played or observed during the class. While discussing game structure (Navigation and Clues), the group decided that the AI or the monkey provides instructions when the players are unable to progress, similar to what they experienced during their game play of Portal. In discussing the principle of Immediate Feedback, they focused on incorporating the feedback into the narrative, that is, boats will not make it to the next island if not built or repaired properly. On Day 7, their discussion on the principles was centered on better incorporating the content into gameplay. For example, when they discussed problem solving (game-based learning category), they delved into how AI can offer hints at the beginning to better explain what the players have to do. Similarly for sense of agency or ownership (game-based learning), they discussed how the creation of avatars and the opportunity to assemble their own boats would work well with elementary students. The lusory attitude was therefore visible in their effort to incorporate major learning principles while interpreting and following the rules of the card game.

The SA members, on the other hand, loosely followed the rules by having conversations on the design principles in each card regardless of their turns. They designed a game for English language learners and focused on improving the game mechanics. They used ten principles focusing on conveying “meaning” by players using vocabularies within the game. The overall design was to generate various pictorial mazes (see Figure 2b) within the game either through levels or through failure states. Another example is from their discussion on how learners relate to facts and their associated themes while comprehending a narrative on Day 6. They created an overall narrative of collecting and delivering items to the sorcerer, in order to create potions to defeat attacking poisonous creatures. After examining the design principle of themes and narratives, they decided that each level would have a thematic collection of vocabularies. The narrative would evolve with the elements of non-player characters, setting, rising complication, climax and resolution. These characters came in the form of poisonous creatures and at the initial levels the setting involved easy mazes with easily achievable goals. Similarly in order to retain the interest of the players as new language learners they worked on how to make failures interesting on Day 8. They discussed various design choices for the failures (i.e., wrong match between a word and an object) in the game, such as a more complex maze with creatures of stronger poison or faster speed, the changing colour of the wizard (darker and darker) or sudden appearance of enemies who they would have to fight. By going through each principle card, they had an opportunity to be much more critically about their design of the game. Even though they were less careful in following the rule of the card game, they showed lusory attitude towards understanding how game design relates to creating engaging learning experience.
Group members’ identities

During this card game play, it was apparent that each one of them contributed based on their ideas and experience of playing games, and working with children on particular subject areas. In CA group, one member was viewed as a content expert whereas other members emerged as a leader and supporter of the project, according to their reflection papers. As elementary teachers, they showed their understanding of how children would prefer dealing with avatars such as “the monkey” asking players to work in teams or even inducing creativity battles in the game where the children would have fun decorating and naming their boats. As mentioned above, it was clear that CA group members carefully follow new rules presented. For example, on the second day (Day 7), each of them took on disciplinary, interdisciplinary, or multidisciplinary role as our example showed three facilitators taking on one of them without overlapping. It was unclear from this preliminary analysis that they were choosing cards based on their existing area of expertise.

In SA group, there were three teachers working in Asia and the Middle East and based on some of their design ideas it appears that they took cultural perspectives of their contexts into consideration. For example, they thought of including a sense of urgency and stress to relate to real world problems of not understanding a foreign language within the DGBL principles such as rewards, motivation, or sense of urgency and ownership. On Day 7, they made provisions for players to notice that their vocabulary is increasing through the Learning and Identity card. Of those who chose the Learning and Identity card one is a science teacher in the Middle East and hence took on the role of an interdisciplinary expert focusing on knowledge being transferable, active, and critical and players progressing through rewards and levels. Again, with game mechanics principles such as Focusing Attention & Balance, they specified how the magic balls added time pressure or the timer gave points that created stress for language learners since the learners already had to deal with more words and more enemies at each level. We also found that one of the members took on the role of technology design and gaming expert based on her experience as a Minecraft player. She chose to be a disciplinary expert on “game aesthetics” and contributed to the design conception of monsters and zombies attacking the players while learning language, as seen in Minecraft adventure or survival mode. Thus the collaboration became evident.

Figure 2. Sample mock screens of two groups’ game designs.
through the way each participant thought through the game design utilizing the principles from the cards and infusing their own experience garnered through various identities.

Identifying areas of ignorance

Both groups showed their curiosity or ignorance through their game designing activity. CA group made multiple changes to their game design throughout the three days of the role-playing card game to improve their game. On Day 8, students created new principle cards for their games. These cards may indicate their identification of what was lacking in their games. Their discussion centred on what principles to add so that they could score on what they were able to improve upon during these three days. CA members created a card on Game Stucture about Backstory, which reads, ‘A compelling & engaging backstory is presented’ with 3 points. They created two cards on Game Aesthetics based on Dewey’s (1934) account on aesthetic experiences. They initially assigned 5 points to all three cards, but upon further critical examination realized how it was a challenge for them to address Unity in their game design and how backstory was not as a complex principle. They finally decided to give Unity principle 7 points and Backstory 3 points (See Figure 3a).

![Figure 3. New cards created by two groups on the last day.](image)

SA group, who were designing a language learning game started to identify literature on language learning to better rationalize their game design as they examined their game much more deeply by playing this card game. They realized after an in-depth discussion how their game could not fulfil many of the principles in the cards without completely changing its design. They came up with the notion of embedding a “Playful Spirit” in all elements of the game and especially in communication and input mechanisms. And this playful spirit was reflected in their consistency with retaining interest in the game because they were aware how vocabulary mastery games placed lower in the order of Bloom’s taxonomy could be monotonous experiences. They categorized it under Game Aesthetics and assigned the card 6 points. Similarly they felt that there need specific design elements to incorporate failure in order to motivate the players to attain success. They categorized this card under Game Structure and assigned it 9 points. This also exemplifies how they were trying to contextualize and add to the game design principles in a broader context to make the design more relevant from a gamer’s perspective. Both groups’ work indicates their engagement in critical inquiry that challenged the relevance of creating educational games for present day learners.
Conclusion

The earlier iterations of the course had identified the need for more playable in-class activities. Hence this third iteration was designed to accommodate in-class design activities through a role-playing card game, which would facilitate learning through play. The role-playing card game itself utilized most of the design principles of DGBL in the cards, which forged stronger alignments between course activities and game design principles thereby making the in-class activities more playable. The assignment or choice of cards by the players also allowed for meaningful roles highlighting collaboration and multidisciplinary work towards the gamefulness of the players. Although it was not clearly visible through course activities, their gameful participation was encouraged as XP were granted based on on-going leadership and contribution to the guild. Students self-assessed their XP throughout the course. This helped bring out their identities, their interests and their expertise, which added to their gamefulness. It also became easy to determine the lusory attitudes that emerged from players’ voluntary and focused attempts to play with academic content of the course in relation to their identities as educators and emergent identities as designers (Holden et al, 2014). The lusory attitudes towards playing the card game also helped understand their need to question the articles or principles they were learning in relation to the games they played in class taking into account their relative experience at playing digital games. The inquiries covered a wide range of topics on the connections between game design and digital game-based learning and learning in general. This helped measure their gameful learning from the curiosity or ignorance (Holden et al. 2014) that they generated during their discussions or class debriefs. Since the classroom was also a place the learners could explore and take risks with low real-world consequences it helped us to comprehend their multiple identities – real world, virtual and projective identities that fostered new ways of thinking about themselves, their potential and their social relations (Holden et al. 2014).

References


Invasion of the Energy Monsters

A Spooky Game About Saving Energy

Michael S. Horn (Learning Sciences and Computer Science, Northwestern University), Amartya Banerjee (Computer Science, Northwestern University), Pryce Davis (Learning Sciences, Northwestern University), & Reed Stevens, (Learning Sciences, Northwestern University)

Abstract

We present a cooperative tabletop game called Invasion of the Energy Monsters designed to encourage entire families to reflect on how to use energy at home and to think about implications for global environmental sustainability. After briefly reviewing related work, we outline our design principles, describe our game, and share preliminary findings from playtesting sessions with families in their homes.

Introduction

Confronting issues of global climate change will require creative approaches to energy production and consumption across a range of human activities. One pressing area of concern is residential energy consumption, which, in the United States, accounts for over 20% of the country’s overall energy
expenditure (US EIA, 2015). Reports from the US Energy Information Administration suggest a range of simple actions that families can take to reduce their impact on the environment. Yet research on environmental education and eco-feedback technology has repeatedly demonstrated that consumers lack a basic awareness of the magnitude of their own consumption, the basic units of energy (such as kilowatt hours), the relative impact of different appliances, and the cost of energy in their city or region (IBM, 2011; Chetty, Tran, & Grinter, 2008; Kuo & Horn, 2014).

To help address these issues, Green Home Games is a research and design initiative with the goal of creating playful learning experiences to help families think about how they use energy and how they can reduce waste. Our prior games have focused on heating and cooling systems (Horn et. al, 2014) and hidden forms of energy consumption (Banerjee & Horn, 2013). In this paper we present a tabletop board game called Invasion of the Energy Monsters that deals with household electricity consumption.

The premise of the game is that your home is being invaded by a menagerie of menacing energy monsters, each representing a different form of waste. The monsters start out weak but quickly grow stronger as they feast on your excess energy use. You, the energy heroes, must band together and expel the monsters before it’s too late. Below we review related work, describe a set of design principles, and provide an overview of the game. We then share preliminary findings from playtesting sessions with 5 families in their homes along with reflections on directions for future work.

Related Work

Our game builds upon the following areas of previous research: (1) eco-feedback technology for homes and (2) playing to encourage pro-environmental behavior.

Eco-feedback technology for homes

Prior work has argued that environmental sustainability is not a global standard, but something that must be defined by families and communities for themselves and on their own terms and in light of their unique circumstances (Fitzpatrick & Smith, 2008). However, in the case of electricity consumption, household energy use remains largely invisible and intangible (Chetty, Tran, & Grinter, 2008). Energy bills at the end of the month do little to shed light on this situation and they don’t provide appliance-level consumption data. Thus, one important goal of eco-feedback technology is to help make consumption more visible in terms of scale and impact (Chetty et al., 2008). Over the past decade, the human-computer interaction community has created many innovative designs that visualize resource consumption on a personal level (e.g., Kuznetsov & Paulos, 2010; Gustafsson & Gyllensward, 2005; Laschke et al., 2005; Froelich, 2012).

Playing to encourage pro-environmental behavior.

The research community has long explored games as a means of fostering engagement with environmental issues. For example, Trails Forward (Bell-Gawne et al., 2011) is a multi-player simulation game that provides an approach to help understand human behavior in relation to local environments.
Similarly, Greenify (Lee et al., 2012) is a Real-World Action Game (RWAG) designed to teach adult learners about climate change and motivate informed action. While the examples listed earlier are mostly adult oriented, researchers have also investigated gameplay that caters to teenagers and younger children. Cumbo et al. presented foundation work (Cumbo et al., 2014) that helps us understand what motivates children to interact with nature, and a discussion of how technology based play may enhance this interaction. With Youtopia, Antle et al. (Antle et al., 2014) presented a tabletop learning game that allowed children to share their values around sustainable development during game play. Horn et al. presented Turn Up the Heat (Horn et al., 2014), a cooperative board game that encourages families to reflect on the use of residential thermostats and tradeoffs related to money, comfort, and sustainability.

In line with the research cited above, Invasion of the Energy Monsters uses gameplay to improve the visibility of energy consumption. The game attempts to do so by building upon the social dynamics of households while giving players the opportunity to get a realistic look at appliance-level consumption.

Design Principles

Our game design was guided by four overarching principles that helped us set priorities and evaluate the relative success of individual iterations.

**Principle 1: Designing to engage entire families in intergenerational learning**

In our work we emphasize the interplay between children, adolescents, and parents. Young people represent the next generation of adults who will face increasingly complex challenges related to energy consumption and the environment. However, prior research suggests that kids are often excluded from consequential household energy decisions (Horn et al., 2015). Kids are often passionate about the environment and can play an important role in influencing a family’s eco-friendly behavior (Larsson et al., 2010). More than that, we agree with researchers such as Ballantyne (Ballantyne et al., 1998) and Darby (Darby, 2006) who make the case that we should not treat children as one-way recipients of environmental knowledge. Rather, kids are active participants in helping families and communities co-construct knowledge about what it means to be environmentally sustainable. In our game testing sessions with families, we have observed many instances in which adolescents took a leading role in developing strategies and interpreting game representations. Kids are also often more willing to engage in playful explorations of the game interfaces and rules than their parents. Parents, on the other hand, play an important role by encouraging reflection, focusing children’s attention to relevant details, and bringing a more nuanced, real-world perspective (Crowley et al. 2001; Gutwill & Allen, 2012).

**Principle 2: Build on cultural forms of literacy, learning, and play**

Games are prominent cultural forms of literacy, learning, and play that are valuable for shaping social interaction in free-choice learning activities (Horn, 2013). But, within the broader universe of games, there are many different genres that invite subtly different forms of social interaction and learning (Guberman & Saxe, 2011; Berland & Lee, 2011; Horn, 2014). For example, tablet computer games
might engender very different kinds of in-room (Stevens et al., 2007) play experiences than console games, board games, card games, or playground games. In our designs, we have focused on board games and playground game forms (e.g., hide-and-seek, tag) because we see them as well suited for engaging *entire* families. Cooperative board games, in particular, have excelled at promoting discussion and collaborative strategy development (see also Berland & Lee, 2011).

**Principle 3: Fun first!**

This third principle should be obvious to the Games, Learning, and Society community but is still worth restating. Games should be fun. Yes, we want families to reflect on the relationship between household energy consumption and environmental sustainability. We also want families to pick up on specific learning objectives related to energy saving strategies, the magnitude of energy consumption, and the relative impact of different appliances and electronics. But, if families never play our game because it isn’t fun, then we have failed in all respects. We have spent close to two years of design and testing to achieve a balance of suspense, enjoyment, and replayability. In thinking about our learning objectives, we are guided by the notion of *intrinsic integration* (Habgood & Ainsworth, 2011) that emphasizes that target learning objectives and representations should be tightly aligned with core game mechanics.

**Principle 4: Connections to real home infrastructures and data**

The final design principle, which in some ways has been the most difficult to achieve, is that the game should be integrated with real household infrastructures and data. For Invasion of the Energy Monsters this means that doing something like turning on the TV or toasting a slice of bread should make the monsters stronger. By the same token, turning off the lights should make the game easier for the energy heroes. Families should also be able to see their own energy consumption data play out over time. Our intention is to blur the line between in-game and in-world activity as a way to translate game strategies to everyday life. Unfortunately, our ability to test this level of integration in real homes with real families is limited by existing infrastructures and technologies. However, as whole-home smart meters become increasingly common, we expect this will become more feasible. For the time being, we are using a combination of proxy technologies such as wifi-enabled electrical sockets that can transmit the energy use of a single device (“IDevices Switch”, 2016). We describe this more fully in the next sections.

**Game Design**

Invasion of the Energy Monsters is a cooperative tabletop game for 2-4 players ages 6 and up. In the game, three energy monsters, each personifying a different form of waste, attack your home. Bonehead is a mindless energy zombie who’s always forgetting to turn off lights and appliances. Wattwolf loves poor insulation and old, inefficient appliances. Ampire has a knack for doing things inefficiently, like running a half-empty dishwasher on heated-dry mode.

In the past two years, we have gone through numerous rounds of concept development, playtesting, and design iteration, with at least six major instantiations of the game. Here we first describe the basic, non-digital version of the game, followed by an overview of a planned expansion that will make use of an iPad app connected to a whole-home electricity meter.
Game Play

To win the game, the energy heroes must band together and expel the energy monsters from their home before it’s too late. On each turn, the monsters find a devious new way to waste energy. As the energy level rises, your electricity bill gets more expensive and the monsters become stronger. If the monsters ever get the power level above 3,000 watts or the heroes run out of money, the game is lost. The heroes work together to turn off appliances and electronics while avoiding the monsters.

![Figure 1: Monster figures (Bonehead, Wattwolf, & Ampire). Design by Eric Uchalik (euchalik.com).](image)

At the beginning of the game, players create a house from a collection of 21 room tiles. Monsters make their appearance in the attic, basement, and back porch. Each tile has an OFF side and an ON side that indicate the power used by an appliance or device in that room. For example, the Basement has a spare refrigerator that uses 200 watts when plugged in (see Figure 2). Each tile also indicates the type of switch needed to turn the appliance off. Switches include sockets, remote controls, light switches, power buttons, and thermostats. For the basement, the heroes need to play socket cards to unplug the refrigerator.
On each turn a player rolls a modified six-sided die (with numbers from 2 – 5) and then moves his or her hero token up to the number of rooms shown on the die. Players may then play hero cards from their hands and trade cards with other players in the same room. At the end of their turn, players must flip over one purple monster card indicating a new form of energy waste. For example, flipping over the basement card means that Wattwolf plugs in the old spare fridge in the basement. Players must then pay an energy bill indicated by the current power level. For example, if the power rate is 550 watts, players must pay $10, the approximate weekly bill for electricity consumption at that rate. To turn a device or appliance off, players must move to that room and play two corresponding switch cards. Heroes can also attack monsters by playing an attack card against monsters in the same room and then spinning a power spinner with a probability that changes with the energy consumption level (visible in Figure 3). If the spinner lands in the black region, the heroes win the attack and the monster is temporarily removed from the game. Heroes win the game by expelling all four monsters before they run out of money.

**Energy Meter Expansion**

We are developing an expansion of this game that will make use of a tablet computer app connected to a whole-home electricity meter. In this version, players will start the game with an *Energy Blitz* in which they run around their house turning on as many lights and appliances as they can. This will immediately be reflected on a digital power meter. As the game progresses, heroes will be able to play special cards allowing them to turn off real appliances and devices in their house, thus weakening the monsters.

**Preliminary Findings**

To evaluate our game, we visited five families in their homes to conduct playtesting sessions. Participants included 7 parents and 8 children (ages 6 to 14). Several of these families were visited on
multiple occasions to test different design iterations of the game. All sessions were video recorded with informed consent (Figure 4). We also conducted informal playtesting sessions with our own families, with middle school students at a local after school program, with a family at a community game night, and with students at our university. These sessions were not video recorded.

Here we reflect on some of the strengths and weaknesses of our current game design using examples from a session conducted in the fall of 2015. This family included a father, two daughters, and a son. The families played the game on two separate occasions for roughly an hour and a half each session. This family played a slightly different version of the game than described above. In this version, two teams (monsters versus heroes) competed against one another.

One strength of this version of the game is that it created fairly high level of suspense and competition. After about 15 minutes of play, the tide started to turn in favor of the monsters, and the hero team began to express increasing levels of anxiety. This cued strategic discussions around movement of player tokens and the use of energy cards. Early on it appeared that the discussions would only emphasize attacking monsters while failing to compare energy consumption from different sources. For example, the father suggested discarding a cards that would turn off lights: “It’s only 50 watts. Do you want to discard it?” In another instance he suggested moving to the garage to turn off the appliance there: “The garage is 100 watts.” In both of these instances, he used energy terminology but didn’t mention the specific appliances (lights and refrigerator). And, even though he implied a comparison when he said “it’s only 50 watts”, his strategy didn’t explicitly compare one appliance to another.

But the family strategy discussions started to change when the monster team drew cards for two energy-intensive appliances. In each case, the son made emphatic statements about the advantage of these cards: “Space heater for 500 more watts!”, “Huahh! Air conditioning 500 watts.” As the heroes got increasingly desperate, the dad started to make more explicit comparison between appliances:

Dad: “The most important thing that we need to do is we got to get that space heater off.”

Daughter: “Because it is taking up a lot of space. A lot of energy.”

Dad: “That’s the worst thing right now. 500 watts.”

Figure 4. Video capture from a family playing a version of the Energy Monsters game. Right: Celebrating after a successful spin of the energy spinner
And, interestingly, even though the concept of waste was never explicitly emphasized in the game play, the youngest daughter introduced this terminology in a debate over whether or not to lock the bathroom door to keep the monsters from attacking.

Dad: Let’s lock the bathroom.

Daughter: We’re wasting electricity because the lights are on. If we lock it the lights will still be on.

One weakness of this version of the game is that there was no reflection on energy savings beyond turning off appliances. There was also no connection between game play and the family’s real home energy consumption, at least as evidenced by their conversation.

On our second visit with this family, we introduced a Magic Meter card that allowed the energy monster team to turn on a real appliance and measure it with a point-source energy meter. In this excerpt, two girls playing the monster team decided to plug in a lamp in the living room. Unfortunately, it turned out to be difficult to access the electrical outlet behind a couch.

Dad: Oh come on, there has to be an easier one.

Daughter: No this is the brightest lamp.

[…] searching for the plug…

Daughter: There [Light turns on]

Dad: How much is it? What’s the number?

Daughter: Oh, this is lame.

Dad: Ha. Should have picked something better.

Daughter: The only thing on in the house are lamps.

Dad: Yeah. I wouldn’t let you do the refrigerator. Sorry.

Daughter: <SIGH> It’s only 9 watts

Dad: Nine?! Ha ha ha: Bummer.

This excerpt illustrates the learning opportunities associated with connecting game play to the entire
home. Unfortunately, it also highlights problems such as disrupting game play and accessing only things like lamps that can be easily unplugged. Our future versions will tie directly in to whole-home electricity meters to address these shortcomings.

Acknowledgements

Monster & Title Artwork: Eric Uchalik (euchalik.com).

Room Artwork: Maisa Morin (maisamorin.com).

Funding: This game was made possible through support from the National Science Foundation (grant IIS-1123574). Any opinions or recommendations are those of the authors and do not necessarily reflect the views of the NSF.

Research, Design Advice, and Playtesting: David Horn, Hannah Horn, Madeleine Reed-Horn, Gabby Anton, Sarah D’Angelo, Pei-Yi Kuo, Cameron MacArthur, Zhao Ziong.

References


Bell-Gawne K. (2012). Meaningful Play: The Intersection of Videogames and Environmental Policy, GLS.


Horn, M.S. (2013). The role of cultural forms in tangible interaction design. Proceedings of Tangible, Embedded, and Embodied Interaction (TEI’13).


Understanding the Gap

Gender Similarities and Differences in Persistence and Self-Efficacy in a Coding Game
Alison Lee (Teachers College, Columbia University), Laura Malkiewich (Teachers College, Columbia University), Stefan Slater (Teachers College, Columbia University), & Catherine C. Chase (Teachers College, Columbia University)

Abstract

Traditional research on gender differences in learning and motivation yield a rich outline of how self-efficacy, persistence, and learning outcomes differ between boys and girls. These differences are especially prominent in male-dominated STEM (science, technology, engineering, and math) subjects, where girls are less interested and engaged despite negligible differences in actual performance. These gender disparities in interest and motivation are echoed in previous research on game preferences, but are quickly transforming as girls take greater interest in and play more games. This paper investigates affective and behavioral differences between boys and girls when learning to code in a game. Results indicated that girls and boys do not differ in their coding self-efficacy, but girls persist longer and may be more resilient in the face of failure. Our analyses provide implications for how future research may disentangle the interactions between self-efficacy in coding and games, failure, persistence, and gender role beliefs.

Introduction

Recent initiatives to engage students in computer programming are starting earlier in children’s schooling than ever before (Office of Science and Technology Policy, 2013). In order to learn programming, young students must persist through often frustrating programming tasks to produce effective code. Historically, girls outperform boys in executive-functioning skills related to task persistence (Kochanska et. al, 2000; Zimmerman & Martinez-Pons, 1990), but motivation research suggests that girls are less interested in and feel less competent in Science, Technology, Engineering, and Math (STEM) subjects (Ceci et al., 2014). Games can serve as a powerful environment for promoting persistence, as failure is an integral part of gaming (Ventura et al., 2013). This paper seeks to explore how, if at all, might late-elementary girls’ and boys’ self-efficacy, interest, persistence, and behaviors differ in a coding game.

Gender differences in self-efficacy, or self-conceptions of ability (Bandura, 1993), are largely reported in STEM academic fields (Zelden & Pajares, 2000). These trends reveal that women feel less competent in STEM fields than men, and these gender differences in STEM self-efficacy emerge largely when students make a transition to middle or junior high school (VanLeuvan, 2004). Women are less likely to choose math-centric STEM careers (Hackett, 1985), and are more likely to leave science-related
fields (Center for Talent & Innovation, 2014). More recent work by the NCES reveals that gender disparities in STEM engagement and self-efficacy persist today, despite a narrowing gap in boys and girls’ performance, course taking, and technology use (Cunningham et al., 2015). While the gap in general STEM degree attainment is slowly closing (NCES, 2013), differences are still prominent in engineering fields. Women represent 15% of computer science majors and 18% of engineering majors in 2011 (NCES, 2013), and 21% of the computer-programming workforce (US Bureau of Labor Statistics, 2015). Self-efficacy or confidence has been proposed as a major cause of the general disengagement and attrition of women from science and engineering (Ackerman et al., 2013; Hill et al., 2010; Brainard & Carlin, 1997; Zeldin & Pajares, 2000). Female computer science majors report lower confidence (a related construct to self-efficacy) in using computers than even male non-majors (Beyer et al., 2003), and that gender biases in the field contribute to lower interest and engagement (Cheryan et al., 2009). In sum, there is an overall trend of women persisting less and feeling less competent in STEM fields, especially in computer science and engineering, as they get older. Lower confidence and self-efficacy in their science and engineering abilities seem to lower girls’ global persistence in pursuing STEM careers. However, most of this body of research has been conducted on high school and college-aged populations across a variety of STEM subjects. Few studies examine gender differences in coding or computer science self-efficacy at the middle-school transitional age, which is the focus of this paper. A critical question of this study is to determine whether late-elementary girls will report lower levels of self-efficacy in a coding game environment.

Games can be particularly useful for promoting persistence, where previous work indicates that both children and adults find games “addictive” and persist highly in game environments, even when the game is difficult or provides many opportunities to fail, because failure is a ubiquitous part of game play (Ventura et al., 2013; Yee, 2006; Juul, 2013). How might gender differences translate into the domain of digital gaming, a subcomponent of STEM? While boys and girls both play video games, boys are more likely to play for longer periods, identify more as gamers, and play games for different reasons (Bonanno & Kommers, 2005; Lucas & Sherry, 2004; Yee, 2007). Historically, gender biases and sexism in commercial games have negatively impacted girls’ motivations to play and identify as gamers (Ogletree & Drake, 2007). However, gender disparities in gaming are shifting as digital natives become younger and play games more frequently. Recent commercial polls indicate that female gamers now make up 48% of game consumers, and that girls are more likely to play casual and mobile games than other game types (Nielsen, 2014). Do disparities in game identification, interest, and engagement still apply when we consider the population of young, late-elementary digital natives in our study? How might their predisposed attitudes towards games interact with their self-efficacy or persistence in a STEM subject like coding?

Gender differences in self-efficacy and interest in both STEM fields and games contrast directly with work in gender and persistence in academic tasks. Task persistence is often discussed as a component of both motivation and self-regulated learning because a critical part of self-regulation is the ability to sustain and regulate attention and effort on a task, even when it is unpleasant or difficult (Zimmerman & Martinez-Pons, 1990; Pintrich & de Groot, 1990; Zhou et al., 2007). This study is particularly interested in the construct of task persistence because coding entails the ability to continue working on solutions even when met with frustration or failure. Work in child development unequivocally demonstrates that girls generally are able to sustain attention, persist, and emotionally regulate better than boys (Kochanska et al., 2000; Zhou et al., 2007). Furthermore, persistence and diligence is highly correlated with academic performance (Pintrich & de Groot, 1990; Zimmerman & Martinez-Pons, 1990). Generally, self-efficacy is a common predictor of persistence because students’ self-conceptions
of ability may increase their expectations of success (Zimmerman & Martinez-Pons, 1990), thereby increasing their willingness to persist on the task (Schunk, 1991; Mulfon, Brown, and Lent, 1991). However, there is less known about whether girls demonstrate higher task persistence behaviors in computer programming or in games, given that they may feel less self-efficacious and interested in those domains. From work on gender disparities in engineering careers, it is clear that girls demonstrate lower global persistence in the sense that they do not select and pursue engineering careers as often as boys. It is not clear, however, whether boys and girls’ differ in local persistence at coding tasks (task persistence), particularly if the task is in a game environment. However, given that persistence is a critical feature of learning and practicing coding, we hypothesized that persistent behaviors would mediate learning of coding principles.

The purpose of this paper is to identify how gender differences in persistence, self-efficacy, and interest in computer programming and games intersect for late elementary students, and whether these differences mediate how effectively students can learn from a game. Analyzing this first wave of true digital natives will reveal whether or not previous findings on differences in game use, self-efficacy, and persistence in engineering still apply today.

Methods

Thirty-seven fifth grade students (54.1% female) were recruited from an urban charter school after-school program. 89.2% of the students reported no prior coding experience, and all students reported having less than a month’s worth of coding experience. All students played a digital game designed to teach basic coding. Each game level involved a problem that required students to guide an agent over obstacles to reach a goal using coding blocks similar to Scratch (Maloney et al., 2010). Levels got progressively more challenging and introduced increasingly more sophisticated coding concepts such as loops, conditionals, and nested functions. Students were randomly selected to play either the Full version of the game \( (n=18, 55.6\% \text{ Female}) \) or the Minimal version \( (n=19, 52.6\% \text{ Female}) \). The Full Game contained many standard game features such as a narrative, failure feedback, performance metrics, and purely fun “bonus” levels with no academic content, while the Minimal Game omitted these features. However, both games contained identical problems, hints, and gating (students could not move forward until all previous levels were completed). The study’s original premise was to explore differences in learning and persistence when students engaged with a more game-like or less game-like coding environment. However, the data presented here bear only on gender differences observed in both versions of the game. Because there were negligible interactions between the game versions and gender, all analyses collapse across conditions. For discussion of condition differences see Yan, 2016.

The study consisted of five, 40-minute sessions: a pretest session, two gameplay sessions, a challenge session, and a posttest session. In the pretest session, students took a pretest of coding knowledge, and a baseline global coding self-efficacy measure. In the two gameplay sessions, students played the game individually on iPads. During the challenge session, students were given an impossible coding problem set in the context of the game (the challenge task). The challenge was for students to navigate a spaceship through a grid with obstacles to reach a target location, using only 9 coding blocks – one less than the minimum number of blocks required for the solution. An impossible task, a common task for measuring persistence, was selected so that students’ willingness to persist would not be conflated with their ability to actually solve the challenge (Ventura et al., 2013). Students did not indicate that they believed that the task was impossible, only that it was difficult. At the end of the two gameplay and challenge sessions, students reported their local self-efficacy for coding within their respective game environments. In the
posttest session, all students were given a post-survey, a coding post-test, and another persistence task where students were asked to generate the best solution to a difficult coding problem by writing their codes on paper (the paper persistence task). Regardless of their solution, students were told that their solution was not the optimal one, and asked if they wanted to try again or do something else.

Global (general coding skills, such as debugging or writing) and local (task-specific) coding self-efficacy measures were constructed on a Likert 7-point scale based on Bandura’s Guide for Constructing Self-Efficacy Scales (2006). Game play data was collected using screen recordings and embedded log capture. Only a subset of student gameplay data ($n=9$ for both groups each) was available due to technical difficulties. For the in-game challenge task, students’ persistence was measured by how long they voluntarily spent trying to solve the challenge task before choosing to give up and do something else. The post-survey assessed students’ game interest, global self-efficacy for coding in and out of the game environments, interest in future coding tasks, and previous gaming behaviors. The 16-question paper coding posttest assessed students’ ability to write, debug, and interpret code, as well as their understanding of coding concepts such as conditionals and nested functions. Persistence on the paper persistence task was measured by how many solutions students generated. Teachers were also asked to provide evaluations of student academic performance (estimate of average grade), dedication to school, and ability to focus on school tasks.

**Findings**

Due to the small sample in this study, it was difficult to demonstrate statistical evidence for all of the effects we were interested in investigating, especially when considering the subset of log and video data available to analyze game behaviors. Given this, we explore and discuss both significant ($p < .05$) and marginally significant ($p < .10$) findings.

Boys and girls differed in their prior game experiences, but not in their interest in coding or the current game task. Boys reported playing more hours of video games per week than girls ($X^2(1, N = 37) = 11.37, p = .045$), and identified more as gamers ($X^2(1, N = 37) = 11.31, p = .004$). They did not differ on baseline global coding self-efficacy ($p = .10$) and coding knowledge at pretest ($p = .416$). There were also no significant differences in teacher evaluations of student dedication ($p = .158$) and focus ($p = .142$) between boys and girls. Here, we see mixed evidence for prior work: while the boys in our study played and identified more as gamers, they did not differ from girls in coding interest, prior experience with coding, or in teacher reported measures of self-regulation.

In a repeated measures ANOVA on local self-efficacy, by gender and day (Day 1 and 2 of Gameplay, Challenge Day), girls demonstrated non-significantly different self-efficacy from the boys on most days, but trended towards being more self-efficacious right after a failed challenge ($F(1,34) = 2.53, p = .094$; post-hoc $t(36) = 2.925, p = .096$) (see Figure 1).
Figure 1. Local self-efficacy by day.

Our trends suggest that while boys’ self-efficacy for coding dropped after failure, girls’ self-efficacy was unaffected by failure. However, due to low statistical power it would be difficult to confidently conclude that this higher self-efficacy after failure is a true effect. These results also contradict prior work predicting that they would have lower overall coding self-efficacy (Day 1 and 2 of gameplay). Boys and girls did not differ in measures of intrinsic interest in the coding game \((p = .16)\) or in future coding tasks \((p = .436)\) after the study.

For the in-game challenge task, girls persisted longer in generating the target solution than the boys – see Table 1 \((t(37) = 3.73, p = .05)\). Girls also produced more iterations on the paper persistence task that followed the post-test \((t(37) = 7.11, p = .01)\). Thus, girls demonstrated greater persistence at a challenging coding task both within the learning environment (on the game persistence task) and outside (paper persistence task). Either girls generally exhibit more persistent behaviors, or their development of persistence through the game transferred out to other coding tasks. A linear regression revealed that neither self-efficacy coming into the challenge (Day 2 SE) or it’s interaction with gender \((p = .54)\) predict persistence on the challenge task \(R^2 = .03, F(1, 35) = 1.16, p = .29\).

![](image)

**Table 1.** Means and SD of persistence measures and learning outcomes by gender.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge Persistence (mins)*</td>
<td>19.85 (7.44)</td>
<td>25.96 (11.06)</td>
</tr>
<tr>
<td>Paper Persistence (# of codes)*</td>
<td>1.41 (.507)</td>
<td>2.15 (1.04)</td>
</tr>
<tr>
<td>Day 1 Time On-Task (mins)</td>
<td>34.70 (3.47)</td>
<td>35.72 (1.47)</td>
</tr>
<tr>
<td>Day 2 Time On-Task (mins)*</td>
<td>27.14 (6.61)</td>
<td>33.70 (6.30)</td>
</tr>
<tr>
<td>Out-of-Sequence Moves*</td>
<td>3.67 (2.00)</td>
<td>1.22 (0.83)</td>
</tr>
<tr>
<td>Post-Test (out of 16)</td>
<td>8.29 (3.03)</td>
<td>9.05 (2.69)</td>
</tr>
</tbody>
</table>

Note. *p < .05

A repeated measures ANOVA of time-on-task (time actually spent playing coding levels) by gender and day (1 and 2 of play) demonstrated that while boys and girls did not differ in their time on task on Day 1, girls spent more time on-task than boys did on Day 2 \((F(1, 16) = 6.156, p = .03\) post-hoc \(t(16) = 4.65, p = .047\). This means boys spent more time on the level selector screen and in bonus levels, and less time actually coding on Day 2, after the novelty effect of the game had worn off. On the other hand, this is further evidence of greater task persistence from girls, where they were more willing to keep coding even when the task became tedious. Boys were also much more likely to go out of the sequence of the game levels \((t(16) = 11.456, p = .004)\) than girls were. However, boys and girls did not differ in the
proportion of easy or difficult levels they played \((p = .14)\), or the complexity of codes used (using one or more conditional or loop block in lieu of longer but simpler commands) during the gameplay \((p = .61)\). When analyzing the different kinds of codes students used in levels that required multiple attempts, we saw that boys and girls did not differ in either starting with \((p = .12)\) or ending their solutions with complex codes \((p = .86)\): both boys and girls generally started with more complex codes, and ended with simpler code. In other words, boys and girls equally gave up on employing more complex code in their solutions when they couldn’t get it right on the first try.

An ANCOVA on post-test scores by gender, controlling for pre-test scores revealed that both boys and girls learned about coding in the game, but did not differ in their post-test outcomes \((F(1,34) = .515, p = .478)\). A linear regression of persistence times and gender on post-test scores revealed that persistence on the challenge task is predictive of learning \((R^2 = .24, F(1, 35)=10.33, p = .002)\), but gender \((p = .33)\) and its interaction with persistence \((p = .32)\) are not. Given that persistence was associated with greater learning, and girls persisted more in play and in challenge, this finding that girls’ persistence did not lead to greater learning is very surprising.

Conclusions and Implications

Despite extensive prior research demonstrating that girls possess lower self-efficacy in STEM domains and engineering in particular, we found no evidence that this was true in our coding task. Boys rated themselves the same as girls in self-efficacy leading up to the challenge task. A possible explanation for the lack of self-efficacy differences before the challenge task is that this particular population of 5th grade students had not yet internalized the gender expectations in coding and engineering that typically diminish girls’ self efficacy. Before starting the study, teachers informed us that most students did not even know the meaning of the word “coding.” It may also be that this game is more gender-neutral than other games, and that this similarly translated into more equivalent coding self-efficacy. The game is a tablet-based puzzle-style game not unlike other casual mobile games, and recent census of commercial gamers indicate that girls are just as likely to play mobile games as boys are (Nielsen, 2014). These interpretations about diminishing gender biases are supported by Cheryan et al.’s (2009) work that showed how making computer science environments more gender neutral can encourage women’s interest and retention. A final possible, optimistic explanation is that the gender gaps found in games and STEM domains like coding are closing. These explanations are supported by our results showing that boys and girls did not differ in their intrinsic interest in the game, the coding task, or future coding tasks.

Boys and girls did, however, did appear to differ in their self-efficacy immediately after the challenge task, where girls rated themselves significantly higher than boys, and insignificantly different from themselves before the challenge task. Given the low statistical power and borderline trends of the statistical test, we tenuously discuss the possibility of this effect, while acknowledging the vulnerability to Type I error. As such, we might conclude that experiencing a failure in a challenging task did not impact girls’ self-efficacy, but did significantly lower boys’. One possible explanation is that the effect of failure – their inability to complete the challenge – negatively impacted boys’ sense of competency and willingness to persist more than girls. This is supported by earlier research on how important success and failure outcomes are for male conceptions of competency (Eccles, 1987; Hackett, 1985). Conversely, girls’ coding self-efficacy was less responsive to failure, presumably because failing the challenge had less of an impact on their self-conceptions of coding ability.

In general, our findings affirmed previous work on how boys and girls approach academic tasks. Girls
did persist longer on the challenge task within the game and were more willing to persist on a coding challenge outside the game (the paper persistence task), compared to boys. Additionally, girls were more on-task on Day 2 of gameplay than boys, which suggests that they were more persistent on coding-relevant game levels even when the novelty of the game wore off. From research on gender differences in academic self-regulation, girls being more persistent and self-efficacious in the face of failure compared to boys come as no surprise. These results imply that the pattern of greater persistence for girls is true even in game environments and in a STEM domain like coding.

It is unclear whether higher self-efficacy led to more persistent behaviors. The idea that higher self-efficacy leads to higher persistence is supported by the fact that girls’ persistence on the challenge task was coupled by their apparently higher ratings of self-efficacy after challenge. However, there was no predictive relationship between coding self-efficacy at the end of day 2 of play (i.e. prior to challenge) and persistence in the challenge task, and girls did not differ from boys’ self-efficacy prior to challenge. Thus, self-efficacy in itself cannot be the primary explanation for girls’ persistence behaviors. An explanation proposed earlier was the idea that success and failure may have a greater impact on boys because external outcomes hold greater weight in male self-efficacy (Eccles, 1987). As such, it is possible that being told that they did not successfully complete the challenge may deplete boys’ self-efficacy and their willingness to persist if they subscribe to these gendered approaches to success and failure, but not girls’.

Given the relationship found between persistence and learning outcomes in prior studies, we would have expected that girls’ greater persistence would have translated into either better coding behaviors during gameplay or greater learning. Previous analyses in this study revealed that the most significant predictor of learning was the percentage of hard levels a student solved with complex code (Malkiewich et al., 2016). However, girls neither learned more nor used more complex code in their solutions, despite the fact that were more willing to persist and stay on-task. A possible explanation for this could come from differences in how boys and girls approached the game environment. In order to learn how to use complex code through the game, students would have to use conditional or loop blocks as part of their code; however, an incorrect use of these blocks resulted in a failed attempt and lowered the final level score even if a correct solution was generated in subsequent attempts. In other words, the game punished players for using complex code incorrectly. Because the girls in this study played games less often, they may have felt more intimidated in game environments compared to their male counterparts and thus hesitate to use the complex code for fear of lowering the final score. Girls are more risk-averse than boys (Jianakoplos, 1998) and may be less likely to try using more complex code if they can still solve the problem with simpler codes. Another potential explanation is that while girls’ self-efficacy and persistence may be unaffected by large-scale failure (such as the challenge task), they may still be equally discouraged by micro-failures (such as a failed level attempt) as boys are during gameplay. This is evidenced by the fact that boys and girls did not differ in the kinds of codes they used on problems where they required multiple attempts. If this is true, despite their larger patterns of task persistence, they may feel just as “defeated” as boys do by incorrect attempts using complex codes, resulting in similarly “simple” final coding solutions.

In summation, while the girls and boys in our study had the same interest, self-efficacy, and learning outcomes, they differed in their persistence behaviors, navigation patterns in the game, and their responses to failure both affectively and behaviorally. Results suggest that the gender gap in self-efficacy and performance in STEM learning may be closing, and demonstrate evidence that a coding game can encourage persistence and self-efficacy in coding for girls. However, our conclusions are
limited to the features and type exhibited in this particular game, and the late-elementary population of young urban students with low prior knowledge in coding. Our sample size also raises concerns about the interpretability of significance, particularly for claims related to self-efficacy in the face of failure. Further work can investigate whether specific game features may impact persistence behaviors differently for boys and girls, how failures on a micro and macro level can impact self-efficacy and persistence, and if game self-efficacy or risk aversion explains why girls’ persistence behaviors in this game environment did not translate into better learning.

References


An Astronomy Education Game for Facebook

Learning From Those Games You Love to Hate

James Harold (Space Science Institute), Kate Haley-Goldman (Audience Viewpoint), & Dean Hines (Space Science Institute; Space Telescope Science Institute)

Abstract

We have developed a stellar and planetary evolution game for Facebook as part of an informal educational project. The game uses the “sporadic play” model of games such as Farmville, where players may only take actions a few times a day, but may continue playing for months. This framework is an excellent fit for teaching about the evolution of stars and planets: systems evolve in scaled real time (a million years to the minute), so that massive stars supernova within minutes, while stars like our sun live for weeks. The game has now been live for over a year, and has attracted over 35,000 players. Using a mix of data and evaluation strategies, we discuss play duration and retention; player demographics; and content gains. We close with a summary of our current opinions on the perils and promise of developing educational games using this platform and game framework.

Background

In 2007 Facebook began allowing developers to create applications that interacted with core elements of their system. This generated a surge of new games that attempted to take advantage of the of the platform, whether through its social network, or simply as a space that made it easier for a game to stay in contact with its players. Some of these games were of a novel, and perhaps peculiar nature: rather than trying to draw the player in for an extended play session, they deliberately restricted play, forcing the player to return at a later time. These “sporadic” (also referred to as “passive”) games were occasionally lambasted for having more in common with psychology experiments than with traditional skill development or problem solving games. They were also extremely successful, with Zynga’s Farmville peaking at 80 million monthly active players before competition began to decrease its share (Chiang, 2010).

During this period our group of scientists, evaluators, and informal science educators felt that both Facebook as a platform, as well as the sporadic play game framework, might be of interest for educational games. Educational games have been of interest in science learning for some time because of their potential to address multiple goals, including motivation, conceptual understanding, and the nature of science (Honey & Hilton 2009). However, while there was significant research on gaming and learning, there was relatively little academic or publicly available research on Facebook games, especially sporadic games. (Richards, Stebbins, & Moellering, 2013). It was particularly these two features — Facebook and sporadic play — that we found intriguing, for a number of reasons:
1. New audiences. These games were notable for attracting a broad demographic, both in gender and age. Some of this related to the subject matter of the game, but some was undoubtedly the result of the platform and game frameworks themselves: sporadic games could fill small niches in your schedule, and didn’t (on the surface) require a significant time commitment. This was of particular interest for an informal education (a.k.a. “free choice learning”) project hoping to have a broad reach. For instance, studies have shown that women over 40 play web-based games more frequently and for more time than other individuals, including both teenagers and adult males (Harwell 2014, Pearce 2008). In fact, while traditional informal science institutions (e.g., science centers) struggle to attract this audience of adults in the mid-to-late age categories, those adults are the main consumers of Facebook games. Older adult gamers tend to be attracted to problem solving, exploration, and communication (even with single-player games) (Pearce, 2008). These populations (online casual gamers) may not see themselves as gamers (Perrin, 2015) though they play with a frequency and number of hours that might appear to be more than “casual” (Kuittinen et al, 2007). Perhaps partially due to their lack of self-perception as gamers, these populations have also often been ignored by both the gaming industry and the academic study of gaming. (Takeuchi & Vaala, 2014).

2. Sporadic play seemed at least superficially aligned with the experiential learning cycle of acting, reflecting, developing a theory, testing that theory, and repeating (Mumford, 1997). Players waiting for their next session might remain “mind’s on” while considering their next action, and revisiting the game day after day could serve to reinforce the content.

3. Despite the informal education focus of the project, sporadic play could also be a good match for classrooms. While the traditional divisions between formal and informal education have been increasingly breaking down, classrooms continue to be heavily constrained in time and resources. Flexible activities that can be undertaken at home, but still tie to curricula, can help supplement the classroom experience. By extending the play period, the game can take little time on a daily basis, but still cover a significant amount of content over the course of a school term. This type of play bridges the informal and formal goals cited in Squire & Patterson (2009) with flexible, emergent, and voluntary attributes, yet still with largely defined educational goals.

4. The content of the proposed project – solar system evolution — was a good match to this game framework. In general, systems that evolve over time (whether they involve crops or planetary systems) can fit nicely into the sporadic play model. In other words, if you can grow a farm, you can grow a solar system.

The project

With funding through the National Science Foundation and NASA, we produced Starchitect: an online, end-to-end stellar and planetary evolution game designed to teach players about a variety of astronomy and planetary topics (http://www.starchitect.net/). The team included the authors (J. Harold P.I., and K. Haley-Goldman as evaluator) as well as Dean Hines (Space Science Institute/Space Telescope Science Institute) as science advisor, Evaldas Vidugiris (Space Science Institute) as lead programmer, Ben Sawyer (Digital Mill) consulting on game design, and Nina Klymenko for graphic design. Note that the primary program goal was to produce an educational game for informal (non-classroom) audiences, not to perform a research study. However, the project did provide an interesting opportunity to examine an
educational game in a social network, including the types of players it would attract, and the outcomes it could achieve.

*Surchitect’s* solar systems evolve at a million years a minute, so gameplay is naturally drawn out for days or weeks (for reference, at a million years a minute the Earth is approximately 3 days old, halfway through our solar system’s lifetime). With this scaling, massive stars will supernova almost immediately, while lower mass stars like our sun will live for weeks of game time, possibly evolving life before passing through a red giant stage and ending their lives as white dwarfs. While it was designed to probe various features of Facebook as an educational game platform, the game is also available externally so that children under 13 can access it. As an added benefit, this allows us to compare the play patterns of the Facebook and non-Facebook audiences.

**Game features**

Players begin with a simple tutorial that walks them through creating a star and a single planet. From there they can move on to add moons, planets, or create more systems. The player can also pursue life by placing a terrestrial planet in the habitable zone of the star (the location of which varies with star type).

We embed as much accurate astronomy and physics within the game as possible, while still trying to maximize player agency. Players can place planets anywhere, but they will destabilize if they are too close to each other. A player can “design” the look of their giant world, but the colors and patterns of those designs are based both on the planet’s location, and on research models (for instance, of band formations as a function of gas giant size). Rings can be added, but not directly: rings form when a player attempts to create a moon too close to a giant world (inside the Roche Limit). Ring gaps are generated programmatically based on the location of resonances resulting from other moons placed by the player (see Figure 1). Players can also take pictures of their systems, then post them so that others can vote on the most interesting systems. Besides the incentive to create those systems in the first place, other players can learn what’s possible in the game.

The game is built around a “Feats” achievements system, which is a typical approach for this class of games. However Feats also provide several specific advantages for us: they allows us to drive player behavior towards specific learning goals (e.g., “Place a terrestrial planet in the habitable zone”, or “Create a solar system similar to ours.”); they can tie to a system of “Unlocks” that allow us to scaffold the content of the game (e.g., players must succeed at a mini-game on scales before being able to “cheat” and display unrealistic planet sizes in the game); and they provide a tracking mechanism for player accomplishments.

Other game features include mini-games that can address content that might not fit naturally in to the gameplay; the ability to take pictures of your system and post them to your wall; and a separate application that lets visitors rank system pictures submitted by players.

**Evaluation strategies**

Evaluation of the project presents a variety of opportunities and challenges. The opportunities include the fact that the game provides a fairly large “N” (over 35,000 players to date), and that the in-game data is very rich when it comes to measuring activity and progress. Game activities can also be specifically designed to collect data (for instance, the quiz described below). With the addition of
Facebook demographic data, we can study our players by (at minimum) gender and age. However, in-game data is still limited: both the PI and evaluator agreed that interview data would be necessary to fully probe the player experience. In addition, ongoing privacy concerns by Facebook users lead to periodic (and unpredictable) tightening of the rules governing the data available to developers.

Of the challenges, probably the most difficult lies in the nature of the game. The intent is for players to engage for long periods, which means that traditional focus groups are of limited use (though still useful for testing the general interface, playability, etc.) Furthermore, only a fraction of the players stays with the game for an extended period. This means that if we want to specifically address the effects of longer term play, we need to target those players after the fact in-game, and then encourage them to respond to surveys or interview requests.

All of this lead us to build an evaluation strategy around four primary data sources:

- **Game data.** The game is heavily instrumented in order to provide evaluation data at a variety of levels, including player counts, Feats achieved, time spent in game, etc. For Facebook players, this data is supplemented with age and gender information.

- **Online surveys.** Designed by our external evaluator, players were recruited for these surveys using popups from within the game. This allowed us to target specific audiences: for instance, a recruiting popup could be generated if a player came back for at least one day after completing the game tutorial.

- **An in-game quiz.** Designed to appear as just another part of the game, this quiz was populated with a mix of general science and pop culture questions; science survey questions with documented results for the general population (National Science Board, 2014; LoPresto, & Murrell, 2011); and questions that specifically targeted content knowledge that could be acquired through playing the game. These last questions could be triggered by the game based on a series of pre/post criteria, allowing us to look for potential content knowledge gains.

- **Phone interviews.** As with the online surveys, players were recruited using popups within the game, allowing us to ensure that they had actually played the game for a reasonable amount of time. Interviews require contact information, so these players were offered gift card incentives to participate in the interview process.

**Results**

**Who’s Playing**

Facebook data indicates that about 3/4 of the players are male. The age distribution is quite broad, with a quarter of the players under 19, and 30% over 35. Since Facebook limits participation to users 13 and older, the non-Facebook contingent (approximately half the player population) may well skew younger. Results from the game’s quiz questions on general science knowledge indicate that our players are significantly better informed about science than the general public. This last result is particularly relevant for an informal educational game, since our content gains are going to be influenced by our players’ prior knowledge. For instance, news reports are fond of citing that a quarter of the American public doesn’t know that the Earth revolves around the sun (National Science Board, 2014). However, virtually all of our players already know this coming into the game, so we can’t expect content gains in this area.
In addition to being well informed about science, the online survey results indicate that players see themselves as science interested and literate. Nearly 90% were interested in learning more about space science, and enjoyed learning about new scientific discoveries or inventions. Over 50% said other individuals would describe them as a “science person”. This “science person” view is reinforced by the in-game quiz. Two of the quiz questions in particular are more accurately described as relating to “worldview”, rather than content knowledge: whether the universe began with the Big Bang, and whether humans evolved from simpler lifeforms. These questions have some of the largest differences between the general population and our players, suggesting that the game is selecting for science minded people, not just knowledgeable ones.

What are they doing?

Overall, a quarter of players come back for a second day, with a significantly higher rate for Facebook versus non-Facebook players (see Figure 2). That initial rapid drop-off is followed by a much flatter curve: of the group that returns, half come back at least a third day, and 20% at least 10 days. This type of progression appears to be typical for this class of game (Trefren, 2010). Play time can also be stretched out over a long period (relative to traditional education games): half of those who returned to the game at least once spent a minimum of 12 days between start and finish. Finally, there is also a significant difference between people who log in through Facebook, and those who do not: Facebook players on average return to the game at almost three times the rate.

Beyond simply measuring time spent playing the game, we can look at the number and type of Feats achieved to get a sense of engagement. For our purposes we use the “Goldilocks” Feat (place a terrestrial world in the habitable zone of a K0 star) as a threshold. This is somewhat arbitrary, but the concept of habitable zones — the region of a solar system where planets could support liquid water and, presumably, life — represents a core piece of content for the game. Succeeding at this Feat also indicates that a number of prior steps have been taken (20 Feats, on average). Around 20% of the players that complete the tutorial eventually complete the Goldilocks Feat, suggesting reasonably deep engagement with the game.

What are they learning?

A number of the in-game quiz questions were specifically designed to perform a pre/post assessment. For instance, for the question “what can prevent a moon from forming?”, players are either asked prior to attempting to place a moon (forming the “pre” cohort), or after successfully placing a moon (forming the “post” cohort). A given player is not asked a question twice. Since the conditions that define pre and post can create narrow windows when the question can be triggered, the number of players in each cohort varies dramatically. Nevertheless, this approach produces a number of interesting results:

- As mentioned previously, strong prior knowledge by the players can create a ceiling effect. This is most obvious in the “Does the earth orbit the sun” question taken from the Science and
Engineering Indicators survey (National Science Board, 2014). Over 95% of players could correctly answer this question even in the “pre” cohort, leading to no significant difference in the “post” cohort.

- Gains of up to 20 percentage points were seen in questions directly relating to game content: e.g., “What is a possible color for a star” (+20%), or “What can prevent a moon from forming” (+21).
- Two questions specifically relating to time scales (“Which mass stars live longest”, and “What takes longest” in the evolution of a habitable world) produced little or no gains. It may be that players do not recognize that elapsed time in the game is representative of elapsed time in the real world, even in a relative sense of “which takes longer”. If so it’s unfortunate, since it was one of the more appealing elements of this game model. Future iterations of the game could place a greater emphasis on the elapsed time to focus on this issue.

Lessons learned (and would we do it again?)

From the perspective of a producing an educational game, the answer is qualified yes. The game showed reasonable success at meeting its goals. Players engaged for long periods, and some content gains were seen. Furthermore, the difference in play patterns between Facebook and non-Facebook players reinforces the idea that the Facebook creates specific affordances for certain types of games: to the extent that your content fits these game frameworks, it could be a productive platform.

There are a few caveats, however. First, these types of games tend to come with expectations of indefinite play. We periodically receive feedback from players who have completed every possible Feat and are requesting even more gameplay. For grant funded game development projects, this can be unrealistic. In addition, competing in environs such as Facebook can imply the use of specific strategies that may be seen as distasteful. Our team was unenthusiastic about many of the aggressive click-bait and advertising strategies often used to acquire players and visitors. Adopting a position of “Don’t be evil” is laudable (and possibly a requirement of grant funded work), but it may restrict your game’s growth.

The research and evaluation perspective is somewhat different. When we originally conceived the project, the idea of evaluating an educational game for Facebook promised a wealth of potential user data well beyond what is presented here. The developer is, however, entirely dependent on Facebook for that data. Over the course of the game development we found some of the data access rules tightening, and by the time the summative evaluation was in play it became clear that it would be a struggle to gain access to everything we might want. In principle these are solvable issues: shorter time scale development (so that data access requirements did not shift), or even using an existing game for research purposes, would decrease the risk of having data access problems.

We close with a note from the player interviews. Several of the players indicated that they were specifically looking for a game of this type: something science based that they could learn from. This “attracting the choir” effect may impact the content goals of the project, but it also indicates an active desire on the part of the public for educational games. Given that some developers argue for trying to sneak educational contest past players unawares, it may be helpful to reinforce the idea of games that openly declare their goals and invite the player to learn while they play.
Figure 1: Main game screen, showing a ringed planet. Ring gaps are generated programmatically based on the locations of the moons (visible at the upper right of the rings).

References


Understanding Habits of Participatory Civics in High School Students’ Crafting and Coding of Collaborative Game Controllers

Gideon Dishon (University of Philadelphia) & Yasmin B. Kafai (University of Philadelphia)

Abstract

The civic world is rapidly changing in response to the affordances of the digital age, which ushered the rise of participatory civics: interactive peer-based modes of civic action. In the spirit of Dewey’s vision of civic education as participation in a community, video games have been presented as a potential site for practicing civic interactions. We expand this approach, contending that collaborative game making can serve as a uniquely ripe setting for youth to develop habits characteristic of participatory modes of civic action. In a pilot study, high school students designed and build in small groups collaborative controllers for Scratch games. Our analyses reveal how collaborative game making potentially cultivates habits attuned to the challenges of participatory civics: engaging youth in interactive, peer-based and open-ended design processes, while demanding they reflect on the needs, perceptions and behaviors of diverse others.

Background

The civic world is rapidly changing in response to the affordances of the digital age, which ushered the rise of participatory civics: interactive, loosely structured and collaborative modes of civic action (Benkler et al, 2015; Bennett & Segerberg, 2012; Zuckerman, 2014). Coupled with a decline in traditional measures of civic participation such as voting and membership in political parties, these shifts have led researchers and educators to seek novel forms of civic education which will increase its effectiveness and prepare students for the evolving civic sphere (Kahne, Hodgin, & Eidman-Aadahl, 2016). Though still a nascent field, video games have been presented as a ripe setting to offering students an engaging, situated and participatory form of civic education (Bachen et al, 2015; Lenhart et al., 2008).

Broadly defined, research on the civic contributions of video games has focused on two central educational mechanisms: games that present content relevant to the civic sphere, and games that facilitate civic interactions.¹ Civic content games – both educational (e.g., People Power) and commercial (e.g., SimCity) – offer players opportunities to engage with civic issues from social

¹ These categories are in no way mutually exclusive; “civic content games” can simultaneously facilitate civic interactions. Yet, in practice, games that combine the two are rare.
inequalities to global warming in a situated and complex manner (Waddington et al, 2014). Civic interaction games, most notably MMORPG (e.g., World of Warcraft), are not characterized by civic content matter but rather offer players settings in which they engage in simulative civic interactions (Steinkuehler, & Williams, 2006; Curry, 2010). Therefore, we contend that civic interaction games offer a digital version of Dewey’s (2001) vision of democratic education as a process in which children develop “habits of democracy” through participation in a community (Stützlein, 2014).

However, existing research has largely concentrated on examining civics in game playing, leaving out game making. The academic advantages of game making are well documented: introducing youth to programming, integrating academic content matter, developing design skills and nurturing system thinking (Kafai & Burke, 2015; Hayes & Games, 2008). We propose that game making can concurrently function as a site for cultivating habits of democracy. While game playing allows overcoming the often passive nature of classroom instruction, collaborative game making endorses learning that is not part of a carefully designed space, situating youth as shapers of their (physical and virtual) environments, much like citizens in a democracy. Therefore, game making is particularly suited for cultivating habits attuned to the emerging forms of participatory civics, defined as “interactive, peer-based acts through which individuals and groups seek to exert both voice and influence on issues of public concern” (Kahne et al., 2016, p. 2).

In this paper, we offer a conceptual analysis of the unique attributes of collaborative game making as a context for developing habits of participatory civics, and illustrate our arguments using case studies from a game making workshop. We conducted a pilot study with 13 high school freshmen who in small groups designed collaborative controllers for simple games using Scratch, a youth-oriented programming platform and MaKey-MaKey, a small USB device that connects to conductive materials and transforms them into touch-sensitive buttons (Silver, Rosenbaum, & Shaw, 2012). Our analyses focused on the unique aspects of participatory civics identified above by Kahne et al. (2016). Accordingly, the research questions guiding this inquiry are: (1) To what extent can the interactions characteristic of collaborative game making cultivate the habit of participation in interactive peer-based acts? (2) How can the other-oriented design demanded in game making contribute to participation in civic action towards issues of public concerns?

Theoretical Framework

The rising prominence of participatory civics has led to renewed interest in Dewey’s (2001) conceptualization of civic education as cultivating democratic habits by “immersing individuals in practices of shared living where those habits serve their needs well” (Stützlein, 2014, p. 68). Dewey (1922) emphasizes that democratic habits can only be developed if schools structure educational environments in which practicing such habits is an integral part of achieving students’ aims. Distinguishing between mechanical and dynamic habits, Dewey argued that the former are a form of repetition, usually unconscious, and can be achieved through training while the latter are accompanied by critical reflection, which means they are reconstructed according to accumulated experience, and their cultivation is the essence of education (Hansen & James, 2016). We wish to concretize and contextualize

2. Marina Bers’ (2012) research is an exception to this norm; however, Bers is interested in the civic interactions within the virtual realm, while we focus on the civic potential of the process of game making itself.

3. While we focus on the making aspect of our workshops, the distinction between making and playing should not be overstated.

Commercial games have been blurring this distinction by offering players more opportunities to actively design parts of the games they play in (Kafai & Burke, 2015).
this framework by outlining how the cultivation of contemporary forms of civic action – habits of participatory civics – can be pursued in a specific setting – collaborative game making.

This inquiry is rooted in the fact that the constructionist approach to learning is in essence civic – defined by an emphasis on social participation in creating public artifacts (Kafai, 2006; Papert, 1980). The common thread in the various approaches to learning through crafting and design is the emphasis on the three complimentary components of this activity: defining the ends of the design process, formulating potential solutions, and critically (and iteratively) carrying out the practical steps necessary to achieve these solutions (Horn, Crouser & Bers, 2012; Kolodner, 2002; Roth, 1996). A similar set of challenges faces citizens in today’s civic sphere: identifying the problems they think are worth tackling, coming up with possible solutions, and implementing the required means. More specifically, the modes of experimentation and failure characteristic of game making are particularly attuned to the emerging forms of participatory civics: a collaborative, self-directed, open-ended and nonlinear process in which both the goals and the methods utilized to achieve them are largely determined by participants (Ratto & Boler, 2014; Stokes, 2012). Moreover, game making facilitates opportunities for practicing civic interactions in the virtual realm. Several game making platforms are structured around online communities of users who share, remix and comment on projects (Kafai & Burke, 2015). These communities are crucial as an increasing portion of participatory civics is pursued online (Kahne et al., 2016).

Finally, games are public artifacts – created with the intent of being used by others. Therefore, game making develops the foundation for public thinking: collaborating on projects which are created in light of the needs and desires of others. As famously noted by Piaget (1997), games are central spaces for children’s moral development. In games, children encounter rule-systems under a relative lack of adult supervision and develop the capacity to comply, interpret and negotiate these rules. In this vein, we contend that establishing an interactive rule system which governs the social interactions within the game space demands a complex form of perspective taking: reflecting on the perceptions, motivations and behaviors of future players as they develop over time across a host of possible choice sets (Flanagan & Nissenbaum, 2014; Salen & Zimmerman, 2003). Most importantly, in game making reflection is endogenous to the decision making characteristic of the attempt to make a successful game, rather than an external element added in retrospect (Kafai & Peppler, 2014). Assessing the perspective of others, and planning projects accordingly, is an invaluable step towards cultivating the habit of effective participation in issues of public concern (Ben-Porath, 2012; Mutz, 2006).

Context

Participants

We designed and conducted a “collaborative controllers” workshop for 13 high school freshman (five girls, eight boys ages 14-15 years) situated in a metropolitan city in US northeastern state. This workshop was the second of a series of workshops intended to explore the potential of game making to nurture habits of participatory civics. Students participated in this workshop as part of a partnership their school has with a local science museum. One instructor led workshop activities, while another assisted with data collection. Participants reflect the demographic makeup of the school: 46% African American, 33% White, 10% Latino, 9% Asian/Pacific Islander, and 2% other; 49% of students were eligible for free or reduced lunch.
Workshop Activities

The workshop ran for a total of 16 hours over eight weeks. Utilizing the Makey-Makey’s ability to connect to the computer and transform conductive materials into touch-sensitive buttons, teams created physical controllers which demanded collaboration among players in order to close an electric circuit and control the game on-screen. The choice to require participants to design collaborative controllers was intended to elicit reflection on the game mechanics by deviating from the standard individual and competitive model of controller use. Teams started by designing controllers for the classic video game Pong. For later projects, students were taught the basics of Scratch programming, remixed video games of their choice and created collaborative controllers. Teams presented their final projects in an arcade in their school, offering their peers outside of the workshop an opportunity to play with the games they created and provide feedback.

Data Sources and Analyses

Group interactions were documented in observational field notes (taken by a second instructor) and via video recordings focused on group work. These observations were supplemented by students’ weekly reflections, emergent interview opportunities, and semi-structured debriefing focus groups. Finally, we conducted a descriptive review of participants’ games relying on groups’ Scratch code, videos recording their progress, play-testing sessions and set-up of final projects. Using these data sources, we developed two case studies that best illustrated the relevance of game making to the cultivation of habits of participatory civics. We focus on the final projects of two of the three groups, which were prepared over three sessions and then presented at an arcade in the school.

Case Studies of Participatory Civics in Game Making

We present two cases to illustrate how collaborative game making can potentially cultivate one of two habits of participatory civics: interactive peer-based participation and pursuit of issues of public concern.

Blaze It – Interactive Peer-based Participation

The Blaze It group consisted of six participants (three boys and three girls) from diverse backgrounds, which were largely not familiar from earlier contexts in the school. This lack of familiarity and a foundation of shared interests proved particularly challenging in identifying and setting the goals the team wished to pursue. In contrast to three earlier shorter projects, in the final project participants were not offered any limitations beyond the need to create collaborative controllers. As a diverse and unfamiliar group, this group struggled with setting their own goals. This was particularly notable at the brainstorming stage in which members were dumbfounded to even begin, and seemed openly frustrated. Maria (all names are pseudonyms) later summarized:

“When we were first getting started, we were all pretty, I don’t know, we didn’t have a lot of ideas, and um, it took a while to come up with something that we all wanted to do… we spent a whole class time I think just kind of sitting in silence.”
The challenges characteristic of a collaborative, nonlinear and open-ended process was a constant theme in the team’s work. Blaze It’s struggles in creating their controllers illustrates this point. The group’s choice of controllers based on tilting water (see Table 1) was creative yet technically challenging, and the group encountered a consistent problem of lagging controllers. The group engaged in an iterative trial and error process, tinkering and improving the controllers, as Natasha notes:

“With the trial and error… we did see so many ways that it could go wrong and we found so many ways to improve it, and um, like, with each trial we saw, um, I don’t know, like, things we could take from it… I think it made our design better at the end.”

The cyclical and collaborative process of tinkering and play-testing was very insightful from a civic perspective – offering a glimpse into the challenges characterizing a peer-based and self-directed process of production. Maria later stressed the communal aspect of these struggles: “I learned by seeing what other people were thinking”. Jennifer elaborated on what this process had taught her:

“For me, it was like, I am not good at thinking ahead… if I do something it’s like, yeah, that’s it… I finally thought ahead during the actual arcade… it was thinking in the future, I know it’s just a basic human thing, but I don’t have it all the time.”

Table 1. Teams’ final projects: video game and collaborative controller design.
Potato Hunt – Issues of Public Concern

The challenges encountered by the Potato Hunt group illustrate another civic aspect of game making: nurturing participants’ habit of acknowledging diverse perspectives and partaking in public projects in light of these. In contrast to Blaze It, Potato Hunt members (two boys and two girls) were all friends prior to the workshop, which was reflected in high levels of collaboration and creativity in projects related to their shared everyday interests. Where other teams tended to work until the game reached the required levels of functionality, Potato Hunt constantly tinkered with their game in an attempt to improve it. Sarah, a group member, describes:

“We worked really well as a team together… we kicked around ideas and no one idea’s was really like disregarded, or like, that’s stupid… we always built upon them and we just worked well.”

While their game was highly successful in internal playtesting sessions, boasting unique game mechanics, advanced coding and polished visual and audio effects, their experience in the arcade in their school were drastically different. The group only recruited players for 10 minutes of play in contrast to Blaze It which drew a steady crowd of players for the entire 45 minutes. When reflecting on this state of affairs group members (accurately) acknowledged the game’s high barriers for participation which included taking off shoes and holding other players’ hands:

Emily: “The game was a good idea, it just might have been a little too active because it was a bit hard and a lot of people weren’t comfortable with what they had to do.”

Sarah: “The other games seemed popular because they didn’t require as much physical activity and also you had to take off your shoes for the game we created.”

When explaining why they might have not considered these barriers beforehand, they state:

Sarah: “Because we were all pretty comfortable with it, because we were all, um, awesome.”

Emily: “I also probably think it’s their fault because they suck.”

This failure exposes how game making potentially creates a tension between the designers’ needs and desires and those of future players. In the process of creating a successful game, designers are demanded to consider and analyze the game’s rule system from the perspective of diverse future players, which might be different and even contradictory to their own. In the case of the Potato Hunt group, the feedback from the arcade allowed them to assess aspects of their game they were unable to think of during the initial design and playtesting. We now turn to explore what the experiences of the two groups illuminate concerning the potential of game making as an activity that cultivates habits of participatory civics.

Discussion

This study offered an exploration into the potential of game making as a site for developing habits of participatory civics while concurrently pursuing academic ends (in this case – computer programming and design thinking). As stated, the emergence of participatory civic demands citizens to take part in loosely-structured and collaborative action geared towards public, rather than private, ends. From a Deweyan perspective, this requires schools to offer youth comparable environments in which they can practice and cultivate such habits. Moreover, for the practice of such habits to have enduring effects, they
cannot be limited to explicit civic lessons and must characterize the school environment more broadly (Dewey, 1909). Consequently, it is important to explore other academic settings in which such habits can be nurtured.

Two aspects of game making seemed particularly conducive to habits of participatory civics. First, the ill-structured, non-linear, collaborative and iterative nature of game design is reflective of the challenges of the evolving peer-based and loosely structured sphere of participatory civics (Stokes, 2012). While Gee (2010) argues that games are “pleasantly frustrating”, striking the balance between challenge and “doability”, game making offers a crucial form of frustration characteristic of participatory civics – that of collaboratively tackling a self-guided process which lacks external structure that ensures success, as Ben succinctly stated during Blaze It’s brainstorming: “UGH! This is so painful.” However, these struggles are vital if students are to cultivate the habits of setting their own goals and striving to pursue them. A whole session in which participants tentatively brainstorm (as described above) might be perceived as a waste of time when viewed from the perspective of progress towards manufacturing a final product. However, from the perspective of cultivating habits of participatory civics, this is exactly the sort of experience lacking from many educational projects in which the teacher, or the game designer, guide the broader aspects of the project. The failures and iterations in the process of solving the controller problems, had vital contributions (“thinking in the future”) that are compromised when students are offered a structured solution to the problem, or when educators take the lead in an attempt to save time or ensure a better final product.

Second, the reflection demanded to make a well-designed game encourages elaborate and sophisticated forms of perspective taking: analyzing the game’s rule system according to the motivations and behaviors of future players (Flanagan & Nissenbaum, 2014). Whereas game playing can situate players in roles and interactions characteristic of the civic sphere (Curry, 2010), we suggest that game making can add another layer to the simulative civic role of games: providing students with the expectations and roles characteristic of active citizens working collaboratively to shape social environments. In this respect, game making can serve as a first (and intrinsically motivated) step towards developing public thinking: examining one’s actions from diverse perspectives. While due to the workshop’s length, members of Potato Hunt did not have an opportunity to implement the lessons they learned from their failure, their experiences explicate the unique perspective taking afforded in games. In contrast to most educational projects that are evaluated by a teacher, or by their ability to fulfill a certain function (e.g., programming a functional script), games are an other-oriented project which are assessed according to the reactions of diverse peers. Practicing the habit of viewing their projects from multiple perspectives, and designing it accordingly is not an intellectual exercise divorced from the activity, it is at the heart of learning to make well-designed games. Importantly, when accompanied by opportunities for play-testing, game making offers experiential and real time feedback concerning the projects’ weaknesses and strength, one that is likely to have a more lasting effect than after-the-fact comments offered by an instructor. Therefore, game making does not only facilitate opportunities for perspective taking, it also increases the motivation to do so.

In summary, this workshop allows identifying two vital characteristics of game making as a context for practicing habits of participatory civics. To begin with, it is important to structure game making as a collaborative and self-directed activity. Students need to be offered the time and freedom to set their own goals, and to struggle with the iterative process of making their vision a reality. While this often results in stretches of time in which students do not demonstrate any visible progress, and might jeopardize the quality of their products, it offers challenges and experiences vital for participation in
today’s civic sphere. In addition, designers should be offered meaningful playtesting opportunities. One of the important civic aspects of game making is that it affords youth opportunities to create work intended for the use of others. Students are not attempting to fulfill a predetermined goal set by a teacher, but rather to appeal to a diverse set of interests, perceptions and motivations. This can only come into play if students experience firsthand the ways in which players interact with the games they have created.

While this inquiry is still at an early stage, it points out avenues for future research. First, one of the central advantages of game making in nurturing collaboration is the opportunity to offer students opportunities to collaborate not only with their classmates, but also with members of the virtual Scratch community (Kafai & Burke, 2015). Future research could explore how game making may concurrently nurture larger networks of collaboration; in line with the increasing importance of online collaboration in the civic sphere (Bennett & Segerberg, 2012). Second, as implied by their name, habits of participatory civics require a prolonged process in order to develop into ingrained modes of behavior. Hence, future research could also explore how such habits develop over an extended period of time, while simultaneously considering the learning gains of this activity. In this respect, we see this paper as a small step in the journey towards better realizing the civic potential of game making.

Acknowledgements

The research reported in this paper was supported by a collaborative grant from the National Science Foundation to Yasmin Kafai (NSF-CDI-1027736). The views expressed are those of the authors and do not necessarily represent the views of the Foundation or the University of Pennsylvania.

References


International Center on Nonviolent Conflict (2010). *People Power* [Computer game]. Washington, D.C.


Environmental Attitudes in Youth-Created Computer Games about Climate Change

Gillian Puttick (TERC), Eli Tucker-Raymond (TERC), & Jackie Barnes (Northeastern University)

Abstract

This paper presents findings from case studies of two girls who designed games to teach other youth about climate change. Analysis of how their environmental attitudes shaped their design decisions, and on how game design changed their attitudes, offers a window on the relationship between the two. Implications for creating game design experiences aimed at learning science, particularly when the topic is as difficult and complex as climate change, are discussed.

Introduction

Initiatives that support youth to design games have increased with the advent of graphical programming environments such as Alice and Scratch. Game design can be effective in teaching about domain-specific content, e.g., systems thinking (Puttick et al., 2014; Salen, 2007), mathematics (Tucker-Raymond et al., 2012), and model-building (Repenning, Webb & Ioannidou, 2010). Games provide a unique environment within which players can interact with a dynamic system, as well as feel empowered by seeing immediate consequences of their actions in a game world.

In this paper, we focus on exploring the agentic engagement of designing games, rather than playing them, in the context of the issue of climate change. We designed a summer workshop for young people to explore the affordances of game design with respect to learning about climate change. Elsewhere, we report findings that show that game design productively supports learning (Puttick et al., 2014; Puttick & Tucker-Raymond, 2016). In the present study, we focus on how environmental attitudes are manifested in the kinds of games participants designed, and how their attitudes were changed by game design.

Theoretical Framework

Why design games about climate change? Psychological studies of people’s engagement with climate change and its implications suggest that the complexity, scale, and abstractness of the concepts and issues concerned discourage people from dwelling on the meaning of climate change for themselves (Swim et al, 2009). Realizations about the reality of climate change, and the feelings of powerlessness
that result, can be overwhelming (e.g., Hicks & Holden, 2007; Threadgold, 2012), particularly for young people, in part because their sphere of influence to effect change is limited. However, research has shown that taking action can mitigate a sense of paralysis (Clayton & Brook, 2005). We conjectured that creating games designed to teach others about climate change would provide young people with an opportunity to take action (Leiserowitz, 2005; Swim et al., 2009). In addition, since climate change is an issue of ethical complexity, this has been modeled and explored with games (Harteveld & Drachen, 2015; Wu & Lee, 2015). Given this, games have a place in exploring contemporary ethical issues.

**Relevant insights from psychology.** Interest in identity has risen as the impacts of human pressures on the environment become more visible, and researchers seek to understand what psychological factors might be implicated in environmental preservation (Crompton & Kasser, 2009; Clayton & Brook, 2005). While defining and investigating identity broadly is expansive, the relatively new field of conservation psychology has focused on those attitudes and behaviors that constitute part of an “environmental identity” in particular (Clayton, 2003), and that support environmental sustainability (Saunders, 2003). Relevant constructs from this field include attitudes towards: a) nature and the environment, b) sustainability, c) the importance of raising awareness through education, and d) possible paths to action.

Environmental attitudes, particularly related to valuing the environment and feelings of affinity with nature (Muller, Kals & Pansa, 2009; Bang, Medin & Atran, 2007), also have a moral dimension. Britner (2002) investigated the moral reasoning of urban middle school students with respect to the environment, framing moral reasoning in terms of “care” and “justice” moral orientations. Care orientations emphasize connections among people and attempt to fulfill the needs of all concerned, and are expressed more frequently by girls (Gilligan, 1993). Britner writes, “It is this contextual and connected view of moral problems and their solutions that Gilligan described as an ethic of care” (p. 1). On the other hand, a “justice” moral orientation, more frequently expressed by boys, emphasizes abstract and formal moral reasoning (Kohlberg, 1984). Britner found that students’ responses were strongly oriented toward care reasoning, with a slightly higher care orientation among African American students and among girls. Szagun & Mesenholl (1993), in an empirical study of West German adolescents’ ethical concern about nature, note that their respondents all rated harm done to an ecosystem as immoral.

Researchers have also begun to investigate the ways in which young people cope with the psychological impact of global environmental problems. For example, Ojala (2013) investigated the strategies that Swedish adolescents use to cope with the facts of climate change. She found that problem-focused coping – in which people confront the problem by looking for information or talking to others about what to do – was positively related to felt efficacy and to pro-environmental behavior.

One of the primary goals of the workshop was for designers to focus on game design as a tool to learn about climate change, and embrace the task as a form of taking action. However, we also conjectured that environmental attitudes might be a formative influence in shaping the kinds of games that participants would design. Therefore, we also surveyed and coded for environmental attitudes and values, and attitudes about behavior.

**Research Design and Methods**

In this study, we ask: 1) In what ways are participants’ environmental attitudes expressed in the games
they designed to teach others about climate change? 2) Do participants’ attitudes change as a result of designing a game to teach others?

Participants

Participants were recruited through outreach and flyers to school districts, parent listservs and other youth organizations through which the authors had contacts. The five participants were in 6th, 7th, and 8th grades, each from a school in a different municipality. Three were African American, one was European American, and one was Nepali American. Two had no prior experience with game design, one had begun 8 months previously, and two had more than a year’s familiarity. When asked what drew them to the workshop, three of the five participants listed learning or using programming; the other two attended because it was school vacation that week. Participants and their parents consented to participation in the research. Participant pseudonyms are used.

Workshop

The program was a four-day intensive game design and climate change workshop for five middle school participants, all girls, held in July 2014. Participants used Scratch (scratch.mit.edu) to create games based on a systems perspective on climate change. The program ran six hours each day for four days. There were laptop computers for each student and a room computer with a projector. The two researchers acted as facilitators – Puttick led discussions on climate change, while Tucker-Raymond provided support for game design and programming.

Participants were told that they were to think about choices people make when deciding to use certain kinds of energy sources, to connect these to climate change, and to create a game that would help other young people make these connections. On day 1, they were introduced to Scratch, completed a group concept mapping activity to see connections about climate systems, viewed an informational video about climate change, and visited a local wetlands reserve to observe and discuss possible connections from components of the reserve to climate change. On days 2-4, designers worked alone to design their games, user tested their games in pairs, elaborated the concept map as a group, and ended the workshop with presentations to family and community members.

Data Sources

Interviews: We conducted individual semi-structured interviews of 35-40 min at the end of Day 3 to capture designers’ attunements to game design affordances and understand their goals in relation to their design choices. We asked them: (i) How does your game work? (ii) How is your game related to global warming? (iii) Where did the idea for your game come from? Surveys: Girls completed a brief pre/post survey to provide demographic data and level of Scratch experience. It also included items on attitudes, values and general knowledge of climate change, constructed on a 5-point Likert scale. Where available, items were adapted from validated instruments (e.g., Leeming & Dwyer, 1995; Leiserowitz et al., 2011). We tested the survey with a focus group of four middle schoolers, and adapted the vocabulary of some items. Content was validated by expert review. Games: Versions of the games were archived at the end
of each day. **Participant-observer notes:** Researcher notes provided additional data and directions for analysis.

## Data Analysis

Transcripts from interviews and conversations, and logs of video data were imported into Dedoose, a web application for organizing and analyzing mixed methods research data. We generated a set of pre-determined codes based on principles in our theoretical framework (Miles and Huberman 1994) to categorize our data along dimensions prescribed by the categories shown in Table 1. At the same time, we paid attention to new patterns and ideas from the participants as they emerged and integrated them with the existing scheme (Creswell, 2009). This approach allowed us to apply both a priori and emergent coding categories to the data. For instance, we started with broad categories of analyses we had intended the survey to capture, such as socio-ecological connections as they related to values, psychology, and behavior. Reading through the transcripts allowed us to create more nuanced categories such as between behavior that mitigates or contributes to climate change.

| Table 1: Coding categories. (See Puttick & Tucker-Raymond, 2016 for details.) |

**1. Attitudes about the environment**  
Positive or negative attitudes about own relationship to the environment  
Example: I think that happiness is a priority but it shouldn't be one if it involves hurting the environment

**2. Socio-ecological/human connections**  
Ethics/morals associated with contributing to climate change  
Example: We all need to help because the environment is getting worse and we have to step up and do something

Psychological impacts of climate change  
Example: It’s kind of nerve-wracking; The people are trading the safety of the planet for their own comfort

Human actions that contribute to climate change  
Example: I don't think people realize how much pollution, from the stuff that you buy, can actually make

Human actions that can mitigate climate change  
Example: Planting trees is an easy way to help decrease carbon dioxide

## Results

All of the participants chose to focus on the causes and mitigating factors of climate change. Overall, games incorporated methods to sequester carbon dioxide and methane, two important greenhouse gases. All of the participants expressed their hope that the games would have an impact on players’ knowledge and potentially also on their future behavior. We discuss two cases: that of Ciara, one of the three African Americans attending the workshop, and Lane, the European American. We focus on these two cases because both girls expressed strong environmental attitudes yet produced different games.

Given her 2 years’ experience with Scratch, Ciara was able to create three games during the workshop. All focused on socio-ecological connections and helping players learn about actions that can be taken to mitigate greenhouse gas levels. The first game involved capture of methane (“farts”) from cows (Figure 1, L), and the second was a quiz about sources and sink for carbon, which ended with an information screen that explained the connection between trash incineration and greenhouse gases. The third game asked the player to sort items into trash or recycling (Figure 1, R).
Coming into the workshop, Ciara had expressed contradictory views about the reality of climate change. On the survey, she agreed with two statements, “Global warming isn’t happening” and also “Humans can reduce global warming and will do so successfully.” However, when asked in the interview what she had learned, she said:

Puttick: OK so you learned a bunch of new stuff. Can you just give me one example?

Ciara: I learned about carbon sinks and methane and how the environment is really in drastic need of help […] I thought we weren’t as endangered as we are right now. Because it [the video] talked about these are the hottest years we’ve ever, in recorded history and stuff like that so I hope people learn that they need to do their part to help the environment because we all need to help because the environment is getting worse and we have to step up and do something.

She now agreed that global warming is happening, and, in light of this, she went from disagreeing to agreeing with the survey statement that she would soon talk with people other than her family about climate change. Intention to act is an important factor in determining whether or not individuals are likely to move from expressing an environmental attitude (Clayton, 2005) to actually taking action (Thogersen & Olander, 2003). For Ciara, a first step in taking action meant educating others in her game about something important she had learned – the role of carbon sinks in potentially mitigating climate change.

More important, this change in attitude directly informed the design of her second two games. Her goal became to teach others what to do to “do their part to help the environment.” We conjecture that the desire to help out that she expressed in the interview was motivated in part by learning about climate change, but also in part by a positive environmental attitude. Coming in to the workshop, she had prioritized protecting the environment, disagreeing with two pre-survey statements: “Both the environment and comfort are important, but my comfort should come first,” (item #3) and “The highest priority should be given to the happiness of people living right now in my area, even if it hurts the environment here or anywhere else” (item #4).

Ciara appeared to show a care orientation, like the African Americans and girls in Britner’s (2002) study on moral reasoning. Evidence can be seen in the quote cited above in which Ciara framed the need for action as an imperative, “we all need to help because the environment is getting worse and...
we have to step up and do something.” Ciara also included others in the need for action, by positioning “people [who] learn that they need to do their part” within the collective “we,” and aligns herself with this community as well. In the same study, Britner noted that interdependence and connection are both central to the ethic of care (Britner, 2002).

Ciara elaborated on her attitude towards the environment when we interviewed her about her response to survey item 3 (see above):

Ciara: I was going to say neutral on number 3, because some people actually do find comfort in the environment, and I happen to be kind of like that, like I find comfort you know, going outside.

This attitude relates to an aesthetic choice she made for the background in her first game. She selected a bright yellow field with a sunny blue sky in the background. Color theorists report that yellow can be a color associated with happiness and optimism (Elliott, Fairchild & Franklin, 2015), although the perception is culturally and contextually based, and evidence of the psychological impact of colors is still limited. Nevertheless, one could argue that such a landscape reflects one in which “comfort” could be derived. In addition, it could also be seen to reflect her optimistic attitudes for change, and to reinforce the larger mitigation theme of all her games.

Lane also came into the workshop exhibiting positive environmental attitudes. She responded “very true” to the item that asked about whether she talked with parents about environmental problems, and to the item that she would soon talk with people other than her family about climate change. In addition, she “agree(d) very much” that protecting the environment was more important than saving money, convenience or comfort. She also agreed very much that sacrificing “happiness” by foregoing an activity that used energy was important because that would protect the environment.

Lane created a game that asked the player to use plants to sequester carbon dioxide. It was designed to teach players that plants have different uptake capacities, and that their capacity had limits (Fig. 2). Lane’s positive attitude towards and feelings of affinity with nature were directly evident in her depictions of plants and animals in her game. There one can see birds, a rabbit, and snails, as well as at least five types of carefully chosen or drawn plants (and one carrot).
She was most concerned about the looming impacts of climate change. She responded “a moderate amount” on a survey item about how much she thought global warming would harm her personally, and “in 10 years” on an item about when global warming would begin to harm people in the U.S. Unprompted, she expressed her anxiety about societal inaction multiple times during the week. In her depiction of the humans in her game, it could be argued that these expressed fears about societal inaction are emphasized. We see a smiling couple that is literally sitting on the fence, a girl lying and relaxing in the foreground, and happy children playing in the background. The scene is predominantly one of inaction, in spite of the looming cloud of carbon dioxide above them. In addition, the little creature that is behind the “Buy Time” stand bears witness to the irony that, while the player can sacrifice points to buy time in the game, humankind has little time left to buy.

In the interview, she lamented the attitudes of people who choose to ignore the impact of their own behavior on the planet:

Lane: the people are […] living their lives not ignorant but in willing ignorance. It makes the planet worse […] they could talk about global warming a lot and someone could overhear it, someone could get a spark in their head to do something…

She also remained certain at the end of the workshop that humans would not address climate change, agreeing very much that “people aren’t willing to change their behavior, so we’re not going to [address climate change].” Lane’s ethic of care, evident in her game and documented in this survey response, align both with the findings of Britner (2002) who found a strong ethic of care in girls, and of Szagun & Mesenholl (1993), whose respondents rated harm done to an ecosystem as immoral.

Lane’s pro-environmental attitudes strengthened pre- to post-survey. From feeling neutral in the pre-survey, she expressed an intent to act in the post-survey by agreeing very much with the statement, “I will talk with people other than my family about how to help with environmental problems soon.” Could
the experience of designing a game about climate change have empowered Lane to contemplate taking further action in talking to others about what to do? This finding would align with Ojala’s finding (2013) that adolescents concerned about climate change can confront the problem by talking to others about what to do, and that this was positively related to felt efficacy.

Discussion

Our intent in this paper was to investigate the environmental attitudes of young people in relation to the design choices they make while creating games about climate change, and to investigate whether or not participants’ attitudes changed as a result of designing a game.

The games designed by both participants show the influence of their attitudes in different ways. Ciara’s positive environmental attitude was reflected in the appearance of the environment in her first game. In addition, although she was unsure about the reality of climate change at the beginning of the workshop, she appears to have left in possession of this understanding, and with the motivation to inspire environmental action in others. This change was reflected in the design of her second and third games, which were designed to teach others how to take action. On the other hand, Lane came to the workshop with a strong awareness of climate change. She expressed a strong sense of affinity with the environment, but also expressed a sense that humans were not going to address it. Her attitudes about nature and about humans appeared to be reflected in the design of her game too.

We took these values and attitudes into account as part of our theoretical framework for the workshop design in several ways. Features of the program included a connection to nature (Muller, Kals & Pansa, 2009; Bang, Medin & Atran, 2007) – we conducted a half-day field trip to a local natural area to observe nature, and to talk about possible connections of the area to climate change. By framing the design task as one in which the goal for participants was to educate others about climate change, we incorporated a path towards action (Leiserowitz, 2005; Swim et al., 2009). We also stressed those individual and societal behaviors and investments that might make a difference in mitigating climate change (Clayton, 2003; Saunders, 2003.

Implications

Limitations to the findings of our study include the small number of participants, the short time the girls had to engage with the topic, and the limited time they had in which to explain their decisions in a naturalistic setting. Therefore, our findings can only show girls’ attitudes in this unique context (Erickson, 1996). However, given that the attitudes of these two girls showed a clear impact on the types of games they designed, these results suggest that it is important to take into account the values and attitudes that participants bring to any game design experience, in particular when the topic at hand is the difficult and complex one of climate change. Attitudes are important for two reasons; i) they should guide the design of the experience, and ii) they should be taken into account when seeking to understand from a research perspective, the games that have been designed.

Several studies have reported that many young people feel worry and powerlessness about global problems, including climate change (e.g., Hicks & Holden, 2007; Threadgold, 2012). We agree with Ojala (2013), who states that teachers need to encourage students to verbalize their emotions about climate change. She states, “In order to counteract the negative affect related to cognitive problem-
focused strategies, teachers can help their pupils to find concrete actions concerning climate change and let them work together on these issues” (p. 2204).

The impact of environmental identity and attitudes towards the natural world, and more specifically, towards the impact of humans on global climate, would be a productive focus for future study. This will continue to be a focus of our own research into students’ learning about climate change through game design, but also bears closer scrutiny in climate change education programs more generally.

Acknowledgments

We are grateful to Amanda Strawhacker for her back-up technical support during the workshop. This work grew out of an exploration of ideas with Lis Sylvan, for which the first author is indebted. The manuscript was improved by feedback from anonymous reviewers. This work was supported by TERC, and in part by grant #1542954 from the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the view of the National Science Foundation.

References


Threadgold, S. (2012). ‘I reckon my life will be easy, but my kids will be buggered:’ Ambivalence in young people’s positive perceptions of individual futures and their visions of environmental collapse. *Journal of Youth Studies*, 5, 17–32.


20.

How Student Game Designers Design Learning into Games

Charlotte Lærke Weitze (Aalborg University, Campus Copenhagen)

Abstract

This investigation examined how to support students in creating learning designs for specific learning goals in analogue and digital games as a means of learning. The study also explored the learning trajectories that emerged in the digital games created by the student learning-game designers. The DBR study was developed through three iterations over two years, involving teachers and students in co-design processes. Together with the teachers, an overall learning design supported the learning process for students by inviting them to be their own learning designers as they designed digital learning games for specific learning goals in cross-disciplinary subject matters. The findings were that the students succeeded in developing and implementing specific learning goals in their games. The students also developed learning trajectories through the games by designing various learning and evaluation opportunities for the player/learner playing the game.

Introduction

Educators and educational theorists have long advocated for learning games as an active way of learning by experience. If carefully designed, learning games can allow learners to interact with learning situations that cannot be replicated in a traditional classroom setting (Barab & Dede, 2007; Squire, 2011; Gee, 2003). Kafai & Burke (2015) argue that there may be a valid alternative to the serious game movement’s debate over whether the educational potential of games is realised through commercial games or skill-and-drill exercise games. Perhaps the debate should instead be between the practice of playing games and the practice of making games. There is a growing body of research on extending game-based learning—be it the use of simulations, virtual worlds, or games developed with the purpose of learning—to creation of games as a means of learning (Earp, 2015; Kafai & Burke, 2015; Weitze, 2015). Instead of giving the student a less active role as game player, creating games as a means of learning positions the student in a more active role as game designer (Oygardslia, 2015, Weitze, 2015).

Learning-game creation as a means of learning originates in a constructionist pedagogical approach. Constructionism builds upon the thesis that there is a strong connection between designing and learning. When students design learning games, the activities involve making, building, and programming, all of which provide a rich context for learning (Harel & Papert, 1991; Kafai & Resnick, 1996; Weitze, 2017). The learning-game designer needs to think about the meta-structures in the game (Earp, 2015). This
involves interactions and game mechanics (what you can do in the game) as well as how the game’s learning design is set into play. When using game design as a means of learning, the focus is often on learning to programme and develop computational thinking skills (Brennan & Resnick, 2012); teachers seldom have an expressed expectation that students must attain specific learning goals. The generally accepted notion is that “conceptual understanding of subjects such as mathematics and science, as well as the dynamics of teamwork and task prioritization, are not learned as ends in and of themselves but put expressly toward the purpose of creating genuinely playable games, resulting in more genuine—and collaborative—learning experiences” (Kafai & Burke, 2015, p. 323).

In contrast, the purpose of the current experiments was for students to incorporate specific learning goals in the process of creating their own learning games. The aim was to create an overall learning design which would facilitate the students’ learning process by letting them be their own learning designers. In designing their own digital learning games to achieve specific learning goals in cross-disciplinary subject areas, students would themselves attain specific learning goals in those subjects. The term learning design describes 1) how a teacher shapes social processes and creates conditions for learning and 2) the phenomenon of the individual student constantly re-creating or redesigning information in his or her own meaning-creating processes (Selander & Kress, 2012, p. 2). In this experiment, the teacher was the primary learning designer. But the students were also their own learning designers, as well as their peers’ learning designers: they discussed the subject matter, found content, and conscientiously negotiated how to implement learning into the small digital games they were creating in order for future players/learners to learn (Weitze, 2015).

The main focus of the research process was on creating innovative and engaging learning designs for students. As expected, the students learned the most while designing learning games as they created learning situations and built learning content into these games. According to the teachers’ formative assessments, the students reached their learning goals: they could explain, discuss, and critically think about the concepts from the curriculum, confirming that they had reached a complex level of understanding (Weitze, 2015; 2017). The quality and characteristics of the learning situations built into the games were found to be important for the depth of the students’ learning processes. Therefore, the following research questions were relevant to investigate in this study: How can students be supported to create a learning design for specific learning goals in analogue and digital games as a means of learning? What learning trajectories emerge in those digital games that succeed in creating learning events?

Methodology and Research Design

Approach, Data Collection and Analysis

The investigation was conducted as a design-based research (DBR) study through three iterations over two years (Spring 2014 to Spring 2015). The teachers and students were co-designers in the development and testing process. The study used mixed methods. Semi-structured interviews were conducted with teachers after each workshop, and semi-structured interviews were conducted with students after the final workshop. All workshops were observed, and actions and utterances were audio- and videotaped. Data included field notes, evaluation documents written by the students, videos of students’ games being discussed and playtested, and the students’ digital games themselves. The analysis was made by coding the transcribed data using the qualitative research software NVivo with an informed grounded theory
approach. This was carried out as concept-driven coding (using concepts from the theory and previous empirical data to find themes in the data) and data-driven coding (reading the data and searching for new phenomena which are not known from previous preconceptions of the subject)

Participants and Setting

The audience in the main iterations (the first and third) were adult students from two upper secondary general education program classes at VUC Storstrøm, an adult learning centre in Denmark. These students participated in a full-time education program lasting two years; building games supported learning the curriculum. In the second (smaller) iteration, the participants included children in the 7th grade. In this class, students were studying *creative use of IT*, but the students still created the games for specific learning goals. The second iteration narrowed down to experimenting with a specific part of the overall learning design: the conceptualisation of what a *learning design* is and how to help students imagine *how to implement learning into a game beyond the quiz-level*.

<table>
<thead>
<tr>
<th>Project Iteration</th>
<th>Period</th>
<th>Participants</th>
<th>Form</th>
<th>Subject Matters</th>
<th>Pedagogical Approach: Constructionism &amp; PBL</th>
<th>Game Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st iteration</td>
<td>Spring 2014</td>
<td>17 adult students, 3 teachers</td>
<td>3 student workshops, 4 hours, 1-week interval</td>
<td>History, religion, and social studies; fixed learning goals</td>
<td>Fixed overall learning goals. Part of the evaluation process. Students had already been introduced to the subject.</td>
<td>Game Salad</td>
</tr>
<tr>
<td>2nd iteration</td>
<td>Fall 2014</td>
<td>14 children in 7th grade, 1 teacher</td>
<td>1 student workshop, 2 hours</td>
<td>Own choice of subject matter and learning goals</td>
<td>Problem-based approach. Students chose subjects and found content themselves.</td>
<td>Scratch</td>
</tr>
<tr>
<td>3rd iteration</td>
<td>Spring 2015</td>
<td>19 adult students, 2 teachers</td>
<td>3 student workshops, 5 hours, 1-week interval</td>
<td>History, English as a second language, and source criticism; fixed learning goals</td>
<td>Fixed overall learning goals. Problem-based approach. Students had to find information about the subject during game development, learning in that process.</td>
<td>Scratch &amp; RGB maker</td>
</tr>
</tbody>
</table>

*Table 1. The three iterations in the project.*

Workshops

All of the students and teachers were new to game design. Each team developed their learning-game concepts by following the instructions in an overall learning design. The students brainstormed to create game narratives that could encompass their chosen learning goals, and they documented their explicit learning goals for the game. The aim for the overall learning design was to let the students integrate aspects of relevant academic subjects into small analogue games that they then transformed into digital games, enabling them to become deeply involved in the learning process and content of the various subject matters to be learned. In examining the academic knowledge, they would become reflective about the academic knowledge; as a result, they would become academically proficient themselves.
The students were divided into teams in all iterations. The purpose was for students to direct their own learning trajectory and create learning games that could be played by their fellow students. This would enable the students to become the designers of their own learning through collaboration, discussing ideas and possible solutions. The students created the learning and game designs in iterative processes. Therefore, the learning goals and the learning process were addressed and questioned in many ways. The learning goals were further addressed in the playtests that student teams carried out with other teams. Details about the iterations are listed in Table 1.

**Empirical and Theoretical Findings**

The following is an analysis of how the students were supported and inspired to implement specific learning goals into the digital games. It was found that qualifying how to implement learning into the games was a means to create deeper learning processes for the students (Weitze, 2017).

**Imagining the Unknown – First Iteration**

In the first iteration (Spring 2014), the adult students had to describe several aspects of their learning design in writing before building the games. The intent behind making the learning design very explicit to students was to scaffold them through a learning process and also to support the teachers who were new to this kind of gamified learning design. The questions were inspired by Hiim & Hippe’s learning design model (1997), which encompasses learners’ prerequisites for learning, setting (learning situation), learning goals, content, learning processes, and evaluations. Even if students understood the learning design only on an implicit level, this could be detected when analysing their answers. The results of the first iteration revealed that students had difficulties in understanding learning design concepts and therefore also had difficulties in describing the learning design for the game (learning goals, learning activities, learning process, evaluation, etc.). This resulted in the students’ becoming superficial in their learning design approach.

The research results from the first iteration showed that the inexperienced students and teachers had difficulties in imagining a mental model for how to build a learning game that enabled learning above the remembrance level of cognitive complexity. Almost all games became quiz-games. An analysis of the questions posed in the games revealed that the composed questions were either 1) exactly consistent with what the students had learned in the previous lessons (and therefore could only be answered if the player knew the exact answer in advance) or 2) common knowledge—questions most people would be able to answer. The learning implemented in the students’ games showed signs of facilitating learning processes only on the cognitive complexity level of remembering. Other cognitive complexity levels were neglected, such as understanding, applying, analysing, evaluating, or creating—both for the learning designers themselves and for the players/learners of their games (Anderson & Krathwohl, 2001, pp. 67–68). When evaluating the project’s success the teachers asked for a learning game example in the actual game tool to help them imagine the possibilities for creating a learning game and implementing the learning goals. The analysis of the students’ games suggested that the learning games would enable a deeper learning process by creating learning situations or scenes for a community of practice inside their small games. This made it possible for the students to compose learning trajectories for the characters in the game, using relevant content while learning in this process. Therefore, as one of the first elements in
the overall learning game design, it is important to discuss context and narrative in the game, as they are the foundation for these learning situations.

Creating Supportive Artefacts for Students Learning by Designing Games

According to the findings in the first iteration, there was a need for an initial discussion with the students on learning design in general in order to qualify their knowledge and considerations about learning goals, learning processes, learning activities, and evaluation processes. There was also a need for an illustrative learning game example in the game tool. Therefore, two artefacts were constructed as support: a simple learning game example, created in the relevant game design tool Scratch (2016); and a related mind-map which explained how the learning design was illustrated in the learning game example (an example of the game prototype can be found at http://scratch.mit.edu/projects/31359632/).

To help the students understand the concept of learning design, the second and third iteration began by introducing the small prototype learning game. After students were shown this small game, they were introduced to a mind-map (Fig. 1), which showed how the learning design concepts and the game were connected. The mind-map had two parallel tracks. One (yellow) told what part of the learning design was introduced in the game, and another (red) told what happened in the game at this point and also introduced questions to discuss.

Figure 1. Mind-map illustrating and discussing the learning game example.

The purpose of the mind-map was to make the concepts of learning design clear and to discuss the learning goals, the learning activities, and the evaluation in the game. The learning process described in the mind-map was discussed with the students and compared with the game example. By discussing how the learning and the game were connected, the aim was to help the students start reflecting on how to design their own games to facilitate specific learning goals. As this particular example was a quite poor learning game, students were invited to contribute ideas for a way to make the game a better and deeper learning experience. As a result of using these artefacts (the digital game example and mind-map), teachers and students were discussing learning design concepts and how to implement learning goals in a learning game from the very start.

In the second iteration, students were directed to create games that would facilitate subject matter learning for future players/learners of their small games—that is, no quiz-games. Students also had to make sure to evaluate the facilitated learning by deciding if the player/learner would be evaluated on the game’s subject matter after playing the game or while still inside the game. Finally, students were told that it would support learning processes in the game if they considered making the small game into a
learning situation or a small community of practice; students were then allowed to reflect on how and why this should take place in their game. This process was equivalent to findings on how learning can be implemented in efficient learning games (Ramirez & Squire, 2015).

Choice, Development, and Implementation of Learning Goals

In the learning game example and mind-map, the learning goals were introduced and discussed: the character discussed what learning goal to choose (Figs. 2 and 3). This was intended to inspire the students to discuss the topic of what to teach and also to help them develop a mental model of what a learning goal is.

The 7th grade students in the second iteration could choose their own learning goals. Since this iteration investigated how to support a conceptual understanding of the learning design combined with the game design process, the goal was not to aim at a specific learning goal, and the teacher did not decide the area for the learning goals; students were free to choose their own. Their chosen goals ranged from “learning the concept of how to drive a car”, “Learning the concept of prime numbers”, and “how to start building a game in Scratch”. Due to a lack of time, students did not finish their games. But analysing the partially-completed games and the learning processes taking place around them revealed that students had found information for their learning goals and had discussed those goals, and further, that students had already learned in this process. They had also designed a learning situation and narrative in their games, which, to a much larger extent than the first iteration, suggests that a deeper learning process took place both in and around the small games. The variety in choice of learning goals for the games illustrated how students themselves imagined how the creation of learning games could be used as a means of learning various subject matters.

![Figure 2: Character considering which learning goal to choose.](image-url)
Creating Learning Activities in the Games

The adult students in the first and third iterations were assigned learning goals; however, they created their own variations of the learning goals and content for each game. As a result of the introduction and discussion of a learning game example, the adult students in the third iteration had a much easier time implementing their learning goals into learning situations in their games.

In the game example, the character and the mind-map (Fig. 1) illustrated how to teach the chosen subject, suggesting different approaches. This part of the example was also discussed with students and teachers in both the second and third iterations. The purpose of these artefacts (game example and mind-map) was to help the students create a mental model of what a learning situation could look like in a game and to inspire them to start imagining how to create a learning situation in their game. In the assignments for the second and third iterations, the student game designers were asked to describe 1) What does the player/learner learn by playing? 2) What can the characters do in the game? and 3) What does the character learn when doing things in the game?

Examples of Learning Activities and Learning Trajectories in the Digital Games

Inviting the player to be an apprentice

The students created teaching and learning trajectories for the non-human actors inside the small digital games, thereby creating them for the players outside the digital games as well. For example, in a math game, the 7th grade students created teaching conversations between two non-human actors in the roles of student and teacher. In another game that sought to teach players how to use the software program Scratch, questions and conversation were exchanged between the character and the player of the game. By creating these scenes, the students invited the non-human student as well as the player/learner to be a learner or apprentice.
Learning-by-doing

The students teaching math had planned a teaching section in the game that was to be followed by an interactive section in which the player/learner should be able to solve the kind of equations the students had just been taught. This would enable a learning-by-training or learning-by-doing in the game, with feedback for the player/learner. A learning-to-drive game also planned for an instructional section and a learning-by-doing section in which the player/learner had to “push the right pedals” in the game as a way of assessing his or her new knowledge. The type of knowledge facilitated through the games was both declarative knowledge (knowing what) and procedural knowledge (knowing how), and the acquisition of this knowledge made it possible for the players/learners to do things that they learned in the games.

The adult students developed four learning games in the third iteration of this gamified learning design. The students were specifically advised to create small learning situations in the games and to build the learning activities into the game mechanics, that is, what one can do in the game.

Learning by “clicking”

One of the adult groups created learning activities by “placing information” at various objects in the game. The learning goals, and therefore the activities in the learning games, involved the themes of human rights and the American Civil War. One of the groups constructed a learning situation involving pictures of objects the students found in the Library of Congress Digital Collections (https://www.loc.gov/library/libarch-digital.html). When players/learners touched (clicked) these objects, they were introduced to information about human rights and the Civil War. The information was, however, not directly connected to these objects, and in the team-peer-review this missing connection was criticised and suggested improved. In order to proceed to the next level in the game, the player/learner had to be able to remember this information and write it down in the game.

Learning by experience

Students designed a learning game in which the player/learner was a character that embodied a person from history. By experiencing and perhaps identifying with this person’s situation and experiences, the player/learner learned about the historical period and historical events. The character met other characters in the game and was continuously introduced to various choices when meeting other characters in specific contexts. These choices could, for instance, be different questions their character was given to ask other characters; or it could be something their character could choose to do in the game.

Learning from direct information

The answers to some questions provided information about the historical period and historical events relevant to this context in the learning situation in the game; whereas others simply added to the narrative with the purpose of engaging the player in the game.
Learning from authentic hints

Some answers explained how the historical person being played by the player/learner could overcome a challenge in the game world that related to challenges the character would have faced in the real world in that historical period. For example, a learner/player might be travelling on the Underground Railroad, which helped enslaved people flee from the South to the North. The game character would have to determine whether a house was a safe house, with people who would help them in this process. To create a playful atmosphere, the solution was not supplied directly, but only in hints, so the player/learner had to explore to overcome the challenge.

Learning through stealth assessment

Examples like the one just mentioned at the same time functioned as stealth assessment in the game, that is, the kind of assessment in learning games that happens as part of the story through real (game) world consequences (Shute, 2011). The player/learner had to find and learn this information in the game in order to meet the game challenge and move to the next level. The player/learner could choose which path to take in the game; however, specific pieces of knowledge (part of the learning goals) were needed to move on in the game.

Learning by consequence

This way of learning might involve a historical character asking an anachronistic (historically inappropriate) question, given the historical period and the characters’ positions in the situation in the game. As a consequence, the character would then “die”, and the learner/player would have to start over again. These consequences that were built into the game enabled the player/learner to learn about habits, human rights traditions, and culture from that period by playing the game.

Learning from just-in-time additional knowledge

One of the games was designed so that when the player/learner had completed a scene or learning situation, additional knowledge and information about that particular subject or period was presented as additional text moving over the interface like scrolling credits of a movie, providing more detailed information about the subject just introduced in the situation.

In some of the games, the students spent a long time creating engaging dialogues for the game characters; this contributed to the students’ experience of being involved in the learning situation.

Conclusion

The article investigated the most effective ways to support students who are creating learning designs for curriculum-based learning goals in analogue and digital games as a means of learning. The article also identified the various learning trajectories that emerged in the students’ digital games. The finding from this DBR study’s three iterations was that presentation and discussion of a learning game example in a
relevant game design tool, combined with discussion of learning design concepts, supports students in deepening the learning processes in their learning games. Introducing and discussing the learning game example together with learning design concepts contributed to the students’ creation of more complex learning games—above the level of quiz-games and the cognitive complexity level of remembrance.

When students followed the newly developed strategy, they succeeded in creating and implementing specific learning goals in their games. These strategies included presentation and discussion of two artefacts (a digital game example and a mind-map) in order to educate students about learning design concepts and teach them how to implement learning goals into a learning game. Students were directed that the games they designed should facilitate learning about the subject matter and that the facilitated learning should be evaluated. Finally, students were encouraged to create a learning situation in their game. The following learning trajectories or learning opportunities were designed into the games: inviting the player/learner to be an apprentice, learning by experience, learning from direct information, learning from just-in-time additional knowledge, learning from authentic hints, learning by consequence, learning through stealth assessment, learning and assessing by doing in the game.

Combined with knowledge from earlier research results (Weitze, 2017), the fact that the students succeeded in creating nuanced learning and evaluation processes inside the games contributed to cognitive complex learning processes for the student learning-game designers. Future experiments will involve the development of new learning-game examples involving these learning trajectories as inspiration for new student learning-game designers.

References


Designing Scientific Argumentation into the Mission HydroSci Game Based Learning Curriculum

Joe Griffin (University of Missouri), So Mi Kim (University of Missouri), Justin Sigoloff (University of Missouri), Troy Sadler (University of Missouri), Jim Laffey (University of Missouri), & Ryan Babiuch (University of Missouri)

Abstract

This paper provides an introduction to the argumentation system being developed as part of the Mission HydroSci (MHS) learning game. We will report results from the early stages of development over three iterative phases of design work. The results of these phases suggest progress toward richer argumentation scenarios, which support scientific learning and the Next Generation Science Standards (NGSS). We will describe how the system supports richer argumentation interactions in three specific ways: 1) dynamic evidence collected by the player in problem-based simulation experiences, 2) complex argument generation, and 3) an intelligent assessment system, which allows for specific player feedback. We will discuss our design progression and how these game mechanics evolved as well as provide implications for supporting argumentation development in learning games.

Introduction

Mission HydroSci (MHS) (Laffey et al., 2016) is a game-based, 3D virtual learning environment and incorporated curriculum that supports middle school-level science learning. MHS is being developed in the Unity game development engine for use in distance and blended learning environments. Research and development efforts are supported with grants from the US Department of Education. The MHS curriculum is anticipated to take 12 to 15 hours of game play and one of the two core curricular objectives is to deeply engage students in scientific argumentation, scaffolding their ability to argue scientifically and integrating the practices of argumentation (Osborne et al., 2013) with core earth science ideas related to water systems.

Though argumentation has been integrated into the core of science curriculum, literacy, and practice, few games have been specifically developed to impact students’ ability to perform argumentation. Next Generation Science Standards (NGSS) stress that students engage in scientific practice to learn and apply the science knowledge they are gaining (Ford, 2015; Grooms, Enderle, & Sampson, 2015); Common Core State Standards also fall in line with NGSS, emphasizing argumentation as core literacy (Kuhn & Moore, 2015). A few recent innovative efforts have been made to support argumentation learning in
games. Bertling and her colleagues (2015) demonstrated that their Mars Gen One: Argubot Academy improved student engagement and structural argumentation skills during gameplay. Other game such as Argument Wars and Citizen Science (Mechtley, 2015; Schrier, 2015) also showed potential to improve students’ deliberation and civic engagement. These games typically conceptualize argumentation as part of dialogue between the player and non-player characters (NPCs) to solve problems or issues in the game environments; and provide structured scaffolding and feedback to support argumentation skills development. Despite their success in promoting certain aspects of argumentation, students are given pre-selected evidence sets and structures, which reduces complexity, and therefore loses the authentic scientific thinking and practice necessary to foster argumentation strategies. While playing such games, students often employ naïve strategies such as process of elimination, which is not possible outside of the game–based environments that feature them. There are strong needs to devise game mechanics to truly capture the authenticity, dynamics, and engagement involved when people practice scientific argumentation in realistic settings.

Against this background, we set our design goal to foster knowledge and skills that transfer outside of the game into realistic argumentation scenarios. In the following sections, we will share our design and research process in which we iterated three phases of design and development in order to facilitate richer argumentation interactions and foster deeper argumentation strategies. We examine how the three game mechanics listed above have been realized and evolved in order to mitigate the use of the process of elimination and provide appropriate feedback to students.

**MHS Argumentation System Overview**

Our decision to combine scientific argumentation with a game that teaches water science was motivated by the NGSS focus on using argumentation as a scientific practice (Ford, 2015; Grooms et al., 2015). Integrating argumentation into a game–based environment brings with it certain affordances as well as design constraints. The affordances include the ability to use fantasy to create any desired problem–based scenario, such as preventing the New Orleans’s levees from failing or exploring the Nile. These scenarios are not just labels for different feature sets, but rather become visually rich, data–filled, interactive environments. These environments provide both contextual support and motivation to explore, collect data, and engage with the narrative and characters.

Constraints that accompany game–based environments involve maintaining the gameplay loop of player exploration, action and feedback. The feedback portion of this loop requires game–based assessment for a seamless gameplay experience. For our design and development teams, this meant we could not include any text entry, which required human interpretation of player answers. These constraints prevent written response and student debate, which are two of the more common forms of argumentation practice students engage in during traditional classroom lessons.

**Design of the Argumentation System**

This section describes phases in the design, development, and testing of the MHS Argumentation System from September 2014 to April 2016 and includes a brief summary about the iterative design process, prototype development and evaluation of the system at each phase. In each phase, we reviewed prior
design work, developed a prototype, and conducted usability testing with representative users employing methods such as think-aloud techniques and interviews (Someren, Barnard, & Sandberg, 1994).

Phase-1: Dialogue Based System

The first phase of development focused on grounding the argumentation in context. Accordingly, players were allowed to create their own water systems (e.g., watershed) and place sensors in a 3D terrain simulation environment in order to collect measures of different environmental features, such as the total amount of rainfall and the area of a continent (see Figure 1). Players then used dynamically generated evidence to advance an argument with a claim and supporting reasoning statements.

Video games traditionally use dialogue systems to deliver interactive narratives or conversations. In our initial design efforts to ground the argumentation scenarios in context, we conceptualized an argument as a special type of conversation with a non-player character (NPC). To foster such conversations, we created an antagonist NPC who challenged the player with argumentation-framing questions. After the player had dynamically collected evidence in their terrain simulator, the antagonist NPC would guide them through argumentation by first prompting them to make a claim, then asking them to choose the relevant evidence, and finally asking them to choose a reasoning statement (see Figure 1). This argumentation was delivered through the dialogue system so that each choice was required to be made sequentially and had to be correct before the player was allowed to move on to the next.

The usability testing results indicated that this dialogue-based argumentation system combined with a dynamic evidence collection mechanism was successful in terms of creating initial engagement and seamlessly integrating instructional scaffolding features. However, the dialogue-based delivery of the argument was not pedagogically visible; so players failed to extract an argumentation structure out of the interaction. In addition, we found that the limited response options, sequential progression, and corrective feedback (“you need to reconsider your answer”) allowed students to use the process of elimination to create passing arguments. For example, players could loop back to the list of response options while randomly clicking on any possible choice.
Figure 1. This is our initial proof of concept for the game. Panel 1 shows the 3D terrain simulator where players construct a custom continent in real time. Players are able to place various sensors in the environment in order to take different measures, which become evidence cards for use in argumentation. Panels 2, 3, and 4 show the argumentation taking place in our dialogue system. Panel 2 shows the student selecting a claim, Panel 3 shows a player selecting evidence, and Panel 4 shows a player choosing their reasoning.

Phase-2: Tree Based System

During our second phase of design and development, we focused our efforts on visualizing argumentation structure while preventing players from using the process of elimination as a strategy. In our second prototype, we created a decision structure similar to the popular board games Clue and Mastermind. Rather than presenting each component of an argument (e.g., claim, evidence, and reasoning) to the player as sequential, individual decision points; we allowed the player to construct a visual representation of the entire argument, and then submit it as a whole. This solution space is exponentially more complex for the player to randomly explore and forces the player to carefully consider which components to use in combination rather than to use the process of elimination to determine each individual argumentation component.

This restructured argumentation system was presented outside of the dialogue system in a custom user interface designed specifically for argumentation (see Figure 2), which consisted of a three height–level trees, a claim at the root node, evidence at the leaf nodes, and reasoning statements on the middle
level. Players were able to choose an argumentation tree structure, which would determine the number and placement of branches on the tree. The players had all of their claims, reasoning statements, and evidence visually represented as drag-and-drop objects, which could be placed on the various nodes of the tree. In this system, we defined successful patterns a–priori based on each possible tree and component configuration. We used a simple pattern–matching assessment strategy to determine which feedback to provide to the player. The feedback is intended to point out general flaws in the player’s argument such as, “You have redundant evidence” or “Your evidence is irrelevant to the claim you chose.” In this first scenario, the player could choose to use fewer branches in their argumentation tree or choose different evidence. In the second scenario, the player could choose a different claim or choose different evidence.

The usability testing results indicated that this tree-based argumentation system was successful in terms of making explicit argumentation structures. However, players perceived the visual representation to be similar to “school work,” which lowered their emotional engagement. Players also reported difficulties in selecting and fixing a tree structure before fully exploring options for claims, evidence, and reasoning statements. A third issue students had was understanding which elements would remain if they changed the tree structure after going partway through argument construction.

The third phase of design addressed problems that we detected during the second design iteration. In our new attempt, we initially focused on the aesthetics of the system. The goal was to make sure that the look and feel of the system didn’t immediately remind students that they were in school. In
efforts to make the system feel more fun, the first change was to remove the very academic-looking trees. Instead, we created a user interface similar to a solar system with the claim represented as the sun, reasoning statements as planets, and evidence statements as moons. This new structure reimagines the visual representations of connections between claim, evidence and reasoning while still adhering to its underlying model. The new interface solves the difficulties that were inherent in the second-phase prototype. In this new interface, players do not need to select an argumentation structure, but instead they were given the largest possible tree structure without pre-set drop-zones; allowing students to fill out their solar system as much or as little as they wanted. The system therefore allowed us to facilitate pseudo openness, by implementing the largest tree and not representing individual drop zones, which alleviated the players’ need to “fill the empty spots”. This new system required a more complex assessment strategy than the second prototype. Instead of pattern matching, we used a simplistic implementation of regular expressions to create logic rules for how different components can combine. We then created a priority list of all the possible player feedback; so that if a player’s argument matches two of our logic rules; we can display the most desired feedback. The usability testing for the new system is planned for May 2016.

Figure 3: This figure shows our latest version of the Argumentation system. The player is no longer able to choose a tree, and there is much less clear “drop zones” for the player to fill up. The red lines connecting the various components only show up after the player has submitted their argument. The claim is the central element in the system, and reasoning statements are the red circles in the middle. Finally evidence pieces are placed on the outer ring to support different lines of reasoning.

Implications for MHS supporting Argumentation

Due to the dynamic evidence and more complicated assessment necessary, the claimer system is more difficult to design content for, but creates more authentic, dynamic, and engaging argumentation experiences for the player. Throughout usability testing, we have learned that the problem based nature of gameplay benefit players in terms of authentic scientific inquiry, and the rich, 3D data filled
environments allow us to capture great detail surrounding this engaging interaction. We have learned that argumentation support also needs a cognitively challenging yet aesthetically creative representation in order to foster argumentative thinking beyond mechanical composition. We especially emphasize an embedded assessment system that prevents corrective responses, process of elimination, and other naïve argumentation strategies. We believe the claimer system has promise for transferring useful scientific argumentation skills into real world settings because this system requires the most critical thought from the student. The rich narrative gameplay experience provides a stimulating context for the player to ground their understanding in. The complex solution space where students choose all the components of an argument before submission addresses the process of elimination problem. Finally, the regular expressions can create very dynamic experiences with static components by providing custom feedback to any argument the player creates.

Future challenges remain, such as scaffolding evidence collection over an entire gameplay experience. One potential solution we are considering is giving students access to specific evidence–collecting sensors in the earlier units of the game, and then requiring players to re-use and synthesize evidence sources in more complex ways during later units. Another challenge is fostering counter argumentation, which involves more complex interaction and feedback. While there is still much to do and learn before we have a final design and development of MHS our process includes iteration, user testing and teamwork to find creative solutions. Developing innovative mechanisms that can playfully enact important scientific practices is key to developing learning games and advancing the potential of games in education.

Acknowledgments

The work described in this report is by the US Department of Education Institute of Education Sciences (Award Number R305A150364) and Investing in Innovation (i3) program (Award Number U411C140081). The ideas expressed are those of our project team and do not necessarily reflect the views of the funders.

References


New Design Principles for Mobile History Games

Owen Gottlieb (Rochester Institute of Technology)

Abstract

This study draws on design-based research on an ARIS–based mobile augmented reality game for teaching early 20th century history. New design principles derived from the study include the use of supra-reveals, and bias mirroring. Supra-reveals are a kind of foreshadowing event in order to ground historical happenings in the wider enduring historical understanding. Bias mirroring refers to a non-player character echoing back a player’s biased behavior, in order to open the player to listening to alternative perspectives. Supra-reveals engendered discussion of historical themes early in the game experience. The results showed that use of a cluster of NPC bias mirroring techniques enhanced student ability to articulate points of view previously unavailable to them.

Background

_Jewish Time Jump: New York_ (Gottlieb & Ash, 2013) is a mobile, placed-based, augmented reality game (ARG) designed to teach history to 5th-7th grade school students, set on location in Washington Square Park, New York City (Gottlieb, 2015)[i]. The game’s subject matter is at the intersection of modern Jewish history, immigrant history, labor history, and women’s history. Designed on the ARIS platform for iPhones and iPads, the game presents historic media triggered by GPS location.

The game includes digital historical characters, digitized versions of primary sources such as newspapers (with translations from Yiddish), photographs, and ephemera. Players take on the role of time travelling reporters working for the fictional _Jewish Time Jump Gazette_. An editor character presents players with the task of retrieving a story “lost to time.” Guided by a narrator character in the guise of their time travel device, players “land” in 1909, on the eve of the Uprising of 20,000, a garment workers’ strike, and the largest women led strike in U.S. History. Players conduct digital guided interviews with workers, labor organizers, factory owners and manufacturers, and other historic and amalgamated historic figures. They analyze primary sources, and track down clues, to present and discuss their story after the game. Players can trigger different garb to blend in with those they meet, and game mechanics facilitate features of the game including mistaken identities. For example, _shtarkers_, or tough guys hired by manufactures to attack strikers may mistake a player for a striker, and players must evade attacks. Or players may be mistaken for manufacturers and invited to a closed-door meeting at which the owners organize against the strikers.
Enduring Historical Themes & Engendering a Best Case, Fair Hearing

This article presents results from a series of design cycles which were centered on two core goals of the game. First, a key goal was to seek learner understanding of the enduring nature of key historical themes and their contemporary relevance (Barton and Levstik, 2004/2012, Preface, para 1.) What is the meaning of the historical story today? How do the debates and questions remain immediate and relevant?

A second important goal, which aligns with civic and democratic education was to nurture a “best case, fair hearing” of multiple and competing perspectives (Kelly, 1986; Stoddard, Nemacheck, & Banks, 2013).

The particular historical narratives of the Uprising of 20,000 and the Triangle Shirtwaist Factory Fire (1911, also featured in the game) were defining moments in American history and labor history. The owners of the Triangle Factory had been one of the few holdouts against reform for safety and other worker concerns in the wake of the 1909 Uprising strikes. In 1911 the Triangle went up in flames and 146 workers, mostly young Italian and Jewish women, died in the fire. The aftermath revealed locked doors, shoddy fire escapes, and in more recent historic accounts, even suggestions that the owners had made the factory more fire-like as part of planned insurance Fraud Von Drehle (2004). The outrage and protest eventually led to some of the nation’s foundational labor laws. The relationship of labor and business is one of the themes that run through history. Contemporary labor organizing, labor disputes, and unfortunately, disasters and abuses are not limited to the early 20th century. The design of the game and simulation would work to tie the relevance of the past to the present. How could the historical narratives of the game be effectively linked to the broader themes of labor disputes, including those that occur today?

In approaching methods and tactics for engendering a best case, fair hearing, I believed this set of narratives provided an opportunity for exploring an edge case in history. The negligence and culpability of the owners of the Triangle Shirtwaist Factory is obvious and a rare moment of moral clarity in history. That said, historian Hasia Diner (2011) points out that merely casting the owners as villains covers over the complexity of the relationships between the owners and workers. The owners themselves were Jewish immigrants, who not long before were working in sweatshops. They were community heroes for having succeeded in ascending from being fresh off the boat to successful entrepreneurs. As evidence of the connections between the owners and the community, Diner points out that, one of the male workers who perished in the fire was engaged to be married to Isaac Harris’ (one of the factory owners) niece (Diner, 2011).

For a more layered approach to history, one in which understanding surpasses blame, how might one better understand the perspectives of the owners’ stances and decisions prior to the fire? Due to the clarity of the culpability of the factory owners, this narrative could provide an ideal test case for techniques to encourage the understanding (not the condoning of) a very different set of perspectives.

The goal of the design iterations discussed in this paper was to move from the early piloting stage of the game in which players were not necessarily connecting the narratives to wider enduring historical themes. They were also unable to articulate the perspectives of the owners, despite having encountered and conversed with the digital characters, to demonstration of understanding and articulation of the owners’ perspectives.
Antecedents

This study draws on previous research, design, and practice in mobile games for learning, and situated documentary including Klopfer (2011), Klopfer and Squire (2008), Mathews and Squire (2010), Schrier (2005), Gottlieb, Mathews, Schrier, and Sly (2014). James Mathews’ situated documentary, Dow Day (Mathews, 2005), was particularly instrumental in envisioning the project.

Methods

This study uses methods under the umbrella of Design-Based Research (DBR). DBR is suited for any “rich contextualized setting in which people have agency” (Hoadley, 2013). Design-based research is an iterative, proto-theory-testing approach to developing learning theory and design knowledge. Designer-researchers prototype a learning environment or intervention over the course of a number of iterative cycles comprising design, field trial, data gathering, analysis, and return to theory and re-design. Learning theory is used as a starting point for design, and that theory is held suspect during investigation (see Barab and Squire, 2004; DBRC, 2003; Hoadley, 2004a; Hoadley, 2004b).

The particular methods used in this study included participant observation with video and audio observation, pre and post surveys, semi-structured interviews, and server log data. The log data included player movements and actions. Triangulation of data was conducted by matching player logs to survey, interview, and observational video. Given that the context in between iterations shifts in the case of this study, there is not a control group; however, consistent findings across multiple contexts can bolster suppositions regarding outcomes.

Game Days

Jewish Time Jump: New York game days took place over the course of eight months with five supplementary Hebrew schools. Prior to play on location, learners took a pre-survey, then were given a tutorial in the game system in a nearby staging area. Play was recorded using observational audio and video. Also player movements were tracked and recorded on the back-end of the system through server logs. Following game play (approximately an hour), students returned to the staging area, took a post-survey and participated in discussion and semi-structured interview. Additional follow up interviews were conducted following individual game days.

Sample

Forty-three learners in fifth, six, and seventh grade participated in gameplay over the course of six game events and three design iterations (some game days occurred within a few days of each other to allow for more players in each play session, or, in one case, close single-player observation). Group sizes ranged from 18 players to one player (design-based research can be conducted even with individual learners). The single player was followed in a closely monitored late-stage iteration game. The average group size was seven players. In all, 24 girls and 21 boys participated.
Game Day to Iterations Correspondence

There were six game days (not including teacher and administrator meetings and participant observation “hanging out”) referenced in this study. Because there were only a few days between the second and third game days and between the fifth and sixth game day, there were no iterations done between games two and three or between games five and six. Three iterations were completed after iteration 1, iteration 3, and iteration 5 (see Table 1). Changes were not made for each individual case in all iterations.

<table>
<thead>
<tr>
<th>Game Day (pilot, 5 Learners)</th>
<th>Initial Designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game Day 1 (4 learners)</td>
<td>Iteration 1</td>
</tr>
<tr>
<td>Game Day 3 (4 learners)</td>
<td>Iteration 2</td>
</tr>
<tr>
<td>Game Day 4 (18 learners)</td>
<td>Iteration 3</td>
</tr>
<tr>
<td>Game Day 5 (11 learners)</td>
<td></td>
</tr>
<tr>
<td>Game Day 6 (close observation of 1 player with parent)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1: Timing Amid Iterations of Game Days.*

Results: Two Cases

Case A: Seeking Enduring Historical Theme Connections

In initial designs, I drew upon both history education theory (Barton and Levstik, 2004/2012, referred to above) and media and game studies theories, concepts, and techniques (Benayoun and Assayas 1996/2008; Block, 1973; Spector & Smith, 2000; as discussed by Gee, 2007; Vertov, 1929/2002). This led to the use of a self-reflexive design in order to draw connections between the historic narratives in the game and the enduring themes, running through to the present. In particular, towards the conclusion of the game, the connection to modern labor struggles would be revealed through the relevance of the device upon which the game itself is played: the iOS device, meaning the iPhone or iPad. Upon returning to present day, along with two other encounters, learners received a contemporary news story about the labor disputes with Apple’s manufacturer in China, Foxconn, and steps that Apple was making to improve working conditions.

In the pilot, given the sprawling nature of the narrative and the ability for learners to immerse in various historical artifacts, only a few students completed the game, and therefore did not receive the news story. In the first iteration, the game structure was tightened, but in addition, I added an *Afikoman*, referring to a hidden bonus or special event, based on the idea of the “Easter Egg” in video games. The Afikoman refers to a game played during the Passover seder in which a piece of matzah is hidden, and the seder may not be complete until it is found or returned by the children. The Afikoman held both contemporary videos and the news article. In this way, all players who did not reach the conclusion of the game, would be granted the Afikoman by the educators at the end of play so that they could experience them as well.
In field testing of this next iteration, I found that some students picked up, viewed, but did not read the article, but jumped ahead to complete the game. Even when presented with a second chance to read and review the article along with students who received the Afikoman, one girl’s short answer in the post-game survey reveals a lack of connection to the enduring historical themes:

[crossed out]: I was kind of rushing to finish, but I think it had to do with the difference between Jewish rights today and 100 years ago [end cross out]. Jewish rights today are very different from 100 years ago. Human rights in general were different! Some people were so high up the hill, they thought they had more rights than other people! Bosses treated workers like scum and would do anything to earn money, even risk lives of workers!

It is possible the learner is not connecting the global present day labor issues with those of the past. Regarding the humane treatment of workers, she writes, “human rights in general were different [than they were 100 years ago].” It is also possible that the article regarding Apple working to improve its conditions provided a contrast to owners’ disregard for worker safety in the years prior to the post-Triangle fire labor laws. Given this learner’s dual opportunity for exposure to the article, both during gameplay and again during the Afikoman following main play, the persistent lack of connection to the enduring theme signals the need for a better design solution to reach the educational goal.

In the next iteration, I took a different approach, based on Levstik and Barton’s (2005/2010) alternative strategies of “start locally, connect globally,” and “start globally, connect locally” (Chapter 6, Sections 2 and 3). In this case, I tried what I call a supra-reveal. Rather than the giving away the reveal at the end of the game which was a local to a global strategy, I added a global starting point to frame the entire game. At the beginning of the game, the learners receive an article in the form of a clue prior to meeting their editor. It arrives in the form of a 2013 article about a recent garment factory collapse in Bangladesh and the resulting 1100 deaths (Yardley, 2013). Learners are guided to read just the first two paragraphs of the article and then move onto find their editor.

In field testing this version of the game, the discussions of the factory collapse began immediately as players asked how this related to the game and their mission (they had watched an initial introductory video clip telling them to go to the park to meet their editor, but had not yet departed from the staging area to the park). Questions included “what does this article have to do with Jewish history? and “what is the date on the article?” There was no evidence in either post-game interviews or open-ended answers on post-game surveys of lack of awareness of the contemporary global issues of worker safety. Neither was there evidence of such a confusion or misunderstanding in the video footage in the Afikoman about Foxconn.

On the basis of the out-loud pre-game readings and questions and the lack of disconfirming cases of awareness of contemporary labor struggles, it appears that the use of a supra-reveal prior to or at the early stages of play in a mobile ARG can offset issues of lack of attention to contemporary cases as well as provide a conscious frame for the game to come. In addition, the supra-reveal allowed for maintaining the surprise reveal either upon reaching the conclusion of the game, or in receiving the Afikoman.

Case B: Seeking a Best Case, Fair Hearing

In the initial pilot of the game and in two subsequent iterations, players were not able to articulate or understand the motivations of the factory owners. A number of learners were confused as to whether the
owners were workers or owners/bosses (they were both). In the first two iterations, changes included moving the initial encounter with Max Blanck, one of the owners of the Triangle Shirtwaist Factory, earlier in play to try to counteract possible bias in the narrative itself, moving Max Blanck, into a path that was unavoidable in play (as opposed to one of the different branches of the game), locking the players in the conversation with Max Blanck. Some of the dialogue was altered to be more direct, such as “I was a worker” instead of “when I was a worker like you” (to those players who had activated worker garb).

By the end of the second iteration, despite Blanck articulating to all players both his background as an owner who had worked his way up through the most dangerous of sweatshops, and his concerns about business — players remained confused and did not articulate the perspective of either Blanck or Harris (who appears in the game later when Blanck reappears). There was still confusion. The idea that the owners/bosses were once workers was not clear to at least three of the 18 players. Only one player of the group of 18 demonstrated articulation of an understanding of the owners’ profit concerns.

For the third iteration, I returned to theory to determine other possible paths to greater student articulation of the perspective of the owners. Theriault (2013) shows how framing a game (the way in which the game is described prior to play) can accentuate bias and affect player outcomes. Following a similar line of thought, could the learners’ prior knowledge from other museum visits and family discussions (which I learned of through the demographic section of the surveys) have a similar impact? If the tentative assumption is that there may be framing and/or primacy effects interfering with a best case, fair hearing, what design elements might better provide for a best case, fair hearing? I turned to suture theory (Mulvey, 1976 Silverman, 1983) and audience surrogates (David Milch, personal communication, 1998). Suture theory addresses how an audience identifies with characters in the text; audience surrogates are characters placed within the narrative to voice the perspective of the player/audience member. I theorized that perhaps having the non-player character (NPC), Blanck, demonstrate prejudice towards the player might rouse the player from a position of dismissal to one of engagement or consideration.

In the new iteration, a minor dialogue line change was made to the Foreman character removing his claim that the bosses will tell the player who complains about having been shorted pay that “you are lucky to have a job.

In addition, I injected set of three inter-related elements: first, new dialogue so that Blanck would treat the player in a prejudicial way, assuming they were a worker who had already made up her/his mind against Blanck. Also, I injected a line of dialogue for the player-character (an on-rails moment) trying to explain that they were actually a reporter (but Blanck interrupts them and will not listen). “Wait! I need to hear your story. I’m not a worker, I’m a report — “ Previous on-rails moments for the player character (PC) had been paced such that were responses tracking the player’s choices, not enforcing a perspective. This is followed by the narrator explaining that the player will have to gain Blanck’s trust. This set of three moves – paced PC forces, having the NPC mirror the player bias or prejudice, and pointing out the lack of trust by the narrator, I refer to as a whole as “NPC bias mirroring.”

Following the third iteration, in post-play semi-structured discussions, no learners out of 12 expressed confusion regarding Blanck’s or Harris’s perspectives. One sixth grade girl and her brother expressed the perspective of the business owners: that they were once workers themselves and that they felt that the conditions were much better in the modern factories that they had built. The girl expressed the
differences the owners discussed between the sweatshops of the past and the modern factories. This was a marked difference from previous iterations, as no student had previously expressed the owners’ position of relative improvement for the workers without also dismissing that position.

A fifth grade boy (Scott, a pseudonym) in an individual interview offered the following when asked about general interest:

Anon Author: What part or parts of the game were most interesting to you?

Scott: Some of the most interesting parts of the game was like talking to all those people and hearing the different perspectives like the bosses were saying ‘we’re going to go out of business if we raise their wages and the other companies are going to swoop [makes a downward swooping/chopping gesture with hand] in and take everything from us’ and meanwhile the workers are saying “they’re treating us horribly” so it’s kind of [makes balancing gesture with hands, like a scale], trying to balance everything and it’s interesting, it’s kind of interesting to see how that struggle kind of happened, how the bosses’ perspective is actually understandable instead of saying “I just want to make more money,” like he just said “we’re not doing that well and if we raise the wages then it’s not going to work that well for us.”

Anon Author: So you found it interesting that there were different perspectives?

Scott: Yeah, and how there was like—I also didn’t know like about the bosses having a union—to fight the workers.

Anon Author: [making a distinction] Their [the bosses’] organization.

From the semi-structured group interview data, no students fully demonstrated a best case, fair hearing of an alternative perspective prior to iteration three, and there appears to be some success in iteration three. No learner indicated confusion in iteration three. As a result, the responses of the learners suggest that the use of paced NPC forces may deepen player suturing and that NPC bias mirroring techniques may very well open the learner to a fair hearing of competing perspectives. While the slight alteration in the Foreman dialogue is confounded because the change occurred at the same time because it was one of many examples of narrative elements promoting a bias against the owners, its removal is unlikely to be the cause of the shift.

Conclusions

This article delineates two new design principles drawn from the research on a mobile, place-based game. The first is supra–reveals, the use of foreshadowing to establish enduring historical themes early on in gameplay. The second, which aims for enhancing a “best case fair hearing” of alternate perspectives, is the use of non—player character (NPC) bias mirroring. This involves using paced PC (player character) on-rails moments; an NPC to echoing back, through behavior, the player character’s bias; and a role enhancing goal orientation provided to the player. Results demonstrated that NPC bias mirroring with paced PC forces yielded less confusion and better articulation of the NPC’s perspective despite player bias against against those positions.
References


Exploring Student Motivation in Response to Assignment Choice

Benjamin D. Plummer (University of Michigan), Caitlin Holman (University of Michigan), & Barry Fishman (University of Michigan)

Abstract

Giving students choices regarding their work is a core principle of gameful course design. Increasing autonomy should support intrinsic motivation, and enable students to increase their competence by creating a safe context in which to try new and challenging tasks. We analyzed the implementation of assignment choice in three large undergraduate gameful courses. Each course featured a different style and degree of support for student autonomy, and these variations related to differences observed in student attitudes. Students’ answers on open-response survey questions shed light on the underlying reasons for these differences. We discuss the implications of our findings and identify next steps to guide the design of gameful courses.

Introduction

As gamification, “the use of game design elements in non-game contexts” (Deterding et al, 2011, p. 10), becomes more widespread, researchers and educators need a better understanding of how different aspects of gamified learning environments affect both learning outcomes and students’ motivation. Educational settings are inherently messy contexts for research as experimental control is difficult to achieve. This makes it challenging to evaluate the impact specific game elements have on students. Our work operates within an ongoing, multi-year design-based research (The Design-Based Research Collective, 2003) study of gameful learning on a university campus (Aguilar, Holman, & Fishman, 2015). This approach allows us to investigate the effects of isolated game elements by observing their effects across multiple course contexts, design iterations, and student cohorts. In this study we explore how student attitudes shift in response to having varying degrees of control over their coursework.

The Success of Gameful Design: Implementation is Key

The effectiveness of gameful design depends not only on what is implemented but also on how it is done. Adding points tracking to repetitive tasks like image tagging increases performance but fails to promote intrinsic motivation (Mekler et al, 2015). Similar results have been found with superficial implementations of badges and leaderboards (Hanus & Fox, 2015, Dominguez et al., 2013). However, if badges are framed in a mastery-oriented way rather than as a performance incentive they have been shown to support students’ self-efficacy (Abramovich, Schunn, & Higashi, 2013).
Bedwell et al. (2012) conducted a literature review to identify game elements present in gamified learning environments and used card sorting to identify nine distinct attributes. Landers (2014) used these elements as the foundation for his “Theory of Gamified Learning” and proposes that there are two routes through which each attribute can affect “learning-related behaviors or attitudes” (p. 752), a moderating process, and a mediating process. When he tested this theory in an online university psychology course, leaderboards increased performance in the online course as mediated by students’ time on task (Landers & Landers, 2015).

Bedwell et al. (2012) identified control as one of nine core game attributes for learning. This parallels the work identifying autonomy as key to driving player engagement in video games (Przybylski, Rigby, & Ryan, 2010). When applied to an educational context, giving students control over their own work, including deciding which assignments to do, determining deadlines (Han, 2015; Harrold, 2015), deciding how work will be weighted (Boskic & Hu, 2015), and resubmitting work (Han, 2015; Harrold, 2015) have been shown to promote sustained engagement and feelings of self-efficacy. Yet, the implementation of control can take dramatically different forms. Our own theoretical understanding of the impact of different assignment choice designs on student motivation is grounded in Self-Determination Theory.

Self-Determination Theory

In Self-Determination Theory (SDT) the satisfaction of three basic needs: autonomy (choice and volition), competence (feelings of efficacy), and relatedness (sense of connection to others) are said to promote intrinsic motivation (Deci & Ryan, 2000; Deci et al, 1991; Black & Deci, 2000). Supporting these needs has been shown to promote persistence (Guay, Ratelle, & Chanel, 2008; Hardre & Reeve, 2003), and increased performance (Lavigne, Vallerand, & Miquelon, 2007; Van Nuland et al., 2012) in educational contexts. Gameful design for education takes inspiration from the structure and mechanics of good games and applies them to learning contexts in order to better support the basic needs of SDT. Examples of this include giving students: control over some aspect of their coursework (to establish autonomy), the ability to repeatedly attempt an assignment or customize its difficulty level (in support of competence), and the opportunity to collaborate with peers (to build relatedness). Gamefully designed courses should promote basic need satisfaction and greater intrinsic motivation for learners.

Gameful Course Design

Our work is based on observations of courses within a growing “gameful learning community” on the authors’ university campus. We chose to analyze three large introductory courses that each took different approaches to offering students control over their assignments in Fall 2015. The courses studied occupy three different domains: Kinesiology (KIN), Information Science (INFO), and a social science course in the Honors program (SOCIAL). Each course used GradeCraft (http://gradecraft.com), a custom learning management system (LMS) designed specifically to support gameful learning.

This study explored the following research questions:

RQ1: How do students’ perceptions of their autonomy relate to different amounts of assignment choice?
RQ2: How do students’ perceptions of their ability to recover from failure relate to different amounts of assignment choice?

We hypothesized that having more assignment choice would increase students’ perceived autonomy and their perceived ability to recover from failure.

Methods

Course Descriptions

In INFO all 82 assignments were framed as optional, but students had to complete a large three-part project in order to earn enough points to get an A. Up to a third of the final course grade could be earned from a category of assignments called “Pickup Quests” that encouraged students to engage with the intellectual community around the university, including attending academic talks, participating in experiments, and reading academic papers. There were 57 of these opportunities but a maximum of 10 were counted, giving students a large degree of control over how and when to do these. Students who earned low marks on a large assignment, or who chose to skip one altogether, could use these opportunities to build towards their goal grade. While the major assignments had identified deadlines, the smaller exploratory assignments were announced sporadically, as events on campus became known.

In KIN, there were fewer assignments (24 in total) and they were all truly optional, with many configurable paths to success. There were two exams, each worth a total of 3,000 points (potentially up to 15% of an A grade), but students could easily choose to avoid them and still have choices regarding what assignments they wanted to work on. Other assignments included writing case studies and literature reviews, quizzes, participating in in-class activities, and completing diet or fitness challenges. The instructor encouraged students to do as many assignments as they wanted and to “take some risks.” All assignments were announced at the beginning of the semester, and had deadlines pre-determined by the instructor. There were no other course rules limiting assignment choice or order of completion.

SOCIAL featured a mix of required and optional assignments, and had multiple additional rules regarding sequencing and pace. All students were required to complete two “Novice” assignments at the beginning of the course, after which they earned 20,000 points and “leveled up” to “Apprentice.” Students then chose between three categories of assignments, each representing a core learning objective: data collection, data analysis, and theoretical analysis. Students chose one of these three categories to count for double the amount of points towards their final grade. They were able to explore the assignments for the first half the semester, at which point they had to commit to this weighting decision. If students completed one assignment from each category, they leveled up again, received another 20,000 point bonus, and earned the right to complete a Guild Project. Students were allowed to do as many assignments as they wanted before Thanksgiving; after, they were only able to submit two assignments.

Table 1 provides an overview of the different course structures, including the magnitude of the grading scheme points scale, the number of assignments, and the difference between how many points were available and what amount was necessary to earn an A grade—courses with a larger difference between these two numbers have (generally) given students more control over their coursework.
Survey Item Development

We developed a set of survey items designed to capture key motivational responses from students in these courses around their perceived autonomy, effort necessary to succeed, and ability to recover from failure. We consulted with instructors to tailor the survey to their course designs as needed. Students responded to these items on a 5-point scale with 3 being a neutral response, 5 a strong affirmative response, and 1 a strong negative response. The scale anchor language was customized to each item.

Students were also asked to identify up to four things that they liked and four things that they disliked about the class, and to provide any general comments regarding the course and its grading system. The open response data were thematically coded and assigned a valence code to indicate whether it was positive or negative. 13 different topics were identified, producing 26 different codes (positive and negative for each topic). Additionally, we assigned separate codes when students provided positive or negative feedback about the course structure more generally.

Survey Procedure and Participants

The survey was administered at the end of the semester. Students received a link via email and either completed the survey during class or on their own time. On average, it took students less than 10 minutes to complete the survey. $N = 319$ students completed at least part of the survey. See Table 1 for survey response rates per course.

Results

We conducted one-way analyses of variance (ANOVA) and post-hoc Tukey comparisons to determine whether or not survey responses significantly differed between classes, and if so, between which classes. We report Cohen’s $d$ as a measure of effect size for all significant differences. Cohen (1992) describes an effect size of 0.2 as a small effect, 0.5 as a medium effect, and 0.8 as a large effect.

RQ1: Perceptions of Autonomy in Response to Amount of Choice

Students generally responded positively to assignment choice across all three classes (see Table 2 for a summary of the positive and negative tone per research question topic for each class). In their open-ended responses, students shared that these courses “[a]llowed for specialization,” to do work that

<table>
<thead>
<tr>
<th>Course</th>
<th>INFO</th>
<th>KIN</th>
<th>SOCIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Points</td>
<td>1,250,000</td>
<td>34,850</td>
<td>248,000</td>
</tr>
<tr>
<td>Points to Earn A</td>
<td>975,000</td>
<td>21,000</td>
<td>125,000</td>
</tr>
<tr>
<td># Assignments</td>
<td>82</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>Class Size</td>
<td>150</td>
<td>247</td>
<td>147</td>
</tr>
<tr>
<td>Survey Response</td>
<td>139 (93%)</td>
<td>121 (49%)</td>
<td>59 (40%)</td>
</tr>
</tbody>
</table>

Table 1: INFO, KIN, and SOCIAL course structures
“fit best into my schedule,” helped to “figure out what you like.” Students frequently mentioned that the experience was “empowering” and encouraged them to actively plan their work for the semester. Students across all three classes reported that they took slightly more risks as a result of having increased assignment choice (see Table 3), with none of the course designs differing significantly from the others on this metric. On the downside, students mentioned that the flexible scheduling enabled them to procrastinate, and that the system was sometimes confusing.

<table>
<thead>
<tr>
<th>Class</th>
<th>Assignment choice</th>
<th>Recovery from failure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive feedback</td>
<td>Negative feedback</td>
</tr>
<tr>
<td>SOCIAL</td>
<td>16.27%</td>
<td>5.42%</td>
</tr>
<tr>
<td>INFO</td>
<td>9.02%</td>
<td>4.97%</td>
</tr>
<tr>
<td>KIN</td>
<td>24.24%</td>
<td>3.59%</td>
</tr>
</tbody>
</table>

*Table 2: Percent of feedback concerning assignment choice and recovery from failure*

Looking across classes we can see medium to large (Cohen, 1992) differences in students’ perception of the ways assignment choice impacted their experience. Students in SOCIAL reported putting in slightly less effort as a result of their choices, while students in INFO reported putting in slightly more—but both responses were centered around the neutral response of 3 (“I put in the same amount of effort as usual”). INFO had by far the most assignments, potentially affecting the perceived effort necessary to succeed in the course. A small but significant number of students in both INFO (12 students) and KIN (16 students) identified their ability to match their effort to their goal as one of their favorite things about these classes, with comments like “The grading system is well organized and you have the opportunity to put in as much effort as you want and you will get the grade that correlates.”

Students in each class also differed on their comfort in skipping assignments. SOCIAL students were most comfortable doing so ($M = 4.00$, where 5 mapped to “Yes, I felt free to skip assignments. I knew I would still get the grade I wanted” and 3 was “I was not sure, I skipped some optional assignments but I was not sure how it affected my grade”), and students in INFO the least sure of this approach ($M = 3.00$). Students in SOCIAL positively discussed their control over their work almost twice as much (16.22% of the comments, as compared to 9.12%) as students in INFO. Student in INFO called out the way that the LMS grade predictor tool was “cluttered,” reflecting the sheer number of assignments they had to navigate. They also highlighted that the LMS did not accurately account for a course rule that limited the number of exploratory assignments students could do to 10. This limitation in the LMS interface (implemented in a later version) may explain why INFO students were less sure how their choices would affect their grade.

Significant differences were again observed between classes in regards to whether students’ felt overwhelmed by the number of assignment choices, but again with all three classes hovering on either side of the middle response, which stated “At times I felt overwhelmed but not all the time.” Students in INFO reported being the most overwhelmed, and students in KIN the least, mapping directly to the number of assignments available, and thus the number of choices that students had to make.

**RQ2: Perceptions of Ability to Recover from Failure in Response to Choice**
Students in all three classes generally understood that they had the ability to make up for a low grade by doing additional work, but KIN students were significantly more confident in this ($M = 4.66$) as compared to both SOCIAL ($M = 4.28$) and INFO ($M = 4.01$), where 5 was “Yes, I understood that I could make up for a low grade by completing additional assignments”, and 3 was “Sort of, I knew that I could make up for a low grade but I was not sure how”).

However, when reflecting on how this affected their expenditure of effort, SOCIAL students indicated they put in slightly less effort than usual ($M = 2.93$), while KIN and INFO students put in slightly more ($M = 3.34$ and $3.38$, respectively), where an answer of 3 corresponded to “I worked the same as usual.”

In analyzing the open-ended responses about the opportunities to recover from failure, SOCIAL students offered more positive and more negative thoughts: on the one hand they described the course as less stressful and enabling them to take risks, but several also mentioned that the reduced pressure meant they did not feel obligated to “give my 100% for each assignment.”

<table>
<thead>
<tr>
<th>Item</th>
<th>Interpretation</th>
<th>SOCIAL</th>
<th>KIN</th>
<th>INFO</th>
<th>SOCIAL v KIN</th>
<th>KIN v INFO</th>
<th>SOCIAL v INFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did having a choice of assignment options affect the amount of effort you put into this class?</td>
<td>Higher score means more effort</td>
<td>2.76</td>
<td>3.03</td>
<td>3.35</td>
<td>ns</td>
<td>0.31</td>
<td>0.57</td>
</tr>
<tr>
<td>Did you feel like you needed to do every single assignment in this class?</td>
<td>Higher score means more students felt they could choose what to work on</td>
<td>4.00</td>
<td>3.80</td>
<td>3.00</td>
<td>ns</td>
<td>0.65</td>
<td>0.85</td>
</tr>
<tr>
<td>Did you feel overwhelmed by the number of assignments in this course?</td>
<td>Higher scores mean more students felt overwhelmed</td>
<td>2.77</td>
<td>2.32</td>
<td>3.28</td>
<td>0.41</td>
<td>0.80</td>
<td>0.40</td>
</tr>
<tr>
<td>How did the ability to recover from a low grade affect your assignment choice?</td>
<td>Higher scores mean students took more risks</td>
<td>3.57</td>
<td>3.62</td>
<td>3.39</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Did you understand that you could make up for a poor grade by completing additional assignments?</td>
<td>Higher score means better understanding</td>
<td>4.28</td>
<td>4.66</td>
<td>4.01</td>
<td>0.46</td>
<td>0.68</td>
<td>ns</td>
</tr>
<tr>
<td>Did knowing that you had the ability to recover from failure affect the amount of effort you put into assignments?</td>
<td>Higher score means more effort</td>
<td>2.93</td>
<td>3.34</td>
<td>3.38</td>
<td>0.45</td>
<td>ns</td>
<td>0.44</td>
</tr>
</tbody>
</table>

*Table 3: Summary of post-hoc comparisons*

**Discussion**

In this study we sought to understand student reactions to different implementations of assignment
choice. While we observed distinct variation in students’ reaction to assignment choice, it is more complicated than ‘more choice is better,’ our initial hypothesis. Although increased choice was received positively across all three classes, having more choice above a certain threshold, and more complex rules around those choices, appears to have required students to put in increased effort to understand the grading system. INFO, which had the highest number of assignments, and SOCIAL which had the most complex rules system, proved more difficult for students to understand, and thus less successful at supporting student autonomy. More study of gameful courses is needed to determine optimal levels of assignment choice and structure.

We observed that variations in the way that courses enacted assignment choice (autonomy-support) led to different student thoughts and behaviors. This is consistent with the first step in Jang and colleagues’ (2009) and Landers’s (2014) mediation models. Jang and colleagues’ model (2009) showed that the relationship between instructor autonomy support and academic achievement is mediated by basic need satisfaction. Landers’s (2014) model suggests that students’ reactions to gameful course elements are mediated by the relationship between implementations of those elements and academic outcomes. In the current study, we demonstrated that differences in the implementation of gameful design features led to differences in student reactions. We can begin to make recommendations about the best ways to enact assignment choice in gameful courses:

1. Make as much information about assignments, deadlines, and rules available at the beginning of the semester, and change the design as little as possible throughout the semester. If new assignments will be announced throughout, help students know approximately the number and timing of these, and provide a way for them to easily keep track of what is currently available in order to best support student planning.

2. Minimize the total number of rules per course; the more rules students need to keep track of, the more confused they will be, and the more time will be dedicated to keeping everyone apprised of the system.

3. Make sure that tools provided to support students’ sense of progress in the course are able to support all aspects of the rule system implemented. Reconsider both tools and rules if the two are not compatible.

4. Minimize the number of systems involved, and ensure that data (due dates, requirements, etc.) is synchronized across all platforms.

Limitations

This study has a number of limitations. This is the first in a series of studies on assignment choice, and as such does not represent an exhaustive examination of all of the ways that choice can be implemented. In future work, we hope to examine how many more courses have done this. Students’ open-ended responses provided insight into the course experience, but may not be representative of their experience throughout the whole course. Given that the survey was administered at the end of the semester it is likely that confusion regarding the course setup was underemphasized, while stress about final grades may have been overrepresented. This work took place within an R1 university setting, and our recommendations may not be generalizable to other contexts. We have used artifacts, including syllabi, LMS course shells, and student survey responses, to analyze these experiences, but have not been able...
to take into account elements like instructor affect, students’ social network within the class, or students’ relative preparation for each course, all of which may have had significant effects.

Future Directions

We plan to continue to utilize our theoretical framework to analyze differences in the implementation of gameful design features by applying our conceptual framework to future classes that employ gameful design. By analyzing different implementations of assignment choice we can refine our theory of best practices for its implementation. With a larger number of courses to which to apply our framework, we will be able to make comparisons along comparatively less common gameful design elements such as assignment unlocks, leaderboards, and badges. In addition we hope to incorporate additional data sources, such as instructor interviews, that go beyond student self-report and course artifacts. These results provide a starting point in our own endeavor to categorize and operationalize the features of gameful design. We believe that this study can serve as a framework for further study of gameful course structures in context.

References


24.

How a History of Racing Games Can Inform Contemporary Game Design Education

Eric Nunez (Marist College)

Abstract

Racing games are one of the simplest genres of games that are used to teach fundamental game design to beginners. Contemporary examples of the genre can serve to model concepts of the systemic design of games, but are often poor examples of how games can embody values and meaning. However, an examination of the history of racing games reveals that these games were traditionally designed to address a wide array of humanistic, societal and cultural concepts. Rediscovering this history and applying the lessons learned to current exercises and curricula can help game design educators develop a more comprehensive experience for their students.

Introduction

One of the first exercises educators can employ to teach the fundamentals of game design is the modification of an existing game (Zimmerman, 2014). The games often selected for these exercises are characterized by their simple design. The rules, mechanics and goals are easy to understand, and player choice is limited, leaving little room for complex strategy. These types of games are good starting points because they present beginners with an opportunity to build upon a foundation rather than start from scratch. A good example of such a game is a racing game, in which players race against one another from point A to point B, in order to be declared the winner. Racing games are traditionally chance based, relying on the roll of dice to determine a player’s movement on the board as well as their standing in the race. Educators may also use racing games because of the many genres of board games we play as young children, racing games are often among the first. It is likely that many of us have an experiential understanding of these types of games from our childhood experiences.

However, modern racing games are significantly different from their predecessors in regards to the values or meaning (or the lack thereof) they embody in their narrative content. Ancient racing games were designed to convey ideas about the human experience, particularly the journeys we take through life. As racing games evolved, they were modified for children with the intent of imparting facts, ideas or values – all within the narrative context of a journey. In fact, racing games have a rich history of being used in homes or school settings as educational supplements. By contrast, today’s popular commercial
racing games, such as *Sorry!* (Hasbro, 1934), *Trouble* (Hasbro, 1965) and *Candyland* (Hasbro, 1949) are either purely systemic (no narrative design), or focus on commercial or fictional themes (e.g. Star Wars, Spongebob Squarepants, Pirates of the Caribbean, etc.) as a means to target and sell games to young children.

Through an examination of the history of the racing game, educators may be provided with a different perspective on the genre. They may be inspired to draw on this history to not only master game design fundamentals, but also to encourage learners to develop games that reflect current values and shared meaning.

**The Origins of Racing Games**

Racing games are one of the oldest genres of games. Evidence of these games has been found etched into floors of archeological sites in southern Europe, Syria, Persia, India and China. More elaborate examples of these games made from wood, stone or bone have been found in burial sites in Egypt. Over the centuries these games have evolved, resulting in regional varieties with different board configurations, distinct narratives, differing rules and game mechanics, and varying levels of choice and strategy. The one feature that rarely changes is the objective of the game: for players to race against one another from a designated start to a designated finish. This objective is reinforced by the design of the game, which requires players to always move forward, at a gradual pace, towards a clear and stated goal. Racing games also involve “implements of chance” (Murray, 1951), such as lots or dice, and are needed by players to move forward. The design of the game not only results in an experience that offers limited choice to the player, but also influences the meaning we assign to racing games. As racing games model the passage of time or movement through physical space by means of chance, they have often been designed to embody the unpredictable journeys we take through life.

Many games from ancient civilizations were designed to reflect the preoccupation with life, death, and the spiritual world. For example, *Mehen*, an ancient Egyptian game, was designed to model a journey through the underworld from death to afterlife. It is based upon the myth of a snake god of the same name, responsible for protecting souls travelling through the underworld. Although the specific rules of the game have been lost to time, a translation of a religious text, commonly known as the Pyramid Texts, mentions not only *Mehen* the game, as opposed to the god, but describes a soul that is required to travel around a game board (Tyldesley, 2007). The design of the board, a coiled snake, is a reference to the myth, but may also hint at the underlying theme of the game. In many ancient cultures snakes represent rebirth, cyclical, eternity or immortality. *Mehen* attempts to address the uncertainty of a soul’s journey through the underworld, by providing a context in which a soul can be reborn.

The *Game of Goose*, a game introduced to Europe in the mid to late 16th century, resembles *Mehen*, in that the board is arranged in a spiral formation, but rather than model a journey through the afterlife, the game models the journey through life. The decoration of the board uses botanical patterns and other images of daily life to establish an earthly setting for the player (see Figure 1). The *Game of Goose* is often considered one of the first racing games to use an illustrative visual style as opposed to a purely symbolic one (Parlett, 1999). The game also features event spaces that either reward or punish players. The name of the game itself is based on event spaces depicting a goose. Landing on a goose space rewards players by allowing them to move forwards on the board, whereas landing on other squares, such as a well, a tavern, or a prison requires players to lose a turn or to move backwards. These event spaces are included in order to balance the competition between players, and to prevent any one player
from pulling too far ahead or falling too far behind. However, these event spaces also bring meaning to the game in the context of the journey. They are intended to represent real life experiences, and the good luck and bad luck that fate deals us. They evoke feelings of anticipation, tension or frustration adding a sense of excitement to the game.

![Figure 1. Examples of the game of goose.](image)

**Racing Games for Children**

Ancient racing games like *Mehen* and the *Game of Goose* were usually designed for and played by adults. In fact, the *Game of Goose* is believed to have included a gambling component wherein players placed stakes at the start of the game (Parlett, 1999). However, between the end of the 18th century and start of the 19th century, there was a shift to design and publish racing games for children. This shift was due in part to the growing middle class who had the means to afford these games and the leisure time to play them at home (Flanagan, 2007). Educational movements in Europe also promoted the idea that visual aids, including games, could make learning attractive to young children (Shefrin, 2009). As a result of these shifting norms, racing games began to move away from themes of life and death to take on topics of history, geography and science. A number of these games are referred to as *Game of Goose* variants, since the games are structurally and systemically similar to the *Game of Goose*. The French were among the first to publish and popularize these variants including a geographical game entitled *Jeu du Monde* (DuValle, 1645). The game requires players to travel the world starting at an unnamed artic pole, through North and South America, Africa and Europe, finally reaching France. Each space on the board features an illustration of a state or country with the continents represented in the four corners of the game board (see Figure 2).
In addition to imparting factual information, racing games also began to address issues concerning morals, ethics and religion. Like traditional racing games, these games modeled the ups and downs of life, but also noted the characteristics or behaviors that might lead persons to succeed or fail in life. For example, in the late 1800s many American board game publishers were designing games based on the theme of “rags to riches.” These games reflected the contemporary idea that anyone could find success through hard work and merit (Hofer, 2003). Many racing games published during this time designed the experience of the game around the structure of organizations, including the roles or levels of promotions that a player could achieve. In *The Game of Telegraph Boy, or Merit Rewarded* (McLoughlin Brothers, 1888), for example, players were challenged to move up the ranks of a telegraph company starting as a messenger boy with the goal of becoming its president (see Figure 3). This journey through the organization reveals to the player not only the different roles that are required for a telegraph company to function properly, but also the qualities deemed valuable for promotion. Such games included event spaces such as integrity, ambition and intelligence that allow for promotion or for the player to move forward on the board, as well as event spaces such as inattention, impertinence and stupidity that result in demotion or moving backward on the board.
While many games of moral instruction are *Game of Goose* variants, games of moral instruction and professional promotion were also a mainstay of Asian cultures. In fact, one of the most recognized American children’s games, *Candyland*, is a game that is based on an Indian promotion game known as *Moksha Patam* or *Snakes & Ladders*. This game is one of spiritual promotion, in which players rise and fall based on whether they land on an event square containing a ladder (virtue) or a snake (vice). As is the case with *The Game of Telegraph Boy, or Merit Rewarded*, *Moksha Patam* also notes the characteristics or behaviors that are considered virtuous or immoral. The Japanese designed similar games referred to as *Sugoruku*. These games addressed tenets of Buddhist doctrine, or themes involving service to the government.

**Beyond Narrative**

In 2009, veteran game designer Brenda Romero designed a one-off game called *Train* (Romero, 2009), part of a larger series of non-digital games entitled “The Mechanic is the Message.” *Train* is a racing game in which players move train cars down a set of tracks, with the goal of reaching the end of their track first. The tracks are set upon a large window frame with broken glass, and the rules of the game appear on a sheet of paper, spooled onto an old typewriter. Players roll dice to determine either the amount of spaces they move forward or the number of passengers they add to their train car. Players also have the option of using event cards that allow them to move more quickly down the track, switch tracks, block other players’ progress or derail another players’ train car. Once a player reaches the end of their track they flip a card labeled “terminus”, revealing the destination of their train car and the passengers.
inside. To the surprise of many players, the destinations of the trains are concentration camps. This moment, in which the journey of the game becomes clear, instantly changes the experience and meaning of the game for the players. Upon discovering the destination, players understand the specific context of their actions, which in turn leads them to question their complicity in these actions. Furthermore, the experience of Train challenges our assumptions about games. Train raises questions about the emotional capacity of games and whether games need to be “fun” experiences.

Applying Historical Models to Game Design

For those who intend to develop and teach a well-rounded game design curriculum, it is important not only to encourage learners to examine how to design games systemically, but also to understand that games can be designed to embody current values and shared meaning. As the design or modification of racing games is often one of the entry points into game design, reflecting on the history of racing games and how they have evolved over time to reflect contemporary themes may be a useful learning aid for educators with their students. The historical examples presented in this paper touch on a small sample of themes, yet point to a rich history of racing games designed to address humanistic, societal and cultural concepts. Educators might do well to incorporate this history into their exercises by selecting examples to review, alluding to popular themes of the past or developing exercises that identify and reflect current values. At the same time, it is important for learners to understand that value and meaning can be embodied not only in the narrative experience, but also in the actions or choices of the player. As opposed to other forms of media, games not only invite players to step into different narratives and roles, but can also invite them to make choices and consider the implications of those choices.

Designing games with values or meaning embodied in the narrative or mechanics of the game can be challenging, but the process can also be illuminating and rewarding. In designing values-based games, learners are encouraged to think outside the context of commercial or mainstream games and develop new means for engagement (Belman, 2009). Learners also reflect upon their own values and understand how those values correspond to what is societally or culturally accepted. In doing so, they must consider how to design an experience that allows players to explore the extremes of what is right and what is wrong (Brathwaite, 2010). Designing games in this manner may result in experiences and discussions that change a learner’s attitudes about games, as well as the way they think about the embedded values or meaning that can be conveyed through game play. It is likely that this reflexive process may result in a more engaging game education and more culturally relevant and meaningful games.

References


A Cross-Cultural Evaluation of a Computer Science Teaching Game

James M. Laffey (University of Missouri), Troy Sadler (University of Missouri), Sean Goggins (University of Missouri), Joseph Griffin (University of Missouri), So Mi Kim (University of Missouri), Justin Sigoloff (University of Missouri), Eric Wulff (University of Missouri), & Andrew Womack (University of Missouri)
Yetunde Folajimi (Northeastern University), Britton Horn (Northeastern University), Jackie Barnes (Northeastern University), Amy Hoover (Northeastern University), Gillian Smith (Northeastern University), & Casper Harteveld (Northeastern University),

Abstract

The use of games for education has attracted a lot of attention in developed nations worldwide, and is gradually penetrating the developing world. Despite that there are educational and efficiency benefits from the cross-cultural implementation of educational games, most educational games are not designed for cross-cultural usage. This paper seeks to contribute to designing cross-culturally relevant educational games, and examine this in the particular context of computer science (CS) education through a CS teaching game for middle school students. We implemented this game in the USA and Nigeria in order to find what cross-cultural differences may need attention for future work. Results highlight that both populations find the game enjoyable yet challenging. However, a clear difference is noticeable in the learning outcomes, which may have been a result of the game’s design and the evaluation instruments. Therefore, a cross-cultural perspective is needed to both educational game design and its evaluation.

Introduction

There has been an increased interest in the use of games for teaching computer science (Harteveld et al., 2014). This use is likely to grow in the future with initiatives such as Computer Science for All (The White House, 2016). Games are particularly appealing to broadening computer science (CS) education due to their affordance to engage users (Chande et al., 2015; Papastergiou, 2009). Although much emphasis has been put on broadening CS to girls and underrepresented groups specifically through games (Kafai et al., 2008), so far initiatives have not been pursued to broaden CS cross-culturally through games, that is, to make a CS teaching game that would be appealing to two or more different cultures or countries. The aim of this paper is to initiate this type of broadening in addition to the ones frequently advocated for, with a focus on broadening a game from a developed country towards a developing country. The entire world would benefit from a population that is more computer literate and building a completely new game tailored to each culture is not efficient. Additionally, in the case of
developing countries it allows for accessibility to technologies that may help them in their development and prevent a larger gap between nations from occurring.

Because games are like every other artifact culturally defined, most educational games are designed and evaluated for certain groups of people with similar culture and interests, or within the same geopolitical areas. The implication of this is that players will not easily understand nor appreciate the design for a game that is contrary to their attitudes, customs, and beliefs, and this may happen within the same country because cultures are not necessarily bound by borders. This lack of cross-cultural usage is representative for the field of educational games in general and not specific to CS teaching games only. To be validated as being truly cross-cultural, a game should be designed and evaluated among groups of people across varying cultures.

This lack of cross-cultural usage is representative for the field of educational games in general and not specific to CS teaching games only. Existing efforts thus far have been sparse. Kam et al. (2007) evaluated the efficacy of eight educational games among rural children in India to identify the role of contextual factors, and then Kam et al. (2009) conducted an exploratory study to inform the design of a new videogame that rural children in India found to be more intuitive and engaging. Although this work specifically considered culture in designing an educational game, the work still focused on a specific group and, therefore, is not cross-cultural. In terms of truly cross-cultural efforts on educational games, Khaled et al. (2006) developed two versions of a persuasive game to educate citizens about smoking cessation, one for New Zealand Europeans and one for the Maori. They concluded it is best to design with the cultural background of the intended audience in mind. This conclusion is aligned with the findings of Folajim et al. (2012). After implementing a game for educating children about sickle cell disease and implemented with UK and Nigerian children, it was concluded that educational games need to be built with a view to varying cultural backgrounds. Other efforts have involved using existing theories about cultures as input to the design and implementation of games, such as Hofstede’s cultural dimensions (Hofstede & Pedersen, 1999). Additionally, for entertainment games specifically there have been various practical examples as well as documented ones (e.g., O’Hagan & Mangiron, 2013) about the need for game localization, which mostly involves cosmetic adjustments to a game (e.g., changing from red to green blood for games distributed in Germany).

In this paper, we seek to contribute to the design of cross-culturally relevant educational games, and examine this in the particular context of CS education. Acknowledging that varying designs may be necessary based on the work in this area thus far, our efforts have focused on first establishing the differences between two clearly different cultures in order to make design recommendations for future work. For this effort, we have investigated the cross-cultural use and impact of a CS teaching game called GrACE (named after Grace Hopper). Based on a review of existing CS teaching games (Harteveld et al., 2014), GrACE was originally developed to teach CS concepts to middle school students in the USA. Results from an experimental pilot study highlighted moderate improvements in the CS concept being taught through the game (Horn et al., 2016). To assess the cross-cultural use and impact, we have later implemented the same study with middle school students in Nigeria. Although the choice of Nigeria was majorly because of convenience due to opportunities provided to the researchers, we see it as a step towards expanding the reach of the game to the rest of the developing and developed nations in the world. The results of this Nigerian implementation and the comparison with the US implementation are reported in this paper. Before we discuss these results, we will first elaborate on GrACE itself and summarize the results from the USA pilot study.
Broadening CS with GrACE

GrACE has been developed to explore the potential of Procedural Content Generation (PCG) for teaching CS concepts. PCG is the practice of creating game content automatically with a computer (Smith, 2014). A related aim is to broaden CS and while the main aim has been to broaden CS to be more inclusive to girls, we have been additionally starting to explore broadening cross-culturally by implementing the game in Nigeria as well. As PCG can automatically create content, we anticipate that in the future, once it is clear what the design requirements are per gender and culture, we can generate content tailored to the user. In illustrating the potential of PCG, we have initially focused on teaching the CS concept of the Minimum Spanning Tree (MST). A MST connects all the nodes with the minimal total weighting for its edges in a given graph.

![GrACE user interface. Players need to collect all the vegetables.](image)

The Design of GrACE

The game is centered on two characters—a mouse and a rabbit—whose goal it is to collect all the vegetables in each level (see Figure 1). Vegetables (nodes) in the ground are connected by cracks (edges) that only the mouse can fit through. Edge weight corresponds to the amount of bunny energy needed to dig along a crack. Players control the mouse as it explores the map and flags cracks for the rabbit. To minimize the bunny’s digging energy, players must find and flag the MST. Initially, players can only see the starting node and the nodes connected to it. Players choose an edge to traverse at which point
the next node and its connections are revealed. This mechanic discourages players from solving the puzzle visually by examining the entire graph at once. Instead, we designed the game around limited information exploration to encourage stepwise thinking and mimicry of MST solving algorithms. At any point, a player may drop a flag on an edge connected to their current node indicating it is part of the minimum spanning tree. Flags can be removed from edges connected to the player’s current node as well. Once all nodes have been explored and all desired edges have been flagged, players may submit their answer. If the answer is correct, players move on to the next level which increases in difficulty. All puzzles/levels are generated by the computer based on this difficulty, which is defined in the current version as the number of nodes and edges.

The USA Evaluation of GrACE

We developed a three-hour procedure that included about an hour of gameplay with GrACE and evaluated the results of this implementation with an experimental pilot study (Horn et al., 2016). We implemented this procedure as part of a summer program for middle school students (ages 10-14 years) in the USA. The program selects 48 middle school talented students each year (with an average of B or higher in their course work), and focuses on STEM content. The program historically supports underserved and underrepresented students with limited opportunities, is gender balanced by recruiting an equal amount of boys and girls, and is free of charge. The USA experimental setup involved completion of pre-questionnaire after an explanation on how to play the game. This was followed by game play, post-questionnaire evaluation and a semi-structured discussion on the topic of CS and the MST concept in particular. During the day of implementation, 43 students participated, 22 identifying as female and 21 as male. These students reported a high level of enjoyment but also found it frustrating, challenging, and hard. Their perceived experience was unrelated to their moderate improvement in the conceptual understanding of the MST problem.

Methods

We applied the same setup from the USA pilot study to the Nigerian groups, and made modifications where necessary in the procedure and material. For example, we modified terms such that it would be comprehensible and familiar to Nigerian students (e.g., changing Mayor to Governor).

Participants

The pilot study was replicated in two contexts: the Nigeria Geek Girls Collaborative Camp (Summer Camp) and the Ogunsanya Girls Science Academy (Academy). The first context is a computer training and mentoring camp for Nigerian secondary school girls (ages 10-16 years) with the aim of enhancing the talent and skills needed to fuel technological and economic growth. To reach out to the best talents, notwithstanding their social or economic background, the camp is free of charge. The 2015 camp consisted of 40 participants, with 36 opting to participate in the pilot, including four male non-campers who indicated interest in evaluating the game. Of these 36, one student was excluded for neither having survey nor game data. Parental consent and school approval were received from each participant. The second context is an all girls secondary school with a special focus on preparing girls for STEM careers. Of the 30 students that participated from the Science Academy, two students were excluded for lack of
survey and game data thereby leaving us with 28 participants. By default, all participants from this group are female boarding house students of the same school and study science related subjects. Computer science is one of the major subjects taught in the school and almost all the students have personal computers.

Materials

The materials used in this study include a questionnaire, comprehension test, and the game. The pre-questionnaire captured game attitudes and the post-questionnaire demographics and game experience. For game attitudes we aimed to measure the constructs of Liking (3 items; αUS = .76, αNIG = .54) and Leisure (4 items; αUS = .85, αNIG = .75). Liking measures how much the students like playing video games; Leisure measures the degree to which games are incorporated in the leisure time of participants. Regarding their game experience, we aimed to measure how much participants liked playing with the construct Enjoyment (4 items; αUS = .93, αNIG = .69) and had trouble with playing with the construct Difficulty (3 items; αUS = .87, αNIG = .32). For both game attitude and game experience we used 7-point Likert items adapted from the New Computer Game Attitude Scale (NCGAS; Liu et al., 2013) and existing Game Experience Questionnaires (GEQ; Norman, 2013), respectively. Based on factor analyses (principal axis factoring, varimax) and a comparison of similarity indices (after procrustean rotated loadings), and specifically Tucker’s coefficient of congruence (Lorenzo-Seva & ten Berge, 2006), we concluded that our instruments have been applied to a different population reasonably well but need to be viewed with caution due to the low internal consistency with the Nigerian sample. The Difficulty construct seems not to generalize and for this reason we excluded this from our analysis.

The comprehension test aimed to measure a conceptual understanding of the MST before and after playing. The test concerns a multiple-choice assessment of three puzzles with three questions each. The first puzzle is based on edited screenshots from the game (“Game”); the second is an adaptation from the “Muddy City” exercise from CS Unplugged (Bell et al., 2015), which involves paving roads between houses (“House”); and the third is an abstract graph with nodes and edges that we referred to as circles and lines (“Abstract”). For each puzzle one question involved the problem of adding a single edge (“Addition”), one about removing a single edge (“Subtraction”), and one about correcting an incorrect spanning tree (“Correction”). One point is awarded for each correctly answered question. As during the Camp implementation about half of the participants did not receive the house subtraction question, we excluded this question from our analysis. We counterbalanced the test distribution and similarly to the US Pilot did not find a significant difference between the two versions.

The game was instrumented to track all player actions (e.g., placing or removing a flag, submitting an answer) and game states (e.g., mouse and bunny energy). We used USB sticks to retrieve this data from the personal and lab computers used in the study. Unfortunately, a significant number of files got corrupted, leaving us with eight complete data sets for the Summer Camp and 21 for the Science Academy implementation.

Procedure

At the Summer Camp, the study was implemented as part of an educational games activity; for the Science Academy implementation the team was able to organize an informal, extracurricular activity on
a Saturday. In both cases, the experiment followed the same pattern as the USA implementation. For the Summer Camp, the study took approximately 3.5 hours, with one hour of gameplay, while in the case of the Science Academy, the experiment took about 2.5 hours to complete.

Results

In detailing our results, we focus on the main outcomes from the survey, comprehension test, and the game data. In describing our results, we make a specific mention whenever we found a relevant difference compared to the USA pilot study.

Survey

The majority of the Nigerian students (52.5%) reported to play more than 1-2 days a week (as opposed to 61.9% of US students). Interestingly, most (39.3%) reported to play games multiple times a day, which is more than what the US students reported (16.7%). Despite seemingly playing more games on a daily basis, the Nigerian students disliked various game genres more so compared to the US students, with an almost entire dislike for strategy, role-playing, and simulation games. Except for the adventure genre, which was more favored by the Science Academy students (81.9% vs. 55.9%), there were no differences between the two Nigerian groups, suggesting that they were homogenous in terms of what games they play and like. Similar to game genres, the Nigerian students liked fewer school subjects than the US students.

Regarding game attitudes, the majority of students indicated a liking of games, similar to the US students. When it came down to the degree to which games are part of their leisure time it becomes clear that for Nigerian girls games play overall a more important role than for US girls, \( t(77) = -3.24, p = .002, r = .35 \) but less so than compared to US boys, \( t(75) = 2.68, p = .009, r = .29 \). Interestingly, the statements where the Nigerian girls ranked similarly to the US girls, it is where the US boys scored higher, indicating more of a gender difference rather than a cross-cultural one. The US boys scored higher on thinking about games while not playing, considering games to be part of their life, and spending their free time on playing games. For the latter statement, the Nigerian girls did differ compared to the US girls but this is attributed to the Academy girls. They are spending more of their free time playing games compared to the Camp girls, \( U = 281, p = .005, r = .36 \). Overall, the Academy girls indicated a more important role for games in their leisure compared to the Camp girls, \( t(50) = -2.82, p = .007, r = .31 \).

As for how the participants experienced the game, it is clear that the Nigerians enjoyed the game more so, \( t(77) = -2.11, p = .038, r = .23 \). They would recommend this game to their friends, want to play it at home, and have learned from it more so than what the US participants. No differences were noticeable in terms of the difficulty of the game. However, amongst the two Nigerian groups it is noticeable that Academy girls found it more challenging, \( U = 330, p = .030, r = .28 \), and experienced more frustration, \( U = 331, p = .025, r = .28 \).

With the US participants a predisposition was noticed in how the game is experienced. For the Nigerian sample, however, no differences were found regarding their preferences in game genres and school subjects. Unlike the US audience, both Liking and Leisure do not correlate to their Enjoyment as well as how frequently they play games.
In order to calculate the performance on the comprehension test, we calculated in addition to the total scores the scores per puzzle (Game, House, and Abstract) and per type of question (Addition, Subtraction, and Correction). Table 1 provides an overview of the average scores per implementation on all these items. Immediately apparent is that large disparity between the US participants and the Nigerian participants. Where the US participants answered on average 60% of the test correct already, and moderately improved after playing, the Nigerian students answered 30% or less on average correct, and there is no noticeable improvement. In fact, for the Camp participants a decrease is almost observable, \( t(33) = -1.87, p = .071, r = .31 \). Specifically, they seemed to have trouble with the addition questions, \( t(33) = -2.54, p = .016, r = .40 \). When looking at the maximum total scores, we see that with the US pilot a perfect score increased from four to 12 participants. With the Nigerians, on the other hand, three students received a score of five points at the start. After playing, one participant received a score of six points and none got five points.

### Table 1. Overview of the comprehension test scores across the different groups, in M(SD).

<table>
<thead>
<tr>
<th>Item (max)</th>
<th>US Pilot (N = 43)</th>
<th>Nigerian Camp (N = 35)</th>
<th>Nigerian Academy (N = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
</tr>
<tr>
<td>Game (3)</td>
<td>1.70(1.12)</td>
<td>2.11(1.05)</td>
<td>0.67(0.77)</td>
</tr>
<tr>
<td>House (2)</td>
<td>1.41(0.74)</td>
<td>1.06(0.90)</td>
<td>0.62(0.74)</td>
</tr>
<tr>
<td>Abstract (3)</td>
<td>1.98(0.90)</td>
<td>2.12(0.85)</td>
<td>1.06(0.89)</td>
</tr>
<tr>
<td>Addition (3)</td>
<td>2.14(0.78)</td>
<td>2.26(0.85)</td>
<td>1.03(0.76)</td>
</tr>
<tr>
<td>Subtraction (2)</td>
<td>1.09(0.76)</td>
<td>1.33(0.78)</td>
<td>0.44(0.56)</td>
</tr>
<tr>
<td>Correction (3)</td>
<td>1.88(1.13)</td>
<td>2.12(1.16)</td>
<td>0.67(0.82)</td>
</tr>
<tr>
<td>Total (8)</td>
<td>5.07(2.03)</td>
<td>5.67(2.16)</td>
<td>2.35(1.18)</td>
</tr>
</tbody>
</table>

The results may have been due to a possible floor effect. The test may have been too challenging, especially considering that the Nigerian students themselves expressed to have learned from it, and more so than the US participants. In exploring possible relationships with the test performance, we found that age may be a factor in this group, \( r = .29, p = .023 \). In addition, and much surprisingly, it seems that player enjoyment is negatively correlated with how much they improved, \( r = -.27, p = .043 \). Further exploration shows that in particular participants with positive improvements agreed less so with the statement “I thought it was fun”. Based on this, we made a new dichotomous variable distinguishing participants who agreed and disagreed on this statement, and ignored those who chose neither disagree nor agree. We then compared this new variable separately for each Nigerian group because with the Camp participants a decrease was almost observable. For the Camp participants the “disagreers” (\( N = 7; M_{pre} = 1.43, SD_{pre} = 0.53; M_{post} = 2.14, SD_{post} = 1.21 \)) improved more so than the “agreers” (\( N = 22; M_{pre} = 2.73, SD_{pre} = 1.24; M_{post} = 1.63, SD_{post} = 1.40 \)), \( t(27) = 2.71, p = .014, r = .45 \); likewise, for the Academy participants the “disagreers” (\( N = 9; M_{pre} = 0.78, SD_{pre} = 0.67; M_{post} = 2.33, SD_{post} = 1.41 \)) improved more so than the “agreers” (\( N = 19; M_{pre} = 1.95, SD_{pre} = 1.27; M_{post} = 1.95, SD_{post} = 1.03 \)), \( t(16) = 2.71, p = .016, r = .56 \). From these results it is noticeable that the disagreeers scored lower on the pre-test than their peers. When only considering the disagreeers, the game did have a significant impact, \( t(15) = 3.45, p = .004, r = .67 \).
For the game data we considered what difficulty levels participants played (1 to 11), the time it took them to complete a level, how many times it took them to complete a level, how many actions they needed to take within a level to complete it, and—when playing the PCG version—when participants requested a new level. Regarding the latter, none of the 17 participants made use of the “random” button to get a new puzzle. If this can be generalized to all of 34 participants in this condition then it explains why the PCG manipulation may not have had any effect. For the US pilot study about a third in the PCG condition did not make use of the “random” button. As for the levels played, compared to the 17 (41%) US participants who completed the final level, only two (7%) did for the Nigerian students. Moreover, the US participants were able to complete at least Level 5, for the Nigerian students this was Level 3. In fact, only six (21%) were able to complete a level higher than six compared to the 38 (90%) of the US participants.

In total, the Nigerians ($M = 33.4, SD = 25.3$) played on average as many levels as the Americans ($M = 31.9, SD = 13.0$); they just played the earlier levels more so and also needed more time to play these levels. For example, it took the US participants a little over a minute on average to play Level 1 whereas it took the Nigerian participants more than four minutes. A difference in performance is not clearly noticeable until Level 4, where the Americans fail about twice the amount less than the Nigerians, $t(69) = 2.34, p = .024, r = .27$. Interestingly, unlike with the US pilot no difference is noticeable in the time to play for the collaborative condition.

Discussion

This study has helped to understand the differences in how students of different cultural backgrounds perceive, interact with, and learn from an educational game. After the implementation, the Nigerian students revealed that they wanted inclusion of hints, which is understandable considering their difficulty with progressing in the game. They also wished for a mobile version of the game. This is also not surprising as smartphones have rapidly penetrated Africa, and is arguably a very important tool in the future of education in Africa (Brown, 2003). However, the main take-aways from this study are the performance gap and the performance paradox. Based on these take-aways and the other results, we discuss the implications, also considering the limitations of this study.

Performance Gap

It is clear from this study that the USA students performed much better than the Nigerian students in terms of test scores. However, it is worthy to note that due to the program’s selectivity, there is an inherent bias that may be responsible for the wide margin. The USA students were selected based on high academic performance while the Nigerian students consist of a blend of students with varying academic status. Although for the Science Academy more than 50% of the participants have their own laptops, the majority of the participants from the Camp are from a humble background, with very limited or no access to computers. This tacitly suggests that their level of proficiency with computers is less compared to USA students and this may have impaired their ability to learn from the game, as they have more trouble to learn how to play it. Additionally, the Nigerian students have much varying game experience compared to the USA students, which may have played a role too. Of course, a possible bias
may have been the research instruments that we used. Although we modified the language of the test, the test itself may have been too difficult to measure improvement. Regardless of all these possible biases, the performance gap is that significant that it would need to be considered in designing educational games for cross-cultural impact.

**Performance Paradox**

Overall, the game did not have a significant educational impact on Nigerian students, which is in contrast to the moderate improvement of the USA students. However, a performance paradox became apparent. Those who did not enjoy the game actually made drastic improvements. It should be noted that these students were the lowest performing students at the start, suggesting that they are academically either uninterested or have more difficulty in performing well. This outcome is promising but also discouraging. On the one hand, the game seems to impact those who need it; on the other hand, those who need it may not make use of it as they do not find it enjoyable.

**Implications for Cross-Cultural Design**

It is clear from the study that the USA and Nigerian students experienced the game in similar ways. The expressed greater enjoyment by the Nigerian students may have been the result that these students receive much less exposure to innovative educational technologies in their classrooms such as games. In fact, in Nigeria a game is still not considered a learning tool in most schools. The idea of a game is even considered a “taboo” in some classrooms. An interesting finding is that Nigerian girls seem more open to games than US girls to games, which is maybe telling about the role of games in both cultures. However, in general it is clear that the Nigerian students experience and play different games, which may have hindered them in accessing the learning content of the game. Both the performance gap and paradox are issues for further investigation but it seems clear that varying levels of difficulty may be necessary to increase cross-cultural usage.

**Conclusion**

By investigating the same game among middle school students in the USA and Nigeria, this study has enabled us to perform a cross-cultural evaluation of a CS teaching game. Findings from the study have led us to conclude that there is a need to introduce a cross-cultural perspective to educational game design and its evaluation in order to broaden a game’s impact. Our results will be used to improve the next iteration of the game and achieve our ultimate goal of broadening the game to be both inclusive to girls as well across varying cultures. We intend to achieve this by integrating adaptive models that will be able to give personalized interactions to players notwithstanding their cultural background.

**References**


Smith, G. (2014). Understanding procedural content generation: a design-centric analysis of the role of


Critical Thinking with Aesthetic Elements of Minecraft

Diali Gupta (Werklund School of Education, University of Calgary, Canada) & Beaumie Kim (Werklund School of Education, University of Calgary, Canada)

Abstract

This paper describes how interactions with aesthetic elements of digital games (Minecraft) might help foster critical thinking skills. We argue that interactions with aesthetic elements of games enable aesthetic experiences facilitating holistic understanding and critical thinking towards the problem. Using a theoretical framework for visualization of aesthetics of digital games, we analyzed how learners in an arts immersive school in Canada interpreted and interacted with the aesthetic elements of Minecraft. Our analysis delves into their construction of meaning and critical thinking skills at work. Specifically, we considered the aesthetical elements of geography and representation of Minecraft. Minecraft uniquely supports user-generated geography and representations. Hence we focused on how learners created aesthetic elements based on their interpretation of the content and how the creation process triggered their critical thinking skills.

Introduction

Present definitions of digital game-based learning environments have stated how games are systematic data-driven pedagogies that enforce critical thinking and problem solving skills (Johnson et al, 2014). Recent developments in research also show how there have been efforts to review cognitive processing, transfer from computer games to external tasks, use of games for evaluation as well as game design to determine how video games could be effectively used in classrooms (Tobias, Fletcher & Wind, 2014). There have been studies on game aesthetics (e.g., Squire, 2011) elaborating on rhythmic immersion of games and how game aesthetics could be an inspiration for learners to commit to academic content. We are also aware that aesthetic learning could be highly engaging for learners (Eisner, 2005; Parrish, 2009). Hence we have previously argued how aesthetics of digital games (Egenfeldt-Nielsen, Smith & Tosca, 2013) reveal the core learning concepts and provide complexities for deeper engagement (Gupta & Kim, 2014). In this paper we delve into the concept of aesthetics further and try to establish how interactions with aesthetic elements of games help create an aesthetic learning experience thereby fostering critical thinking skills in learners. Critical thinking is the ability to solve problems effectively (Snyder & Snyder, 2008) and our analysis highlights how the students investigated and dealt with the problem towards
finding a solution. Our research was based in an arts immersion school in Canada where students started using Minecraft to achieve curricular outcomes in high school Social Studies.

Literature Review: Aesthetics and Games

Discussions around aesthetics in games have come up mostly around design concepts in connection with the mechanics and dynamics of game design (Aleven et al., 2010). Salen & Zimmerman (2004) first used the term aesthetic trappings in relation to game design to clearly distinguish game aesthetics from game mechanics but Niendenthal (2009) emphasized how games are aesthetic, social and technological phenomena adding three detailed perspectives to the definition: aesthetics as the visual, aural, haptic or embodied sensory phenomena that players encounter in the game, as the commonalities that emerge or are shared with various art forms and the experience of the game as in pleasure, emotion, form giving, sociability etc. Egenfeldt-Nielsen and colleagues (2013) extended the definition of aesthetics by stating that aesthetics of digital games is not how a game sounds or looks but how all its characteristics contribute towards showcasing the experience of “how it plays” (p. 117). Aesthetic experience emerges through the interactions with aesthetic elements that the players encounter while playing the game. Aesthetic elements such as geography and audiovisual representations, number of players or temporal characteristics may have direct influence on the players depending on the design of the game whereas rules may exert an indirect influence on the players. Kirkpatrick (2007) similarly argued how play as an intrinsic part of aesthetics is incidentally present in digital games and works through the imaginative and cognitive faculties towards creating an aesthetic experience.

Studies on the aesthetical design of video games have reiterated the pragmatics of human experience that emerges out of human-computer interactions (Wright, Wallace & McCarthy, 2008). In this proposition, aesthetical experience emerges through the interplay of user, context, culture and history and the relations between artifact and viewer, subject and object, user and tool (Wright et al. 2008). Although aesthetic experience is continuous, the integration of the sensory and intellectual faculties brings forth unity or wholeness that is fulfilling for the user (McCarthy & Wright, 2004).

Aesthetic Experiences and Critical Thinking

Dwelling on various notions of aesthetics, an experience becomes aesthetic through whatever one is doing and the pervasive quality marks it out as a whole, continuous, and meaningful (Dewey, 1980). Aesthetic quality is not a specific part of the experience but remains ingrained throughout the experience. In the overall consummatory experience, Dewey (1980) focuses on the instrumental nature of the meaningful experience and appreciates the intelligence in the aesthetic. Psychologists like Norman (2004) point out how aesthetic experiences are sensory phenomena that evoke behavioural and visceral responses in addition to the cognitive responses understood in terms of the emotional design. In his opinion, the aesthetic representations of the games contribute to the flow state. Educational theorists like Eisner (2005) or Parrish (2009) also claim that aesthetics initiate the learning process through a problem and create anticipation for consummation of learning experiences through highly engaging conditions to entrap the learners. We therefore assume that aesthetic experience signifies a holistic understanding of the problem that mobilizes the cognitive powers which makes critical thinking a part of learners’ aesthetic experience. By critical thinking we are referring to the skills that enable students to “deal effectively with social, scientific and practical problems” (Shakirova, 2007, p.42). Snyder & Snyder
claim that critical thinking requires only six steps to solve a problem using effective thinking. The problem is identified and evaluated within the context and upon framing of the problem the solutions are assessed based on available options. The most effective solution is chosen after an in-depth analysis. The problem solving technique enables students to utilize collaborative practices towards assessing and acting upon real world problems (Snyder & Snyder, 2008). Stanton et al, (2011) take a similar approach when they assert that critical thinking skills incorporate both thinking skills and metacognitive critique and is best represented when critical thinkers fuse domain expertise and situational problems with interpersonal characteristics of persistence, creativity, reasoning and organizational skills.

Aesthetic Experience with Minecraft

As a digital game the aesthetics experience with Minecraft is defined by how the five elements play – rules, geography and representation, time and number of players (Egenfeldt-Nielsen, Smith & Tosca, 2013). Here, we have analyzed students’ use and creation of geography and representation in Minecraft using our theoretical framework to show how learner interactions and interpretations within the game foster critical thinking skills. While geography represents the physical space within the game, representation refers to the audiovisual characteristics of Minecraft. Although the visual aesthetic of Minecraft is blocky (Duncan, 2011) what is unique about the game is the random generation of the landscapes that the players get to reinterpret, recreate or change based on their creative endeavors. Researchers (Duncan, 2011; Robertson, 2010) in fact assert how creativity is not something afforded by the game’s elements but is something integral for creating anything within the game given its sandbox nature. Hence both the geography and representation (visual) of the game changes or emerges depending on the gameplay or the interactions and reinterpretations of the learners based on what they intend to show.

Theoretical framework

Our theoretical framework of visualization of aesthetics for digital game-based learning environments highlights how learners visualize the aesthetics of digital games and draw meanings from it using emotions as their resources for learning. Our theoretical framework comprises of visualization theory (Brodlie et al. 2005) which embeds a macro-cognitive model of sense making (Klein, Moon & Hoffman, 2006) and distributed emotion in the design of learning technologies (Kim & Kim, 2010). We understand the process of visualization of aesthetics of digital games through the following principles:

1. Learners, while playing digital games visualize the aesthetics of the games and extract and create meaningful information as data.
2. As the learners visualize the information they start making sense of it from a data frame perspective. The frame initially commences with some data or information and from that perspective other information starts making sense.
3. As the learners make sense of the information, their emotions act as resources for their learning resulting in the cognitive experience of problem solving.

Visualization theory (Brodlie et al. 2005) refers to a process of extracting meaningful information from data and constructing a visual representation of the information. In the field of visualization this process is generally understood in terms of three different yet interrelated semantic contexts. The first semantic
context relates to displaying the data through a digital environment while the second semantic context relates to the process of specifying, depicting and conveying visual representations to the gamers. The third semantic context deals with the process and cognitive experience of interpreting received information in one’s mind. Interpreting this theory from a game-based perspective the learners visualize the game data which represents a problem. As they play and interact with each aesthetic element of the game (rules, geography, representation, time and/ or number of players) they form their own unique understanding of the game or problem. This process of understanding or sense making occurs through a data frame perspective (Klein et al. 2006) or viewpoint. This frame defines what counts as information or data and the frame changes as more and more information is acquired. While the learners interpret the information their emotions act as resources for their learning resulting in the cognitive experience of problem solving (Kim & Kim, 2010). Specifically, in digital game-based learning environments, emotions pertaining to concept, storyline and game play are usually distributed in the objects, events, characters and contexts and depending on their aesthetic capacity, they serve as emotional anchors of learning enriching the relational meaning and providing meaningful experience to learners (Kim & Kim, 2010). The unique visualization process provides for deeper engagement resulting in critical thinking and problem solving by the learners.

Research Context & Design

The research was carried out in an arts immersion school in Western Canada while using Minecraft (Paanaria server) to achieve Grade 9 curricular outcomes in Social Studies. The project included working both on Minecraft and offline towards creating artifacts that would test the application of their geographic and historical skills, communication skills as well as critical and creative thinking skills. It involved illustrating learner ideas about immigration laws and the process against the Canadian perspective while embedding curricular connections to forms of government and economic practices. For this paper we chose to focus in-depth on the work of one group (Team Red) of four students from a Grade 9 class during one session (Dec 7) of social studies for analyzing how the students interpreted and interacted with the aesthetics of the game to reconstruct their understanding of the topics. This particular date was chosen because the group had worked on Minecraft with each player taking the lead on re-interpreting or re-conceptualizing the game aesthetics (geography and representation) in representing the theme of dictatorship through their construction. The students were recorded at work on video. Selected screen recordings of their work and semi-structured one-on-one interviews were carried out with all members of the team after the completion of the project to capture the essence of their gameplay. They built welcome immigration booths and a flag for a fantasy world or island in Pixel Playground. Their immigration booth had to reflect the type of government and/or economic system while artistically borrowing or deviating from the geography and flag of a province of Canada. Three of the group members (Tracy, Tim & Maya) played on Minecraft while one (Jennifer) occasionally took turns but mainly concentrated on research for other offline activities such as narratives of immigrants for their island based on real immigrants to Canada, creating point systems for immigration. All names used in this paper are pseudonyms.

A Brief Overview of the Group Work

Our analysis revealed that the group metaphorically represented the theme of dictatorship through their creations on Minecraft. Here we provide a brief overview of how the group worked together. We observed their critical thinking process (Shakirova, 2007; Snyder & Snyder, 2008, Stanton et al. 2011)
in the interactions with the aesthetic elements they recreated in Minecraft. As they utilized their content knowledge and collectively dealt with the situational problem of creatively representing and elaborating the theme of dictatorship in their creation, they showed persistence, reasoning and organizational skills.

The class project was initiated with a quiz on Minecraft about Canada’s immigration system and groups that completed it could claim any piece of land based on availability. This activity was named, “Land Rush”. Team Red was third in the land rush and claimed a piece of land not too far from the spawning area in Pixel Playground. As it was not as close as they would have liked it to be, they reinterpreted the structure of the booth such that it caught the attention of the villagers as they walked into Pixel Playground. Visually the landscape represented a cold physical space (geography) with vast areas filled with snow and water (Figure 1). Team Red had chosen Quebec as the province and used a political uprising to draw inspiration from and establish a link to reality. The students had worked on a tall dark grey structure with eight sides for their booth. It had a flat roof with a red glass facade near the entrance (Figure 1).

During this particular session they were in the process of creating their flag to be positioned on top of their roof. While Tim & Maya were working on the flag Tracy was working on the interior of the booth. Prior to this session, they chose the colours, height and size of the building to make the structure look dark and imposing because, according to Maya “dark colours can be used to represent evil”. Black represented “darkness” whereas red represented “bloodshed”. And both these colours “popped” against the generally white and blue background as well as against the lighter shades that other students had used in nearby booths. The structure was also sizable and tall because they felt that it would help catch the attention of the villagers who wanted to immigrate. The slight modification (adding angles to the four corners) of the rectangular structure was brought on for aesthetic reasons initially but modified to correlate with the notion of control that was represented through the flag as well as the interior. It was made octagonal in line with the notion of eight tentacles of the octopus to show the extent of control over all facets of ZLO.

The white cross in the flag was an extension of the Quebec flag that divided the flag into four quadrants. A light blue hand was placed vertically along the centre of the cross to signify control (drawing analogies from military imposed dictatorship). At the centre of the cross they placed a watchful eye – the eye of the illuminati to show “the negative stigma in the real world”, according to Tracy. Clasping tentacles in red and pink specifically with analogies drawn from an octopus, were placed in all four quadrants. The interior was recreated with white stained glass floors to mark the “shifting transition” to an “alternate
world” that metaphorically represented a pathway floating on holy water. This pathway led them to the narratives of their world “ZLO” along with access (teleportation) to their world. The floating metaphor illustrated how people did not have a voice under a dictatorship. It also represented how some people liked the experience, considering it holy and willingly gave up their voice. ZLO was portrayed as an evil world where most of the inhabitants loved the form of dictatorship because it had brought progress marked by technological advancement and fast paced life. The contradiction was represented by “dim lighting”, yet “shiny and see through effect” of the interior of the booth (Figure 2). Tentacles on the walls (Figure 2) showcased fluid movement and the lighting behind the tentacles implied possible improvements (i.e., light behind darkness). The students had also started on an underground passageway from the booth to establish control over other worlds – either by setting up black market operations or through military exercise. Thus we find that learners were engaged in form giving (Niendenthal, 2009), by directly interacting with the geography and representation of the game (Egenfeldt-Nielsen et al, 2013). Through their creative representation their play became an intrinsic part of their aesthetic experience (Kirkpatrick, 2009) that evolved out of the construction of relations between the user/viewer and the artifact (Wright et al., 2008).

Findings: Critical Thinking Through Visualization of Minecraft Aesthetics

With designs that the group chose to focus on (e.g., the flag of ZLO and the interior of the booth) during this class session, we have explained how the learners interpreted the theme of dictatorship. They had created the outline of the flag in black, the white cross and the eye against the blue hand in the centre prior to this session. These initial creations became data for them to reinterpret the theme and add details that elaborated and gave meaning to their framework. We also observed how their emotions helped them with their cognition towards physically representing their notion of dictatorship in a 3D format. During this class session the group decided to complete the flag and the interior with representation of tentacles and illuminati as required. While Tim and Maya worked on the flag, Tracy focused on the interior. This highlighted their collaborative effort towards identifying and evaluating the context to frame the problem and then assessing and acting upon the problem through their interactions with and interpretations of the geography and the representation of the game (See Table 1).
Table 1 shows the sequence of Team Red’s progress in Minecraft which clarifies how Maya looked at Tim’s tentacles to create her own and then came up with the idea of branching tentacles. In sequence 2 in Table 1, Maya’s representation of the tentacles on the flag revealed that she was unsure whether the tentacles should branch out in different directions. The discussion that followed clarified that the tentacles should be made to look “clasping” because it better represents the clasp of power. Tim, who was also working on the flag (the illuminati section marked by glow stones) and had chosen the colors (red and pink to draw analogies with an octopus), explained that the clasp might signify how the illuminati exerted its’ power. Tracy who was working on the interior of the booth added that they could however incorporate the fluid movement of tentacles in the booth as that would make more sense. Hence the metaphor of clasping tentacles (in the flag) and fluid tentacles in the interior emerged from the initial idea of having tentacles on the flag. As the work progressed, the illuminati was created in the form of a triangle with glow stones to highlight the power and the “negative stigma” associated with it. Tim worked on the illuminati with reference to the eye in the centre and in his opinion this was the best way to represent how a few elite members of ZLO had power and control which would be seen on either side of the flag (Sequence 3). Tracy walked out of the interior of the booth a few times to have a look at the tentacles while building the tentacles at the back wall of the booth. She later revealed during her
interview that the tentacles were placed in the back wall so that they were visible to passers-by “as they investigate” what the booth represents. The two tentacles were created in different shapes to show the fluid movement of control within ZLO. Glow stones were then placed behind the tentacles to create lighting effects for expressing the idea that there was light behind the darkness or as Tracy explained “room for improvement or uprising” (Sequence 4). During the session, Tracy initiated a discussion on the floor as a “shifting transition to an alternate world”. She changed the clear glass floors to white stained glass floors (Sequence 5). She also mentioned how they should have “light but not too much of it” so that it would create an eerie effect – where the villagers would feel as if they had lost control. Team Red agreed that a floating effect would best represent the feeling of losing control. In Sequence 6, Tracy started building a tiled pathway from the entrance while Tim & Maya joined in to create a second layer of glass floor below the pathway. The second layer of hollow glass blocks were filled with water and the notion of “holy water” (revealed later during the interview) emerged to show how in a dictatorship there are undertones of things being perfect and righteous in the world. The session ended with Tracy creating a pedestal near the back wall to put a chest that would contain some narratives of their world. She along with the others created a teleport station to ZLO on the left hand side of the booth.

For each of the creations or modifications during this session, the students looked at the data/creations (e.g., tentacles on diagonally opposite quadrants, eye, glass floor of the world) that they had built earlier or creations that already existed (such as the floor which could be interpreted as geography). Based on these creations they engaged in critical thinking towards illustrating the theme of dictatorship through a three dimensional format. As they worked on the tentacles or floors, they came up with different connections that helped create representations in the interior of the booth. In other words, the initial data helped visualize the information that urged them to proceed beyond the narrative and test the situation by adding on more data to make sense of it. Hence Team Red exemplified how they engaged in critical thinking by perceiving the problem and then proceeding to find a solution collectively through their visualization of the aesthetics of the game from a data frame perspective.

It was obvious that the creations (tentacles, illuminati, eye, floor) with strong aesthetic capacity (as determined through their discussions and interviews) served as emotional anchors for learning, enriching the relational meanings and providing meaningful learning experiences for Team Red as suggested by Kim & Kim (2010). The facial recordings and field observations during the research also revealed that the students were immersed in their work. Using Lazzaro’s (2004) notion of player experience we have characterized the emotion as hard fun. Hard fun creates emotion by structuring experience towards the pursuit of a goal while playing games (Lazzaro, 2004). In this specific case the challenge engaged the students at interpreting or re-interpreting the representation and interacting with the geography of the game towards establishing the theme of dictatorship. The recordings revealed how the students appreciated each other’s work and provided feedback on their individual progress to keep the team informed of the progress. The sense of accomplishment was visible at the end because all three members congratulated each other by saying “Good job”. The game offered a compelling challenge and the students had to strategize in order to illustrate their understanding of the type of government and economic system they wanted for their world. Thus by using hard fun as a resource for their learning the students were able to critically think and problem solve, which in turn, generated a sense of accomplishment.

Conclusion

In this paper, we demonstrated how interactions with and interpretations of aesthetic elements
(geography and representation) of Minecraft help develop critical and creative thinking skills in learners. We discussed how students in an arts immersion school had visualized the aesthetics in terms of the content or the theme of dictatorship and then recreated the geography and representation using their emotions to exemplify the context and the objects within a digital game-based learning environment. In the process we described how the students identified and evaluated the problem of representing dictatorship contextually within Minecraft and then, collectively assessed the options to find a solution through metaphorical representations that elaborated upon the type of government and economic system of the world. The research is being continued with various other groups and different projects within the Grade 8-9 Social studies curriculum and we hope to generate queries on other aspects of digital game-based learning, including learning of content, student participation, and group dynamics with various levels of Minecraft players.

Reference


27.

Culture-narration games

a definition and pilot study

Paul Gestwicki (Ball State University), Kaley Rittichier (Ball State University), & Austin DeArmond (Ball State University)

Abstract

We are inspired by the educational potential of the board game *Tales of the Arabian Nights*, a popular game based on the eponymous folk tale. Considering this game and others like it, we identify the characteristics that define a genre of *culture-narration games*, which we consider to have untapped potential for educational and transformative games. We describe a design experiment through which a multidisciplinary team followed an iterative and incremental process, in collaboration with a community partner, to investigate the potential of this genre. The result is a game that uses a theme of monsters from around the world to teach cultural empathy. This pilot project reveals both the promise and several complications with the genre, which lead to recommendations for future work.

Introduction

*Tales of the Arabian Nights* (Goldberg, 2009) is a tabletop board game based on the eponymous folk tale. It was originally published in 1985 (Goldberg, 1985), and it was re-released with many revisions in 2009. It is popular among board game hobbyists: on Board Game Geek, it has a rank of 239 (thematic rank 75), and Shut Up & Sit Down rank it as the ninth best game of all time (Shut Up & Sit Down, 2015). In this game, players control a character within a mythical Arabian setting, exploring the known world to accumulate Story and Destiny points. The winner is the player who is able to meet their Story and Destiny point goal while having a successful encounter in Baghdad—the City of Peace.

An intriguing property of *Tales of the Arabian Nights* (hereafter, *TotAN*) is that it eschews the conventional wisdom for game design, that player immersion is dependent upon agency. In *TotAN*, players choose a destination without any foreknowledge about what might be encountered there. They are told the name of the encounter—such as angry merchant, powerful prince, or elephant’s graveyard—and based only on this information, they must choose a reaction from a set of options; for example, table A permits a choice of grovel, aid, rob, avoid, converse, attack, court, abduct, or honor. Another player then reads a corresponding entry from the *Book of Tales*—a 300-page tome containing ~2600 numbered entries. Most entries provide introductory text followed by paragraphs tagged with skills that the active player may choose to use, but the choice is made without any knowledge of potential consequences. The reader then narrates the conclusion of the encounter and informs the player of their rewards, which might include gaining Story or Destiny points, learning new skills, finding treasures, or gaining status cards that modify players’ options in future encounters. *TotAN*
then is hardly a game of skill, where the player with the best tactics wins the game: viewed through this conventional lens, the game is arbitrary. However, from its design emerges a fanciful gameplay experience. Although it is a competitive board game, it is not played to win, but rather for the enjoyment of emerging narrative, similar to tabletop roleplaying games (Grouling Cover, 2010) or story games (Duncan et al., 2015).

This property of TotAN reflects several characteristics of its source material—a book that “changed the world on a scale unrivalled by any other literary text” (Makdisi and Nussbaum, 2008, p.1). Like the original stories, TotAN is a collection of shorter stories that are sometimes linked together and sometimes not. The characters in the folk tales are often victims of fate with very little agency over their own encounters. The games rules follow cultural norms expressed in the folk tales: you cannot win while sex-changed or on pilgrimage, and both marriage and children are great blessings—unless you have an ugly baby, which is shameful. Baghdad is the most important city in the world, where your adventure starts and ends. Furthermore, many stories in TotAN come directly from the tales, such as the Sindbad’s escape from the valley of diamonds or Aladdin’s entrapment in a magic cave.

Playing TotAN inspired members of our team to read translations of the original tales, particularly the youth-friendly translation by (Philip, 1994), which revealed to us the cleverness of the design and its elegant dovetailing with the source material. Indeed, although the game was not explicitly designed as a learning game, we find it exhibits many of the learning game design principles established by Klopfer et al. (2009). Furthermore, in reading the texts, we recognized that we had already learned elements of the stories and the culture through playing the game, although not always consciously or explicitly. This inspired the following analysis, in which we tease apart the various elements of TotAN, considering them from both game design and learning design points of view, and then share the results of a pilot project to create a technology-enhanced game within the same genre.

Defining the Genre

We propose that TotAN is one of very few published games comprising a genre of culture-narration games. This follows the definition for “genre” given by Arsenault (2009)—that it is “the codified usage of particular mechanics and game design patterns to express a range of intended play-experiences.” We define culture-narration games, then, as having the following characteristics:

1. Take place in a believable, consistent setting. Although the world of TotAN may be unfamiliar to the player, everything in it is representative of the world described in the original folk tale. This includes the contradictions that add depth and nuance, such as the inconsistent treatment of outsiders that emerged from the complex historical roots of the folk tales themselves (Matar, 2008).

2. Use narrative as a primary feedback mechanism. In TotAN the player’s reaction and skill choice yields two forms of feedback: the narrative description followed by the changes to the game state. The narrative is primary—temporally, visually, and aesthetically.

3. Have measurable goals. There is a winning condition as part of the social contract of play, following colloquially-accepted standards for board games. The “game” is not simply constrained cooperative storytelling or a role-playing experience without formal end conditions.

4. Incorporate endogenously-meaningful ambiguous decisions. Following Burgun (2012), the
decision that one makes in the game are meaningful even though they are made without complete knowledge of the game state. For example, a player makes the choice of reaction in TotAN in hopes that it leads toward the skills that they have, such as choosing “Fight” while in possession of the “Weapon Use” skill, even though one does not know whether or not this skill will have relevance in the resulting entry from the Book of Tales.

5. Reward players for decisions that reflects cultural understanding. The knowledge that a player uses in the game is not just knowledge of in-game systems. For example, it is not by memorizing the Book of Tales that leads a player to predict that fighting a Powerful Ifrit without the Weapon Use skill will not end well. Rather, this prediction draws upon a cultural understanding of power, spirits, violence, and much more. The game rewards player decisions without resorting to binary “right” and “wrong” (“moral/immoral”, “light side/dark side”, “paragon/renegade”) choices. There remain unexpected twists: perhaps fighting the Powerful Ifrit without combat skills makes him respect you and grant a boon. While the world remains consistent, it also has the potential for surprising results.

Two notable formal elements from TotAN are intentionally excluded from the genre definition above. First among these is the oration between players of each others’ stories. While we agree that this is a critical element of TotAN—and that it dovetails performatively with Scheherazade’s performances in the source material—it is not clear that this is characteristic to the genre. Anecdotal evidence shows that players with low reading skills can ruin the play experience for other players, while those players could have read their own stories, aloud or not. Similarly, TotAN permits a single-player experience which, while having a different aesthetic, still seems to produce the same general outcomes we described above.

The other formal element excluded from the genre definition is the use of an explicit map. The map is an important tangible aspect of TotAN, in particular with its representation of Baghdad as the largest, most important city in the world. However, we also note that virtual spaces can be represented without such an explicit map, such as in text adventures, the MUD family of games, or choose-your-own-adventure books, both of which use discrete spaces without giving them visual manifestation.

To establish these as characteristics of a genre and not just one game, we consider another game that possesses them: Agents of SMERSH (Maxwell, 2012). SMERSH is a cooperative game set in the Cold War, with players as covert agents trying to stop the enigmatic Dr. Lobo—a mad scientist bent on world domination. Players move across the world collecting resources and battling henchmen. While the stories are inspired by spy movies and novels, the game mechanics are clearly derived from TotAN: flip a card to read an encounter title, choose a reaction from a table, hear an introduction, and then get different results based on skills. Although SMERSH uses dice for encounter resolution, the feedback is still primarily narrative, as illustrated with sample encounters in Figure 1.

For contrast, consider Above and Below (Laukat, 2015), a worker-management game of city-building. Underground exploration includes player narration from an encounter book, which at first glance may appear to categorize it as a culture-narration game. However, in Above and Below, reaction choices are thin wrappers around probabilistic risk: an option is essentially a gamble on being able to roll better results on the dice, with higher numbers always having better results. The feedback is primarily in terms of formal rewards, with few encounters providing any narrative feedback, as illustrated in the representative encounter of Figure 1. Hence, although Above and Below includes an encounter book that players read to each other, it does not satisfy the characteristics of the culture-narration game genre.
Cultural Empathy

TotAN uses cultural understanding, not only on a small scale as a way to reward players, but also as a learning outcome of the game. In order for the game to reward players for their cultural understanding, cultures must be presented such that they can be understood by the player. In other words, the game needs to foster a sense of cultural empathy, defining “empathy” as the “state of mind in which someone shares the feelings or outlook of another, sometimes prompted by imaginative exercises such as ‘stepping into someone’s shoes’” (Honderich, 2005, p.242). Therefore, cultural empathy, loosely formed, is sharing the feelings or outlooks of individuals from different cultures.

Cultural empathy is distinct from cultural literacy, which is the capability an individual has to participate in another culture based on their acquired information of the culture (Hirsch, 1983, p. 165). Being culturally literate means having the ability to participate in another culture that you are “dropped into,” similar to how being literate is having the ability to understand or write a given work of text. TotAN focuses on a certain level of literacy of the given culture. Players are rewarded for their cultural understanding and their ability to “perform” in the given culture because of the information they have—a form of what Travis (2011) calls practomime. This is demonstrated in the example above, understanding the cultural views of marriage and sex-change have an important role in the game. However, cultural empathy makes understanding the main point, not performance. TotAN relies on an understanding of cultural values as opposed to just focusing on some of their values consequential norms. Therefore, though TotAN expects some sense of cultural literacy, it focuses more on cultural empathy. When a player walks away from the game they would not have gained the ability to participate in a Middle Eastern culture, although they will have gained some understanding of that culture. Hence, from a learning game design perspective, cultural empathy is a means to the end of cultural literacy. However, outside of the game, focusing on cultural literacy within a semi-fictional world is the means for cultivating cultural empathy.

Context and Theme

In order to explore the potentials within this genre, we formed a team to conduct a design experiment and pilot study. The team adopted a constructionist perspective (Papert & Harel, 2001), that our understanding of the genre would be improved by engaging with design, development, and evaluation—building prototypes as a way to understand them. We formed a partnership with Connection Corner, a non-lending branch of Muncie Public Library (Muncie, Indiana, USA) that provides community, training, and technology services in a low socioeconomic area of our city. Many youth patrons of the library are 4rd-6th grade “latchkey kids” who see the library as an after-school destination to visit with friends, participate in programs, and access technology.

Conversations with program coordinators about culture-narration games revealed that despite other differences, the youth patrons shared a fascination with monsters, horror, and the macabre. This answer in some ways seemed unsatisfactory: horror and empathy—cultural or otherwise—do not seem to be a good match. Indeed, the enjoyment of horror can appear to be no more than the enjoyment of antithetical dehumanization of subjects. However, the love of horror and the monstrous can be seen throughout our culture, in all forms of media. Indeed, monsters have been a hook for narratives throughout history.
Cohen (1996) draws attention to “reading cultures through the monsters they engender” (p. 3). He notes that the conclusions we come to about cultures, from monsters or otherwise, will be a combination of many fragments rather than a “smooth epistemological whole.” A monster is brought about at a particular time and represents not only the fears prevalent in the culture but also the values, that lead to that fear (p. 4-12). Pinning that down is difficult. The monsters work more as a snapshot of the culture at a particular moment than a definition. This point is especially important for us to note when creating a game whose goal is to encourage children’s efforts to see something from others’ perspectives. However, Cohen’s theory also helps us understand children’s fascination with monsters, that “the same creatures who terrify and interdict can evoke potent escapist fantasies” (p. 16).

Our team therefore chose monsters as a key dramatic element for our design experiments. They were not only enticing to our target audience—first observed by our community partner and later proven through play testing—but Cohen’s theory also suggests that they provide an affordance for developing empathy.
Monsters represent various cultures’ sameness, in base forms of fear, yet difference, in the ways that fear becomes specific and embodied. By engendering an understanding of both difference and sameness between cultures, they encourage individuals to try to see something from someone else’s viewpoint.

Figure 2. Screenshots from iteration 1 (left) an 2 (right).

Figure 3. Paper prototypes from iteration 3.

Design Experiment

Our team comprised ten undergraduate students and one faculty mentor. The students’ majors included Computer Science, English (Creative Writing), Philosophy, Telecommunications (Audio Production), and Art (Animation), and each earned three credit-hours during a fifteen-week semester, working together in an academic studio (Gestwicki & McNely, 2016) for two hours each Monday, Wednesday, and Friday. The team collectively agreed upon three primary goals for the design experiment in the cultural-narration genre: to use narrative as the primary form of player feedback; to teach cultural empathy; and to use technology to address problems of analog implementations.

The team proceeded with an incremental and iterative approach to game design and development. The team used a design log to record design decisions (Cook, 2011), and each iteration produced an executable release in accordance with best practices of agile software development (Cockburn, 2006); figures 2 and 4 demonstrate artifacts from the design and development process. Each iteration was tested at Connection Corner, providing valuable feedback to the team. In addition to paper prototypes, the team developed software-based prototypes using JavaFX, PlayN, and Polymer, all of which allow for HTML5 Web deployment. Game images and stories were inspired by the team’s research on monsters.
from world cultures, which included both research sources (such as Cohen (1996)) and children’s books (especially Steer (2008) and Stowell (2013)). The team also consulted with local university experts on games, monsters, world cultures, and literacy. Each iteration concluded with a retrospective meeting, which provided an opportunity for the team’s reflective improvement (Kerth, 2001; Schon, 1984).

The title and theme of our game changed between iterations as we came to a better understanding of the interplay between genre, rules, and our players. The final version—*Traveler’s Notebook: Monster Tales*—positioned two players as rival authors seeking inspiration from monsters around the world. The players travel across Africa, Asia, Europe, Oceania, and North and South America to encounter monsters from local folklore. Encounters are patterned after TotAN as illustrated in Figure 1, and the game exhibits the five characteristics identified for cultural-narration games.

![Figure 4. Screenshots from iteration 3.](image)

While the visual design and overall rules structure remained stable throughout the iterations of our experiment, the encounter stories themselves changed dramatically. Our target audience required that both stories and gameplay had to be much shorter than in other games that we analyzed, our final version having a 175-character limit. Connection Corner is a high-distraction environment, where our game competes for attention against both formal and informal activities. The game takes approximately fifteen minutes to complete, which we found to be a good balance of keeping players’ attention, making them curious to play again, and fitting within our limited means for producing content.

**Conclusions and Future Work**

Based on our design experiments, pilot study, and understanding of the literature, we believe there is a significant potential for culture-narration games as learning tools, particularly for cultural empathy. These games combine the educational value of learning from stories and learning from games, and they provide hooks for designers to emphasize various positive skills, including literacy, oratory, cultural empathy, history, mathematics, and strategic thinking. However, as with any educational intervention, these games do not come without complications. As others have pointed out (Slota et al., 2015, *e.g.*), the exact role of narrative in games and in learning is not well understood. Hence, we focus our conclusions on more immediate goals of continued fruitful experimentation with culture-narration games.

*TotAN’s* 19-page instruction booklet may not faze a games enthusiast, but many are intimidated by the large rulebook, heavy box, and number of components. Combined with the duration of play, complexity
of rules, and relatively high price, such games are inappropriate for use in almost all formal educational settings such as conventional schools. However, the combination of technology enhancement, grade level writing, and shorter duration circumvents these problems. Digital implementations all but eliminate distribution costs, and with clever game design, children can play the game in the relatively chaotic environment of an informal after-school program. With curriculum aides and improved scaffolding, such as post-game debriefing (Nicholson, 2012) or reflections (Hickey, 2013), we are certain the game could be easily integrated into school environments, particularly those with ready access to computers.

The role of text within the game is worthy of particular attention. The textual expression of narrative requires that players already possess literacy skills: players who struggle with vocabulary or decoding words are easily frustrated by such games. There is an opportunity here as well, to differentiate text based on player reading level or provide embedded reading aids; however, this also transforms the dominant outcome of the game from cultural empathy to reading literacy. Player oration—having players read aloud to each other—additionally requires oratory skills. We observed engagement being enhanced when the reader employs theatrical talents as well. The precise role of oratory skill, self-confidence, and the social contract of gameplay (the “magic circle”) is an area for future work.

Acknowledgements

The authors acknowledge the contributions of other team members who created Traveler’s Notebook: Nicholas Boyer, Ashley Cox, Jessica Lohse, Jack McGinnis, Lucas Miller, Joshua Schoen, Brennan Wade, and Caleb Woods. Jennifer Grouling and Joyce Huff also contributed to our design experiment. We are grateful for the cooperation of Muncie Public Library, especially from Rebecca Parker and Stuart Cotton. This work was internally supported by the College of Sciences and Humanities and the Computer Science Department at Ball State University.

References


Privacy, Pedagogy and Protocols

A Preliminary Report on a Cross-Border Alternate Reality Game to Teach Digital Citizenship

John Fallon (Fairfield Country Day School) & Paul Darvasi (Royal St. George’s College)

Abstract

*Blind Protocol* is an elaborate alternate reality game (ARG) that pits two schools against each other in mock cyber engagement. The month-long game’s key objective is to unmask the rival school’s identity and location using in-game tools and gradually acquired knowledge on issues surrounding online privacy and security. The game was co-designed by Paul Darvasi (Toronto, Canada) and John Fallon (Fairfield, CT), and its first iteration was played in January – February 2015. The teacher presenters will review student feedback and report on the virtues and pitfalls of addressing an evolving and hot-button topic as a sustained, embodied and narrative-driven game.

An Embodied Approach to Privacy, Security and Digital Citizenship

As the world rapidly digitizes, the issue of online privacy and security has become a widespread and fundamental concern. By virtue of participating in online life, an individual exposes their identity, reputation and finances to the unpredictable intentions of corporations, governments, criminals, activists, and even pranksters. State sponsored surveillance and cyber attacks, hacktivism, corporate data gathering and criminal schemes all exploit a world that is increasingly dependent on computer networks. The lack of physical immediacy in online interactions renders these potentially harmful entities nearly invisible to the uninformed user.

A recent study by Common Sense Media reports that teens spend an average of 9 hours a day consuming media, much of it online (Common Sense Media, 2015). Considering how much time youth spend online, it is critical that schools actively cultivate the skills and awareness for healthy and secure participation. Students should understand the issues and consequences involved with the decisions they make online. North American curricula sometimes addresses basic topics associated with online privacy and security, but this is complicated by the rapid and ongoing changes in the way that youth engage with media.

*Blind Protocol* is an alternate reality game designed to instruct on privacy and online security by means of an embodied and ludic narrative. Leveraging the benefits of game based learning (Gee, 2003; Dickey, 2005) the month-long cyber engagement simulation was enacted across national borders between two high school classes and ended with them trying to uncover each other’s identities. The natural attributes of an ARG fit well with the topic of online privacy and security. ARGs blur the lines between truth and
fiction, are geographically pervasive and asynchronous, rely on networks and emphasize code breaking, all features that coincide with the real world operations of online privacy and security. Also, the game’s narrative allows for a plot to generate awareness of the larger geopolitical and economic forces at play in a wired world. Ideally, the formal structure of the game would reinforce and support the content in a suitable and relevant way. This type of embodied learning allows students to experience the fragility of their privacy by giving up seemingly innocuous information that exposed them with surprising speed and accuracy – the same type of information that students freely give up daily with little thought or even awareness.

A Brief Overview of Alternate Reality Games

*Blind Protocol*’s closest gaming relative is the alternate reality game. Although *Blind Protocol* makes several diversions from the traditional ARG formula – sometimes out of innovation, sometimes to better align the game with pedagogic principles – its core gameplay would be familiar territory for any experienced alternate reality game player. However, alternate reality games are a niche community in the game world, and even gaming enthusiasts might not be familiar with some of its relatively arcane elements.

ARGs, in their modern form, were born in the 1990s with the growth of the World Wide Web, and they were more or less the creation of tech savvy, creative marketers who took advantage of the still mysterious, yet accessible, nature of the nascent Internet to create unique interest in the content they were representing.

ARGs utilize both digital and real world platforms to engage the player, leveraging elements such as social media, email, phony websites, hidden items, false documents and telephone calls (Szulborski, 2005). The game’s use of real world paraphernalia, actors and multiple channels of communication blur the lines between truth and fiction. A core convention of the genre is the denial that a game is being played at all, popularly referred to as the “This Is Not a Game” ethos. The creators, or “puppet masters”, do not explicitly acknowledge they are running a game, and many players enjoy the high level of immersion. It bears adding that players do not typically act or roleplay in an ARG, but tend to play as themselves.

Players progress by solving difficult puzzles, code breaking and overcoming complex challenges. This aspect of ARGs aligns with the notion of encryption as a central consideration in matters of online privacy and security. Game activities are carried out in a variety of physical spaces, extending beyond the precincts of the classroom and even the school. Players must often gather disparate components, information and resources to crack the codes, essentially searching for needles in virtual/physical haystacks. Much like a cyber analyst, an ARG player sifts through and analyzes volumes of data in order to discover a pattern or crucial piece of information. Typically, players tend to band together in online forums to pool their resources and solve these difficult puzzles. All of these activities involve a meaningful use of critical thinking, creativity, collaboration and resilience, cornerstones of 21st century learning.

Finally, ARG players are motivated to overcome these challenges to uncover a story. As players collect more information to solve the puzzles, they also acquire snapshots of a developing narrative. The story begins with the “rabbit hole” – or the initial event or strand of information that invites the players to
enter into the pervasive fiction of the game. This could be a phone number for a Sentient Machine Therapist on a movie poster for Steven Spielberg’s 2001 film **AI: Artificial Intelligence** (as it was for the influential ARG, *The Beast*), a news article that purports to be real but is woven with strange references to unbelievable events, or a Youtube video that appears to get “hacked” and a surprising message appears. Eventually these narrative fragments – diary entries, voicemails, emails, photos, and even direct contact with live “characters” – coalesce to form a complete story.

**Blind Protocol’s Game Structure**

*Blind Protocol* deviates from the traditional ARG structure in several ways. For one, it has been reformed to accommodate two competing teams. ARGs are typically collaborative experiences: a self-organized thinktank of enthusiasts working together to overcome the game’s challenges together. However, for a large portion of the game neither team was aware of the other’s existence and believed only their class was participating.

The game took place over four weeks and was the complete focus of the class for the duration of that month. It began with a rabbit hole and its mirrored execution is indicative of how the game was run in tandem. On the same day, Darvasi and Fallon engaged their respective classes in a discussion on cybersecurity. A doctored video appeared to be paused as the teachers each left their respective classrooms to answer a fake call. Once the teachers left their rooms (and they did not return), the “paused” video resumed, apparently hacked by HORUS, the central entity/antagonist. After introducing itself, HORUS proceeded to conscript the students and launch the game. Narratively, HORUS is secretly a rogue artificial intelligence seeking to understand human computer interactions, but players only discover this at the game’s conclusion. Like many traditional ARG rabbit holes, the video provides the essential information to begin the game: basic narrative, context of the puzzle progression, and the first set of challenges.

*Blind Protocol* is organized into four distinct stages of progression, or “ranks”. As the students progress through the challenges issued by HORUS, they “ascend” and are given more privileges and content within the game. The challenges are in line with readings and artifact production related to the topic of online privacy and security. HORUS’s identity is a mystery and a central narrative hook throughout the game. Darvasi and Fallon assumed identities as unwilling agents of HORUS, who admitted knowledge of “The Program” but made it clear that they were merely carrying out HORUS’s cryptic orders. This allowed the teachers to easily stay “in character” while facilitating the game’s progress in and out of class.

**Phase 1: Acolyte**

The emphasis in the Acolyte phase was on collaboration, critical thinking and problem solving. This phase began as soon as the rabbit hole video ended. The students were pressed into what HORUS calls its “Program” and worked to assemble four pieces of data that had been hidden around the campus. To find these, students self-organized and worked both independently and collaboratively to synthesize the information and problem solve. The game provided directives, boundaries, and limits but also urged students to progress on their own, with the teacher’s role simply being monitor and minder.
Phase 2: Analyst

The Analyst phase requires the students to hone their research skills. Contained within the final data cache was a guide which delineated the requirements needed to ascend to the next rank. Their primary objective was to compile a database of articles, links, videos, podcasts, and more on a wide variety of cybersecurity related topics. They were given a lengthy list of specific “targets” which guided their research around major people, organizations, current events, and concepts in the cybersecurity world. The scope could be as specific as finding five published articles on Edward Snowden and as open-ended as collecting three news broadcasts on cybercrime.

Phase 3: Architech

After the database was created, this phase required students to produce artifacts based on their inchoate knowledge of privacy and cybersecurity issues. This was an opportunity to develop a deeper knowledge on specific topics that interested them. The guide acquired by the students in this phase was a rubric with dozens of different assignments or “Artifacts” they could create for HORUS. Students could explore the topic of their choice at their own pace. To further allow students an independent work structure, Darvasi and Fallon implemented a pass/fail grading system that required students to show mastery of the media form and content they were producing.

![Video Essay](image)

Figure 1: One of many “Artifact” options students could choose to create

Students could develop an Artifact (research paper, video essay, presentation, infographic, etc) on a self-selected topic and once they felt confident their artifact met all requirements they submitted it for approval. Artifacts could be submitted multiple times for acceptance without penalty. This was partially inspired by the traditional ludic structure of video games: you are encouraged to attempt success multiple times, adjusting your progress and using failure to learn. Once the Artifact was accepted by HORUS,
students were rewarded with in-game currency of “bitcoins” which corresponded with another document they were given at the beginning of this phase: The Catalogue.

The Catalogue was modelled after the real life NSA ANT Catalog which was a clandestine shopping list of intrusion and espionage gadgets and programs for NSA agents. Similarly, this Catalogue contained fictional “cyber-weapons” to engage with their as of yet undisclosed adversaries and could be purchased with their earned bitcoins. However, their targets were revealed not to be their classmates as they expected, but a secret group of participants who could be anywhere in the world.

Phase 4: Operative

As Operatives, the students were now pitched in mock cyber engagement based on strategic procurement of information. The objective was simple: discover the identity of the other team before they do the same to you. The Catalogue featured a series of protocols to “hack” an enemy player and “force” them to follow a simple command. All communication was necessarily transmitted to and from the teachers to limit direct interaction between students. Each protocol had a specific deadline and a severe penalty was levied if it was not carried out.

The protocols yielded breadcrumbs of information such as a team mascot or a photograph outside a school window, but when combined with the data other students collected, they could quickly form a surprisingly accurate mosaic of identity. In fact, both teams quickly discovered the identity of their opponent with less than three pieces of obtained information. This was the climax of the game and the purest form of the unit’s pedagogical embodied learning goals: they had learned in the abstract about the fragility and importance of privacy, but now it was put to the test through the game’s safely controlled competition and mechanics.

The unit concluded with confirmation that they had successfully unmasked their rivals. An informal discussion followed prompting reflection on what they had learned about the topic and themselves through the game. Students were also administered surveys to comment on their experience. The results of the survey are summarized in the section that follows.

Results, Reflection, and Iteration

Informal teacher observations and student surveys indicate that participants were engaged and the learning outcomes were met. Darvasi and Fallon administered an informal, anonymous 13-question survey to all 36 participants at the game’s conclusion to gather data on engagement, learning, and design feedback. 75% agreed that the game was a “unique way to learn” and would “try it again”. On the other end of the spectrum, 5.5% were “indifferent” to the game experience. When asked to assess how much they learned compared to a “traditional unit” in the class, 14% answered “less”, 36% answered “the same”, and 50% answered “more” or “much more”. Students were also asked to indicate if they felt they had to use a variety of general competencies. 86% reported having to apply critical thinking skills while playing the game, 83% said they used collaboration, 75% believed they applied creativity related skills, while design, digital citizenship, and resilience were reported by 36%, 31%, and 22% of students, respectively.

Individual student feedback illustrated some common trends. Many students emphasized the freedom
they were given during the game. This was attributed to both the freedom to
guide their own work in the Architech phase and the physical freedom they were
allowed around campus (or beyond) while they were solving puzzles. Puzzle
solving was also a clear highlight, as many students reported feeling
challenged, excited, and intrigued. Nearly all reported wanting more of those
experiences built in, and several commented that their presence engaged them in
all elements of the instruction. However, some students reported feeling left out
and subsequent iterations intend to foster greater inclusion while puzzle
solving.

Surprisingly, many also reported that producing artifacts – often labelled as the “work”
by the students – was not necessarily a turn-off compared to the more ludic
puzzle solving and even seemed to legitimize the unit in some students’ minds.
This was surprising feedback; if it turns out to be a consistent result
across different groups, it may complicate the commonly held “chocolate covered
broccoli” concept that traditional work should not be included in game based
learning units because students will reject it.

However, students also reported several issues with the game. A small, but not
insignificant, number simply did not feel attracted to the game-based model.
Given the appeal of choice in the data and
the teachers’ experience, a new design would consider offering a more
traditional independent study
alternative for students who choose not to play. In addition, many reported feeling
overwhelmed with the amount of new data they had to assimilate between each
phase of the game. A major planned revision
will be to create simplified guides to every phase, including videos. Students also indicated that an easily
accessible wiki or glossary of game terms would significantly increase their comfort and comprehension
as they progress.

A significant element that will have to be reworked is the research and database
creation in Phase 2. Students reported that the work balance was unequal: some
motivated students shouldered
the majority of the database creation, while others “barely contributed”, as one
student put it in the survey.
However, an initial bulk collection of relevant sources within a large topic might not be a good fit with
the workflow of 21st century students. The database was mostly unused and ignored during artifact
production. Both groups of students did ad-hoc research once they began working on a particular
artifact by finding and utilizing sources that they specifically needed and then moved on.
This phase will be
completely overhauled, as it did not develop the intended foundational knowledge base for the students
to build their subsequent work upon.

Student feedback was essential for gauging the game’s success. The responses confirmed the assumption
that engagement would generally be high when delivering the unit as an ARG. Darvasi and Fallon are
certain there is a foundation to develop and assess this embodied learning method for classroom
instruction. However, the complex, layered structure of ARGs can require a great deal of sensitivity to
design and player experience, which creates a difficult hurdle. The game’s immersion is engaging, but
can intimidate even enthusiastic players let alone students who may be experiencing the genre for the
first time. In addition, the designers can only run the game once a year, and finding the ideal balance
and more accurately assessing learning outcomes will require ongoing iterations.

The enthusiasm and learning informally observed by the teacher-designers during play confirm the value
of this type of approach, and points to the importance to continue improving the design and supporting
research to more clearly identify tangible learning benefits and outcomes.
References


Who Benefited Most from Game-Based Learning in Special Education Settings?

Jungmin Kwon (Seoul National University of Education)

Abstract

In this study, we compared special education students based on their functioning levels and gender in order to investigate who benefited the most from game-based learning. The results indicated that the low-functioning group improved significantly in both speed and accuracy when compared to the no-game group. Further, the boys’ group increased considerably in speed only while the girls’ group did not show a significant difference between the game group and the control group. The implications of this study are discussed in greater detail below.

Need for Study Games are an effective way to educate students with disabilities. Evidence-based research has proven that games have immediate learning effects on students with developmental disabilities. For example in Kwon & Lee’s (2016) study, game play of simple vocational tasks in a simulated environment positively affected actual hands-on performance of the same task in terms of speed and accuracy. Another study we conducted with children with disabilities showed that playing a self-hygiene game immediately increased self-hygiene behavior, in this case, washing hands (Kim & Kwon, 2014). In our study of mobile math games, we found that playing these types of games increased math achievement and motivation (Shin & Kwon, 2014).

We believe the aforementioned studies were successful because the disciplines of special education have a great deal in common with digital games. Many strategies used in games originate from behavioral and cognitive psychology, which is heavily rooted in the teaching and learning strategies used in special education. For example, one of the prominent aspects of games is the use of rewards for successful completion of a task. Games use points, items, coins, and similar rewards to motivate the person to continue playing. Similarly, the use of behaviorist strategies has shown strong effects for students with various disabilities in special education. Some examples of reward systems include Applied Behavior Analysis (ABA), token economy, and time-out procedures (Anderson, Marchant, & Somarriba, 2010).

Games also use repetition as one of their main methods of play. The player can try challenging tasks through repetition, explore new ways to solve a problem, and even repeat the task after succeeding just to achieve mastery. Repetition is known to be the strongest factor for retention (Hintzman, 1976), and one of the most important methods for increasing learning amongst people with developmental disabilities;
especially those who have difficulty with long/short term memory (Turnbull et al., 2012). Children with developmental disabilities can achieve mastery of tasks through repetition, and can reduce the short-term cognitive load by automating the skills (Sweller, 2003).

Games often tell a story at the beginning to immerse the player into the virtual world. Then, new stories are created by the player as the game continues. These narratives can reduce the cognitive load thereby freeing up more space for learning (Park & Jin, 2006). In special education, it has been demonstrated repeatedly that providing context motivates learners since context conveys meaning to the students (e.g., Bottge, 1999; Goldman & Hasselbring, 1997). Therefore, when students find the problem meaningful, their motivation to learn and ability to solve complex problems greatly increases (Bottge, 1999).

The aforementioned research was part of an original study that was recently published (Kwon & Lee, 2016). In the original research, we inquired whether playing the target game affected the performance of the target task. The results indicated that playing Game A only affected Task A but not Task B and vice versa. In this study, we took a deeper look into the effects of games on students with disabilities. Primarily, we wanted to know which ability groups and genders benefitted the most from the game-based learning.

Understanding the impact of games on specific groups is important for several reasons. First, at the current stage, we do not yet know for whom this new mode of learning is most suitable. Understanding who benefits most from game play can assist teachers in preparing to meet the needs of their individual students since all students learn differently. In the case of special education, the variation of each individual’s functioning level varies widely, which requires the teacher to individualize education for each student. By understanding who can benefit most from games, teachers can more efficiently use their resources. Second, from the developer’s point of view, it is critical that game designers understand the various intellectual levels of the audience. An effective and entertaining game has good difficulty control and progression into the higher stages of game play. This is important considering that a group of students with developmental disabilities can vary widely in their range of cognitive functioning levels as well as their behavioral characteristics. Although universal design principles should always be applied in game design, sometimes it may not be possible to include audiences from all levels. The knowledge of who benefits most from learning games could help the designer optimize game objectives and difficulty.

Method

Participants

A total of 45 students with developmental disabilities participated in the original study. The participants were randomly assigned to one of the three groups: Control group, Game 1 group, and Game 2 group. The Game 1 group had 15 students while the other two groups had 16 students each. The average age was 16.69(SD=.87) for the Control group, 16.67(SD=.62) for the Game 1 group, and 16.67(SD=1.11) for the Game 2 group. Based on teacher input, students were categorized as high, moderate, or low-functioning before randomization and were assigned to one of the three groups within the ability groups. As a result, for the Control Group (n=16), 50% of students were high-functioning (n=8), 31% were moderate-functioning (n=5), and 18% were low-functioning (n=3). For the Game 1 group, 47% were high-functioning (n=7), 33% were moderate-functioning (n=5), and 20% were low-functioning (n=3).
For the Game 2 group, 50% were high-functioning (n=8), 31% were moderate functioning (n=5), and 18% were low-functioning (n=3). In general, high-functioning means the student can function with more independence while low-functioning would mean the student functions with less independence in school and daily life.

Research Design

A crossover design with control group design was used in the study. This research design was utilized because, in the original study, we were interested in the treatment effects of games on the performance of tasks. All three groups took three rounds of hands-on task tests. After the first round of testing, Group 1 played Game A while Group 2 played Game B. Then, after taking the second round of tests, Group 1 played Game B and Group 2 played Game A. Finally, the participants took a third round of testing. The Control group took the tests but did not play the games in order to control the effect of repetitive testing for later analysis.

Settings & Games

One classroom was set up as a testing station while another classroom was used as a game station. Each student was called individually to the room to participate in the study. Students went back and forth between the rooms to take the test three times, and play the game in between the tests. The game used in the study was Adventures on Coolong Island, which was developed by the researcher as a serious job-training game for students with developmental disabilities. It transformed a basic job-skills textbook into a simulation game. Out of the eight mini-games, two games were selected for study; the Apple Packaging Game (Game A) and the Hydroponics Game (Game B). Testing consisted of actual hands-on task performance. Therefore, all students took two tests in each test wave: the Apple Packaging performance test and the Hydroponics performance test. In the original study, we wanted to know whether the Apple Packaging Game affected the actual performance of apple packaging, or if the Hydroponics Game affected the actual performance of hydroponics.

Data Collection

Data were collected through observation at the testing station. Time to complete the test was measured for speed data, and the number of errors was counted for accuracy. To ensure reliability, all testing procedures were recorded so they could be analyzed later by a second researcher. In the original study, the reliability was reported to be 97.62% for accuracy and 96.43% for speed.

Data Analysis

For the purposes of this study, we collapsed some data into the following categories:

1. Test waves: Although the data was collected at three time points, for the purpose of this study, only the pre (1st wave of testing) and post (3rd wave of testing) test results were used for analysis.
2. Experimental groups: For statistical purposes, we collapsed the two lower groups (moderate and low functioning) resulting in two groups (high and low) in our analysis. Two game groups were collapsed as well to compare the effect of gaming versus no gaming. ANOVA was used for all analysis.

Further, in the original study, the effects of two games on two tasks were studied. However, the results from the original study indicated that Game A, the easier of the two, showed ceiling effects which compromised the results. Therefore, in this analysis, we excluded Game A and only included Game B.

Results

High-Functioning versus Low-Functioning

The means, standard deviations, and gain scores of pre and post-tests for speed and accuracy are described in detail (see Table 1). Within each experimental condition, we compared the effects of gaming on high and low-functioning groups in comparison to the Control Group of a similar functioning level. One-way ANOVA results indicate that, for the high group, significant differences were not found for speed ($F(1, 20)=1.153, p>.05$) or accuracy ($F(1, 20)=4.356, p>.05$). However, within the low group, significant differences existed for both speed ($F(1, 23) = 16.041, p=.001$) and accuracy ($F(1, 23)=4.773, p=.039$).

<table>
<thead>
<tr>
<th></th>
<th>High (N=22)</th>
<th></th>
<th>Low (N=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>(SD)</td>
<td>M</td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.070</td>
<td>(0.011)</td>
<td>0.072</td>
</tr>
<tr>
<td>Game</td>
<td>0.069</td>
<td>(0.034)</td>
<td>0.084</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>13.462</td>
<td>(0.576)</td>
<td>13.327</td>
</tr>
<tr>
<td>Game</td>
<td>13.210</td>
<td>(0.860)</td>
<td>13.354</td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.035</td>
<td>(0.030)</td>
<td>0.033</td>
</tr>
<tr>
<td>Game</td>
<td>0.037</td>
<td>(0.026)</td>
<td>0.047</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>8.077</td>
<td>(6.688)</td>
<td>8.077</td>
</tr>
<tr>
<td>Game</td>
<td>8.481</td>
<td>(5.962)</td>
<td>10.500</td>
</tr>
</tbody>
</table>

* $p<.05$

Table 1. Pre and post results comparing high-functioning and low-functioning students.

Boys versus Girls

The means, standard deviations, and gain scores of pre and post-tests for speed and accuracy are
described below (see Table 2). Within each experimental condition, we compared the effects of game playing on the boy and girl groups in comparison to the Control Group of the same gender. The one-way ANOVA results indicate that, for the boys group, significant differences were found for speed (F(1, 35)=5.703, p<.05) but not for accuracy (F(1, 35)=3.899, p>.05). For the girls group, the Kruskal-Wallis test (a non-parametric equivalent to one-way ANOVA) results show no significant differences existed for both speed (χ²(1)=1.636, p>.05) or accuracy (χ²(1)=1.481, p>.05).

<table>
<thead>
<tr>
<th>Boys (N=37)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Gain</td>
<td></td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>M</td>
<td>(SD)</td>
<td>M</td>
<td>(SD)</td>
</tr>
<tr>
<td>Control</td>
<td>0.053</td>
<td>(0.029)</td>
<td>0.048</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Game</td>
<td>0.047</td>
<td>(0.032)</td>
<td>0.055</td>
<td>(0.037)</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>10.769</td>
<td>(5.341)</td>
<td>10.671</td>
<td>(5.286)</td>
</tr>
<tr>
<td>Game</td>
<td>10.726</td>
<td>(4.881)</td>
<td>12.471</td>
<td>(2.796)</td>
</tr>
</tbody>
</table>

| Girls (N=10)                             |   |   |   |   |
|                                        | Pre | Post | Gain |
| **Speed**                               | M  | (SD) | M  | (SD) |
| Control                                | 0.051 | (0.029) | 0.061 | (0.046) | +0.010 |
| Game                                   | 0.075 | (0.029) | 0.093 | (0.024) | +0.017 |
| **Accuracy**                            |   |   |   |   |
| Control                                | 10.769 | (6.044) | 10.769 | (6.044) | 0.000 |
| Game                                   | 10.949 | (5.381) | 12.115 | (3.845) | +1.167 |

* p<.05

Table 2. Pre and post results comparing boys and girls.

Discussion

From the results, it is evident that participants in the low-functioning group benefited from the games while the high-functioning group did not show a significant difference from the Control Group. The low group increased in both speed and accuracy for the given task. Lower-functioning students typically have a shorter attention span, difficulty remembering information, and a lack of motivation to learn. These low-functioning students will benefit from the immediate feedback, narrative, and motivating qualities of game play while high-functioning students may learn well in both traditional and game media. Therefore, using games for teaching and learning activities will be more effective for students with lower-abilities in special education. This data, in accordance with other educational technology studies, demonstrates that a technology-enhanced curriculum is effective for assisting low-achieving students become high-achieving (Bottge et al, 2001; Bottge et al, 2007). Therefore, one can conclude that digital media is an effective tool to help students visualize, simulate, and focus on problem solving.

When comparing gender, the results indicate that boys gained task completion speed but not accuracy when compared to those who did not play the game. On the other hand, girls did not show significant gains in either speed or accuracy when compared with the no-game group. However, we must take caution when interpreting the girls’ results because the data was too small (n=10) to be reliable. When investigating the gender effect, recent game studies showed no significant differences in achievement
between boys and girls (e.g., Annetta et al, 2009; Ke & Brabowski, 2008; Papastergiou, 2009); however, those studies did not examine speed to completion. In our observation, after playing the game, participants perceived the test as a game situation and tried to finish as soon as possible. Such transfer of perception from game to the real world may have been in effect, and perhaps more evident in boys. These findings yield for further studies with larger N’s.

These aforementioned findings have several implications for teachers and game developers. For teachers, we recommend that game-based learning activities take low-functioning students into account since they will benefit the most from using the program. For developers, we suggest meeting the needs and levels of low-functioning players when designing various aspects of the game such as difficulty, speed, user interface, and content. Since students with severe disabilities were not included in the study, low-functioning would mean moderate disabilities in a real special education classroom. In this study, each participant only played the games for a total of 30 minutes. The fact that such significant effects were found after such a short period of time is meaningful for special education research. Further studies to confirm the findings of this study will be needed, but our results yield many hopes for the use of games in special education.

References


30.

Occupied Paris

Cultural Immersion in the Past
Terri J. Nelson (California State University, San Bernardino)

Abstract
Session presented results from two pilot tests of *Paris Occupé*, a role-playing game created in ARIS where students complete tasks and make choices in three “chapters” tied to different aspects of Parisian life during Nazi Occupation (World War II). The complexity of the period with its multiple governments, difficult living conditions and moral/ethical choices make it both interesting and challenging to teach. Typically, students minimize the complexity of the time and simply claim “I would have resisted,” as if it were an easy choice. Role-play personalizes the experience for students while giving them both mandatory tasks and free choices (all historically accurate). Individual student game play was supported by class activities to build historical understanding. Results of pilot tests show growth in language production, complexity of reasoning and empathy with the past.

Description of Paris Occupé

*Paris Occupé* is an ARIS-based game in development for use by Intermediate to Intermediate-High-level French language learners in a university classroom. During the two pilot projects, three chapters related to time periods during the Nazi occupation of Paris were studied using the instructor-created role-playing game (RPG). This virtual world implements game design mechanics to scaffold and enrich student learning through player agency, leveling up, chunking information and a rich multimedia environment.

The goals of this project are to enhance linguistic development in a meaningful setting, create a “deeper” understanding of historical events (depth vs. breadth) through historical empathy and critical thinking, and to support ethical development in young adults. In the context of this game, the combination of historical information learned through more traditional course materials (fiction and nonfiction in various media) plus the personal, emotional engagement with their RPG character, helps students engage in higher level critical thinking skills and express more nuanced emotional, moral and philosophical stances while also developing a more comprehensive and realistic understanding of the complex time period.

The game currently consists of three chapters, each set in a different week during the war: Chapter 2 focuses on whether to leave or stay in Paris as the Nazi Army approaches in June 1940; Chapter 3 focuses on rationing and is set in December 1940; Chapter 5 focuses on politics of engagement in August 1941. A total of twelve chapters set in 1939-1947 (postwar France) are planned. Chapters are currently independent of each other. Each consists of regular requirements (food, work, information) and special
quests. Money is limited (based on average salary at the time). Safety/security (i.e. obeying the law) and health points can impact play; a chapter score determines win status at the end of the chapter. Multiple random elements, as well as choices during interactions, make the game unique to each player. Students are asked to keep a daily diary for their character, as well as a news journal (based on information gleaned during game play).

The pilot tests were based on Chapter 3 used in a History of Paris course in Spring 2014 (12 students) and Chapters 2, 3 & 5 in a course titled “Paris Occupé” in Spring 2015 (6 students). One student participated in both pilots. Courses last 10 weeks; each game chapter comprised about two weeks in the schedule.

Meaningful Context for Language Production

In a foreign language classroom focused on developing communicative competence— that is the ability to share ideas with others in the target language— context is key. In more traditional language learning modalities, context establishes the scope of vocabulary needed to accomplish a task or voice an idea (e.g. buying food at a market place or stating one’s preference for X over Y); it also helps to determine the kinds of grammatical structures necessary to appropriate delivery of the message (e.g. a command form to express authority or the conditional form used to reinforce politeness). Beyond the scope of mere vocabulary and grammar acquisition, context can provide important input (things one sees, hears, reads) that set the stage for communicative activities (stating one’s opinion, taking an action, making a request). Learners absorb the language that surrounds them (reception) and this helps prepare them to produce language on their own— much like young children take in language for a long time before they can produce full sentences, or even phrases, on their own.

The use of multimedia in all forms has allowed foreign language students to move beyond the walls of the classroom into more immersive environments where they can receive culturally-appropriate visual and audio stimuli. In the context of computer-based technologies, these immersive environments include, importantly, interactions which can range from the highly scripted interface of an avatar to “meeting” someone from the other culture via Skype. Even seemingly simple activities, such as choosing which objects to pack in a suitcase, can lend to discoveries (“Water only comes in glass bottles?”) or help to learn new vocabulary (“Oh, that’s what bocale means!”). But in the context of the game, each choice carries additional importance. Is it more important to pack water or bring a first aid kit? Should I bring family photos or an umbrella? The player knows that each object may have some additional value later in the game (e.g. family photos may help convince distant relatives to provide housing; water, though heavy, may be critical for survival).
Over the course of the quarter, the instructor noticed the quantity of text generated by students in their daily journal assignments (one entry per “day” of the game required in their diary and another in their analysis of the news) and follow-up activities. Further analysis is needed by a linguist to determine whether the instructor’s anecdotal observations of students incorporating game language into their personal vocabulary is, in fact, verifiable. However, in terms of pure volume of language, there appears to be a significant change. Consider, for example, the question “What was life like during the Occupation?” which was posed in both a pre- and post-game activity (i.e. April and June 2015). Table 1 shows that students produced not only more words but also more details and descriptions of life during the time period. One of the hallmarks that distinguishes between Intermediate and Advanced level writing proficiency is the ability to produce paragraphs that combine and link sentences (Advanced) as opposed to primarily sentence-level discourse (Intermediate) (ACTFL, 2012).
### Table 1. Example of increased language production.

<table>
<thead>
<tr>
<th>Student</th>
<th>April 2015</th>
<th>June 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student A</td>
<td>Je crois que la vie était très difficile.</td>
<td>La vie sous l'occupation est très difficile parce que on n'a pas beaucoup de sécurité depuis cette époque. On vit avec peur de mort ou de danger parce qu'il y a des bombardements et des polices partout. J'aurais absolument peur. On ne savait jamais si au jour d'hui il y aura assez de nourriture ou si on aura encore le travail. Avant la guerre, la vie est différente parce que on a la stabilité et pendant la guerre c'est seulement le chaos.</td>
</tr>
</tbody>
</table>

[Translation] I think life was very difficult. | [Translation] Life under the Occupation was very difficult because it wasn't very safe during that time. One lived in fear of death or danger because there were bombings and police everywhere. I would have been very afraid. One didn't know if there would be enough food today or if one would have work. Before the war, life was different because there was stability and during the war it's absolute chaos. |

| Student B | Je pense que tout le monde a marché sur des œufs. J'ai regardé un film sur cet époque et sur les film il y avait le rationnement de nourriture, gens qui essaient cacher des enfants juifs. Il fut un temps qui fait peur, quelque chose peut arriver. | Pendant cette époque il y avait la occupation et le couvre-feu. Beaucoup de la nourriture a été envoyer à l'allemande, et il n'y avait pas assez de nourriture pour les gens. Il y avait aussi le rationnement et fait tout plus difficile. La vie a cette époque était très difficile pour tout, spécialement nous les juifs qui ne peut pas travailler dans beaucoup de travaille, comme professeur, avocat et des position dans le gouvernemen. [Rest written in English] There wasn't much to do during this time period as in the game, you only had certain activities you could participate in and even when you did there was a possibility you would get in trouble. There were also the two zones, but even then the French government would send Polish Jews to the German government. |

[Translation] I think everyone walked on eggs[whistles]. I saw a film about this time and in it there was food rationing, people who tried to hide Jewish children. It was a time that was scary, something [bad] could happen. | [Translation] During that period, there was the occupation and curfew. Lots of food was sent to Germany and there wasn’t enough food for the [French] people. There was also rationing [and that made everything] more difficult. Life at that time was more difficult for all, especially the Jews who couldn’t work as professors, lawyers or jobs in the government. ![see above] |

Furthermore, the “important” nature of the historical context of this game with all of its ramifications—resistance or collaboration as the appropriate action for law-abiding citizens, intervention or a blind towards the persecution of minority groups (and the effects of the Holocaust), and the extensive use of public media campaigns to influence mindsets—sets the stage for linguistic development by the language learners by engaging them with the content in personally meaningful ways by both their agency within the game and by the freedom offered by role-playing whereby “bad” actions can be “blamed” on the fictional character rather than being representative of the player.
**Historical Understanding**

Role-play personalizes the experience while giving players both mandatory tasks and free choices. One element of choice is reflected in the “daily life” aspect of Paris Occupé: players must “s’informer” by choosing whether to read Nazi-endorsed French newspapers, find clandestine newspapers, listen to Nazi-censored Radio Paris or listen illicitly to the BBC—all choices with potential consequences. Wherever possible, great care was given to connect students to authentic documents—including newspapers, memoirs, autobiographies, films—to show how people faced these difficult choices and the consequences of those real-life decisions. After purchasing a newspaper from the news kiosk, players are provided with a link to the national library of France’s website, *Gallica*, to view the newspaper from day. Similarly, players who choose to listen to Radio Paris are guided to a YouTube video of a popular song from the time period and those who choose the BBC, after losing “Security Points” for breaking the law, may be guided to a BBC radio show from that day and time or a BBC news broadcast. The game format makes accessing these original resources more amenable to students by providing a game-based purpose, as opposed to a more traditional classroom activity where the same links are accessible but without the context of the game.

Role-play also allows players to experience the more mundane aspects of life rather than the viewing the war as the series of narrative highs and lows depicted in movies, documentaries or novels. In the chapter on Rationing, for example, students commented on the repetitive nature of having to “stand in line for food all the time.” This chapter’s game goal is to purchase food for a holiday meal with guests. Points are awarded for gathering more prized items (e.g. a turkey rather than rabbit, a Camembert rather than goat cheese) to “cook” a traditional Christmas dinner. To do so, players must secure their ration coupons from the Mairie (Town Hall), then visit different vendors to purchase food. As was the case in 1940, long lines and short supplies made it difficult for families to find enough to eat, even in these early days of Occupation. Many surprising things emerged in the post-mortem discussions. Students revealed that they had trouble “finding” the Black Market (they thought it was a place, not a type of transaction). They also discussed the problem of the lines. With some faculty guidance (the Socratic method still has a role in the contemporary university classroom!), they came to understand that the hardship posed by rationing was not merely in the shortages of food but also in all of the other factors associated with procuring food.

One of the most profound moments in the Spring 2015 course occurred after viewing the October 1940 chart listing the allocations for different members of society. Students understood why expectant mothers and toddlers would be allocated extra rations for dairy (milk) and why manual laborers were afforded extra calories on a daily basis. But when they saw that the elderly were allocated a mere 670 calories per day, one student exclaimed “They [the Nazi government] are killing off the old people!” The conversation quickly turned, of their own accord, to issues of food security in contemporary society. Students moved beyond the rote recitation of “we learn history so we don’t replicate the mistakes of the past” to a more profound recognition of how we see links between past and current events.

In a follow-up activity, one student wrote (English translation provided here) “When there’s famine, there’s no place for education. In the absence of education, there is no progress. That leaves a country susceptible to economic downfall and also open to its enemies.” Another student wrote in the course evaluation: “I learned about the harshness of the daily life of the average Parisian. It must have been extremely humiliating being rationed by some foreign force as well as being limited of liberties and the things one should be able to do. I think that it must have been especially hard for nursing mothers and
fathers with children. The old must have died very rapidly. It is very sad that the occupied had to live that way.” These connections between the past and the present, as well as the recognition of the relationships between governmental policies and people’s lives are important.

**Ethical Development**

Young adulthood is a period when new choices, new opportunities and new possibilities emerge. College-age students are interested in the “Big Ideas”. Beyond the epistemological growth described by William Perry in his study of Harvard students in the 1950s and 60s, and the subsequent re-toolings of his work (Perry 1968, 1969), whereby young adults move from a position where knowledge is viewed as authoritarian and fixed to a more relative stance where knowledge is viewed as created and positional, our students have high aspirations and ideals. They have an energy and passion to change the world, as is seen in the movements on college campuses throughout the U.S. encouraging change of one kind or another. This is a time of experimentation and challenging authority. Games can play into that while also providing a “safe space” where students, as players in a game, can take on a variety of roles and practice making both good and bad decisions in order to evaluate the outcomes. In a game, *dead* isn’t really *dead* and bad can become good by restarting, rebooting and playing in a new way.

Teaching students about World War II usually means dealing with simplifications: students almost always declare that they would have been part of a resistance movement, that they would have fought back, that they wouldn’t have let “this” happen (where “this” could be the round-up of the Jews, the execution of a resistant, a challenge to the Nazi authorities). For better or worse, film narratives, novels and documentaries can also feed into the perception that the people of France were weak and cowardly for not fighting back. Yet historians understand that things aren’t always as simple as they may seem. Multiple factors contributed to how events unrolled. Trying to teach students to understand the complexity of the context— even when one is hopeful that their ultimate decision will be identical to their initial one— involves encouraging empathy. Endacott & Brooks (2013) define historical empathy as “the process of students’ cognitive and affective engagement with historical figures to better understand and contextualize their lived experiences, decisions, or actions. Historical empathy involves understanding how people from the past thought, felt, made decisions, acted, and faced consequences within a specific historical and social context.” In other words, through a better understanding of the contexts of the past, students begin to see events through another lens or perspective.

In *Paris Occupé*, the role-playing aspect of the game reinforces a more nuanced and complex understanding of context. Although the game structures students’ encounters with events both by the organization of chapters focused on particular aspects of life and by the curation of media (including propaganda), the game also progressively integrates multiple and competing viewpoints of life at that time. In the Chapter 5 (August 1941), game, some newspapers tout the advantages of joining a national volunteer force going to work in Germany at the same time as clandestine newspapers decry the execution of two young men who protested against the Nazis. The Vichy President, Philippe Pétain, launches his campaign calling for a “Révolution nationale” and encourages joining the Légion française to help fight “the enemy” alongside the German Army while student tracts call for increased resistance. Called upon to engage, players find it difficult to know which “side” others are on and what they believe in.

As one small measure of students developing ability to handle complexity was measured by routinely
asking them the question “A friend asks you to hide him/her. What challenges does that pose? What do you decide to do? Why?” (the actual wording of the question varied slightly in each follow-up activity). As we see in Table 2, answers in the pre-game questionnaire (April) were generally “I’d help my friend” though, interestingly, one student just refused to answer demonstrating complete avoidance (“Hypotheticals give me a headache”). Post-game questionnaires show more detailed responses where students weigh the costs and challenges of making such a difficult decision. While one hopes that we will always make “the right choice,” having a better understanding of how difficult these choices can be and why the right answers aren’t always the easy ones, is both a demonstration of historical empathy but also an acknowledgement of complexity. It wasn’t easy to be a hero in the same way that it wasn’t easy at the time to know which path to follow.

<table>
<thead>
<tr>
<th>A friend asks you to hide him/her.</th>
<th>What challenges does that pose?</th>
<th>What do you decide to do?</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 2014 (Student in both pilots)</td>
<td>Cacher mon ami, ce qu’ils faisaient au peuple était injuste et si je n’aide pas mon ami je serais comme ces gens injustes. Je risquerai ma vie, parce qu’ils avaient le même condamnation pour ceux qui les aident.</td>
<td>J’aurais parlé avec mon ami et le demander si il n’avait pas un autre ami a qui le demander. Je l’aurai demandé ça parce que c’était très dangereux. Je considérerai si j’ai une famille ou non. Ma vie et ça de ma famille était en risque.</td>
<td>Je voudrais aider, mais je ne sais pas si je l’aiderai. Ce serait considéré comme une trahison contre le gouvernement et aurait probablement signifier la mort. Bien que mon cœur serait brisé si je ne l’aide pas, je ne suis pas sûr que je le ferais.</td>
</tr>
<tr>
<td>April 2015</td>
<td>Je cacherais mon ami, ce qu’ils faisaient au peuple était injuste et je ne saurais pas si je l’aiderais. Ce serait considéré comme une trahison contre le gouvernement et aurait probablement signifier la mort. Bien que mon cœur serait brisé si je ne l’aide pas, je ne suis pas sûr que je le ferais.</td>
<td>J’aurais parlé avec mon ami et le demander si il n’avait pas un autre ami a qui le demander. Je l’aurai demandé ça parce que c’était très dangereux. Je considérerai si j’ai une famille ou non. Ma vie et ça de ma famille était en risque.</td>
<td>Je voudrais aider, mais je ne sais pas si je l’aiderai. Ce serait considéré comme une trahison contre le gouvernement et aurait probablement signifier la mort. Bien que mon cœur serait brisé si je ne l’aide pas, je ne suis pas sûr que je le ferais.</td>
</tr>
<tr>
<td>May 2015</td>
<td>Je voudrais aider, mais je ne sais pas si je l’aiderai. Ce serait considéré comme une trahison contre le gouvernement et aurait probablement signifier la mort. Bien que mon cœur serait brisé si je ne l’aide pas, je ne suis pas sûr que je le ferais.</td>
<td>Je voudrais aider, mais je ne sais pas si je l’aiderai. Ce serait considéré comme une trahison contre le gouvernement et aurait probablement signifier la mort. Bien que mon cœur serait brisé si je ne l’aide pas, je ne suis pas sûr que je le ferais.</td>
<td>Je voudrais aider, mais je ne sais pas si je l’aiderai. Ce serait considéré comme une trahison contre le gouvernement et aurait probablement signifier la mort. Bien que mon cœur serait brisé si je ne l’aide pas, je ne suis pas sûr que je le ferais.</td>
</tr>
<tr>
<td>Student C (Spring 2014 &amp; 2015 pilots)</td>
<td>I’d hide my friend, what they were doing to the people was unfair and if I didn’t hide my friend I’d be like those unjust people. I’d risk my life because [even though?] I’d be condemned in the same manner as others who helped.</td>
<td>I’d talk with my friend and ask if he didn’t have other friends who could help. I’d ask this because it’s very dangerous [to hide him/her]. I’d consider whether the person is in my family or not. My life and that of my family would be at risk.</td>
<td>I’d want to help but I don’t know if I would. It would be considered as treason and probably mean death. Even though my heart would be broken if I didn’t help [my friend], I’m not sure I would do it.</td>
</tr>
<tr>
<td>Student D (Spring 2015 pilot only)</td>
<td>Les hypothétiques ne donnent mal à la tête. Nous ne savons vraiment pas ce que nous aurions fait alors dans ces circonstances.</td>
<td>Hypotheticals give me a headache. We don’t really know what we’d do in those circumstances.</td>
<td>I’d like to allow my true friends to stay [at my home]. I must be invested in that person. I and my family risk imprisonment or death for helping that person. We would find it difficult to have enough to eat while feeding this person who could not earn money or obtain ration cards. (continues for 2 paragraphs)</td>
</tr>
</tbody>
</table>

Table 2. Do you help a friend hide from the authorities?
Conclusion

Through these two pilot projects, we see that the challenging, but meaningful, tasks of Paris Occupé succeed in a game format, where careful scaffolding combines linguistic support and structured activity sequences. The “important” context sets the stage for linguistic development in these intermediate to intermediate-high level language learners. The immersive environment creates reasons for students to creatively use language and learn history. The combination of historical information learned through more traditional course materials (fiction and nonfiction in various media) plus the personal, emotional engagement with their RPG character, help students engage in higher level critical thinking skills and express more nuanced emotional, moral and philosophical stances while also developing a more comprehensive and realistic understanding of this complex time period.

One student (who declared on the first day of class that she “hates history”) responded to the question How would you describe this course to a friend? in the final course survey thusly: “This class is very focused and centered on France during the World War II. It goes beyond just scratching the surface of this time and really takes you to connect emotionally with the lives of people during this time. It goes in depth rather than breadth. I learned so much more in this class and this short amount of time in comparison to the various history classes I’ve taken in high school and my early years in college. At the end, I can see how everything connected with what I’ve learned outside of this class.” It’s moments like these, among all of the chaff that is inherent to teaching and learning, that keep faculty motivated and make all of the hours preparing and creating projects such as Paris Occupé worthwhile!

Acknowledgments

Many thanks to the ARIS team and the ARIS Google group for support in the authoring with special shout-outs to Phil Dougherty who helped with the javascript for randomization functions and Chris Holden for always finding answers to our ARIS questions.

References


31.

When You Play the Game of Thrones...Everyone Wins!

Fanfiction and Role-Playing Games for Fiction Writers

Trent Hergenrader (Rochester Institute of Technology)

Abstract

Fiction writing classes at the college level are often taught under the assumption that students should be learning to reproduce traditional literary works for print publication. This approach ignores the fact that many undergraduate students do not share this goal and instead take these classes to experiment with their own creative expression. Rather than focusing on print-based literary fiction, this paper argues that students can become more engaged and learn more deeply about narrative concepts and think critically about cultures and characters when they are writing stories in a preexisting world rather than trying to generate their own original settings. The familiarity of preexisting worlds combined with rules of role-playing games to help them feel at ease in the fiction writing classroom, increases engagement, builds a strong writing community. This approach also allows them greater range to explore multimedia compositions and collaborative storytelling techniques.

The Creative Writing Workshop: Literary Fiction or Creative Literacy?

Donnelly (2011) opens her book *Establishing Creative Writing Studies as an Academic Discipline* by stating that the field stands at a crossroads, with on one side a “‘discipline’ that is unaware of the histories and theories that inform its practice” and on the other “creative writing studies, an emerging field of scholarly inquiry and research. As an academic discipline, it explores and challenges the pedagogy of creative writing” (p. 1, emphasis in original). This includes interrogating and expanding creative writing’s “signature pedagogy” of the workshop model (p. 1), which can be described as the practice of having an accomplished writer leading a group of students through a process where students 1) read a published literary work of the instructor’s choosing, 2) discussing its craft elements, 3) write and share their own work with the group, 4) and then take turns critiquing it. Set on repeat until the end of semester.

Scholars in the field of creative writing studies have increasingly challenged this undertheorized approach to teaching creative writing by questioning the power dynamics at play in the workshop (Leahy, 2005), using the classroom space for critical discussions about the historical and material conditions of creative writing (Mayers, 2005), promoting alternatives to the traditional workshop (Donnelly, 2010), and using digital approaches to creative writing that include social media, computer programming, and games (Clark, Hergenrader, & Rein, 2015). Healey (2013) argues that, given the fact that so few students ever find success in a hypercompetitive literary publishing market, instructors
should consider switching their focus from literary writing to what he calls “creative literacies,” which he defines as skills that include

“the ability to use language (along with visual images and many other media) to produce complex affective states in an audience; the ability to think and communicate in associative, metaphorical, non-linear, non-hierarchical ways; the ability to craft evocative stories with fully realized characters, personas, voices; the ability to manipulate or destabilize received meanings and to produce new meanings.” (p. 63)

Healey’s creative literacy dovetails with the New London Group’s concept of “multiliteracies” (1995) that include a range of verbal, visual, and auditory signs people use to make meaning and share ideas with others, a phenomenon accelerated in an age of digital technologies and global networks. Today’s multiliteracies incorporate a range of practices that include reading and composing in different forms of media that contain visual or interactive elements, such as graphic novels or electronic literature, as well as analog and digital games. Gee (2007) uses the language of multiliteracies in discussing how videogames provide useful models for designing classroom opportunities for deep learning. Black (2008) extends this to the sophisticated range of writing strategies employed in online fanfiction communities, where writers add or adapt characters and settings from a previously published work of fiction and share them on discussion boards and chatrooms, noting the levels of engagement and support in this non-classroom writing environment. Curwood, Magnifico & Lammers (2013) have added to this line of research, examining literacy practices around fanfiction both inside and outside writing classes.

The time is ripe, then, to extend this research to the creative writing classroom. By doing so, instructors can provide a more robust and meaningful educational experience than merely teaching students how to reproduce received literary forms, and attend to the skills that Jenkins (2009) says will be required for citizens in the 21st century: play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking and negotiation. The question is how to accomplish this change, and what models can inspire a different kind of writing.

Role-playing Games: Providing Structure for Beginning Writers

Much of the pleasure of reading fiction derives from the reader forming an emotional bond with the story’s protagonist, considering the choices that the character makes, and then reflecting on the outcome of those choices. Novice writers often struggle to give their protagonists compelling or difficult choices. Students often write stories where the story winds up being dull (if the character only has obvious choices to make) or absurd (if the character somehow refuses the obvious choices presented to them). Writing a nuanced work of short fiction is a complicated task and few undergraduates are voracious readers of the form. Thus crafting a balanced story that attends to the six primary elements of fiction—character, setting, plot, point of view, style, and theme—can seem like a monumental challenge, especially when the writer doesn’t know where to start. Many students also feel that the expectation is that they must write something of deep literary importance, further paralyzing their creative process.

I have experimented structuring fiction courses around role-playing games (RPGs) to alleviate several of these problems. As Gee (2007) states, RPGs allow players to explore a fictional world through a detailed avatar, which provides them a situated, embodied experience by which they probe a fictional world and draw conclusions from the outcome. RPGs also provide narrative structure for players through rules and varied sourcebooks (Hergenrader, 2014). Using RPGs in creative writing courses can also help writers focus on specific craft issues that pertain to character and setting (Hergenrader, 2013).
and it also transforms the class into a tightknit writing community (Hergenrader, 2011). Using RPGs as a model means students need to worry less about plot, as RPG plots are largely derived from the character interacting with the fictional world (Hergenrader, 2012), and the collaborative nature of the world building process makes them think critically about social forces present in a world (Hergenrader, 2014). The RPG-based approach allows the student writer to focus on their character’s emotional states and to invest more time in their use of language to evoke tone or present a specific theme. Thus the RPG provides a sturdy framework that bears the weight of many of the elements of fiction, much like a backpack frame distributes weight more evenly to make a heavy load easier to carry.

The scholarly work in literacy studies and fanfiction inspired me to try a different technique and experiment with combining RPGs with fanfiction. While building fictional worlds using RPGs as a model has many benefits, it takes weeks for students to build an entire world from the ground up; many students are also wary of this foreign approach to fiction writing. My hypothesis was that I could use a popular preexisting world to accelerate the rate of student engagement and allow for different types of discussions about fictional worlds. Work in literacy studies that examined fanfiction communities (Black, 2008; Curwood, 2013; Curwood et al., 2013; Lammers, Curwood, & Magnifico, 2012) showed that engagement and writing motivation increased when writers work within affinity groups, which Gee (2007) defines as those people who operate comfortably within the same semiotic domain, defined as “an area or set of practices where people think, act, and value in certain ways” (p. 19). In short, novices feel more comfortable sharing writing and giving feedback in a community where participants possessed the same understanding about the world and the characters being written about. Their familiarity (and in many cases expertise) in the subject matter gives writers greater confidence to suggest ways others may strengthen their work. Given the amount of peer critique that happens in fiction writing classes, a fanfiction course seemed like an ideal ground for blending it with my RPG-driven fiction courses.

A Game of Thrones Fanfiction RPG Course: Rationale and Structure

George R.R. Martin’s Song of Ice and Fire Series begins with A Game of Thrones (1996) and currently stands at five novels with A Dance of Dragons (2011) being the most recently published, with at least two more volumes on the way. A 2013 article estimated the total book sales across all media at 25 million (Grover & Richwine, 2013) and the show’s season six finale set an HBO record with 8 million live viewers (Kissell & Kissell, 2015). Given the popularity of Martin’s work on my campus, I expected students would begin class with knowledge of the world and its characters. A pre-semester survey for the course proved this assumption correct. Of 20 registered students, 14 took the survey. Of those 14 students, 57% had read the first book in the series, and 86% has seen the entirety of the first season of the show; 36% of the students had read all five novels in the series, and 71% (10 students) had watched all four seasons that had been aired by the start of the semester. There was only one student who had no experience with Martin’s work, and on my suggestion he watched the first four episodes of the first season of Game of Thrones to give him some necessary grounding. All other students had a firm grasp on the geography and cultures of the world, and several were bona fide experts, knowing plenty of lore only accessible through semi-canonical texts. Thus even within the affinity group, there were different levels of expertise, which allowed students to share their knowledge and participate in co-teaching of their peers.

The course began with an overview and critical discussion of the world of Westeros. In the second phase,
students broke into small groups and created noble houses, and then perspective characters (PCs) within those noble houses. In the third and final phase, the class played modified role-playing sessions and wrote vignette-length fiction told from their PC’s point of view, and critiqued each other’s writing.

Myths, Legends, & Cultural Beliefs: Deconstructing Who We Are and Where We’re From

The first two weeks of the 15 week course consisted of students reading about Westeros, the continent on which most of the action of Martin’s series takes place. Rather than using the novel Game of Thrones as a primary text, students instead read selections on the history and culture of the continent and seven kingdoms within it from the role-playing rulebooks The Song of Ice and Fire Role-Playing Game: A Game of Thrones Edition (Schwalb, 2013), The Song of Ice and Fire Role-Playing Game Campaign Guide (Pramas et al, 2012), the encyclopedic World of Ice and Fire: The Untold History of Westeros and the Game of Thrones (Martin, Garcia & Antonsson, 2014), and the A Wiki of Ice and Fire Wiki <http://asoiaf.wiki.com> website. These readings and discussions helped the class come to a general consensus of the nature, cultures, and customs of each of the seven kingdoms.

Each discussion period focused on how the information about the world would be relevant to their individual characters. For example, children born out of wedlock do not have a diminished social status in the southern kingdom of Dorne as they do in the other six kingdoms; or that the people of the North are the only kingdom who follow their own ancient faith of the Old Gods rather than the “new” Seven, which is the common religion everywhere else. Class is also a major factor in that nobles in Westeros have a more robust set of rights than do peasants, and that the reputation of a person’s noble house directly impacts how others perceive, or even socially receive, them. All of these differences—along lines of race, class, gender, sexual orientation, religion, and more—are relevant during play during the role-playing sessions as encounters often featured characters hailing from other realms. Prior to playing, students had to know: does their character respect their cultural differences? Is she prejudiced? Does he feel superior? Inferior? We discussed how different characters would interpret events in the world in different ways based on their social position. A marriage proposal that unites two families might be a boon to the male lord who will increase his wealth and status, yet be a bane to his daughter who has no legal right to reject the match.

We also discussed how founding myths and legends shape individual perceptions of the world, as well as their place in the world. We covered the founding myths and legends for each of the seven kingdoms, and compared and contrasted them with the stories of the United States: of George Washington chopping down the cherry tree, the ride of Paul Revere, the causes and results of the Civil War, the settling of the American West, and more, including our nation’s penchant for being involved in armed conflicts. We in turn discussed concepts such as “American exceptionalism,” the cultural logic of Manifest Destiny, the Land of the Free and Home of the Brave, the American Dream, and more, relating them to our own personal identities and what brought us together in the space of a college classroom. We finished with thinking about different aspects of regional pride within our nation, using as one example my pride of being an Upper Midwesterner and a Wisconsinite from the land of the Green Bay Packers, beer, and cheese. Other students shared their identities as Western New Yorkers, Brooklynites, or hailing from the Deep South, and reflected on how they felt that had shaped their view of the world.

The students were randomly assigned two possible kingdoms that their character could hail from. Students could barter or trade their kingdoms with the limitation that each kingdom could have no more or no fewer than five students. We spent the next class period where the students took turns presenting
the history of their kingdom, describing the notable geographic features of the land as well as the major turning points in the realm’s history. This deep knowledge would assist them in the next step, creating their noble houses and PCs.

Noble Houses and Perspective Characters

The groups of five students followed the RPG rules for constructing a noble house within their kingdom. This involves rolling a set of six-sided dice to randomly determine their house’s resources, key points in the house’s history, its major holdings (castles, towers, military units), as well as its motto and coat of arms. The rules provide both structure as well as a great deal of latitude in how to interpret the dice rolls and resolve them into a narrative. For example, the students of House Freitas of Dorne rolled four major events: madness, scandal, infrastructure, and again infrastructure. They wove these events into a narrative that described how the founder of their house had been driven insane by war crimes he’d witnessed (madness), how that culminated in an attempted bloody retaliation (scandal), and then economic expansion that included the founding of a major gambling den and port town (infrastructure) (“House Freitas”). The entire narrative must be agreed to by the entire group, and each student is urged to weigh in with his or her own ideas, or to add or alter other details suggested by their classmates. Thus each student becomes more invested in the history and identity of the house. The house is completed with an addition of a custom made coat of arms and “house words” that encapsulate the house’s identity. The students then create a detailed wiki entry explaining their house’s history and connecting it to the canonical world of Game of Thrones via outbound links to the A Wiki of Ice and Fire (Figure 1).

The next step was the creation of a PC, who would serve as the protagonist in each student’s stories. The RPG rulebook also features detailed instructions on character creation, again determining some aspects by random dice rolls and others are chosen by the player. While each student has autonomy in creating their PC, each PC must also fit within the structure of the house. Some students assume the role of lord or heir to the house, while others serve as advisors, knights, and even attendants. PCs can be loyal to the house’s goals, self-serving, or treacherous. Through an in-depth character creation exercise developed from a combination of RPGs and fiction exercises (Hergenrader, 2014) students determine their PCs motivations, skills, physical traits, beliefs, disposition, and backstories, and provide an image (Figure 2).
RPG Narratives and Fiction Writing

The final unit of the course is a combination of heavily modified RPG sessions drawn from the group website (“Tales from King’s Landing”) and more traditional creative writing workshops. The complexity of running an RPG campaign in the classroom (Hergenrader, 2014) necessitates a different approach. For this course, two groups of students would sit with the instructor and role-play through a scenario in an abbreviated fashion, splitting their time evenly over one 75-minute class session. During the subsequent meeting time, the other two groups would roleplay. Groups alternated each week so the same group did not go first each week and gain an advantage in directing the larger narrative.

As instructor, I attempted to find the most challenging situations for every PC to negotiate. With 20 PCs all participating in a common, interconnected narrative, it became difficult to weave all the stories together. I steered the scenarios into morally gray areas, testing students’ abilities to make decisions based on their PC’s personalities rather than their own. Over the last unit (about six weeks) I adjusted the scenarios based on the decisions the students made in the previous session. Some examples of scenarios where a difficult decision had to be made included:

- For a servant to abandon her house to accept the courtship of a wealthy but very ugly suitor
- For an heir to a house to be commanded by his liege lord to whip his sister for her disobedience
- For soldiers to imprison a group of racially profiled citizens whom they knew to be innocent
- For a daughter to forsake her noble family to run off with a man of low social standing, who in turn needed to renege on his sworn loyalty to own noble house to make the match
- For a bookkeeper to embezzle enough money from an extravagant feast in order to break away from the family and set up shop for himself in the capital
- For an herbalist to accept the invitation of an eccentric spice merchant to travel around the world
• For a swordsman to accept his lord’s order to participate in what seemed to be a suicidal mission

The decisions PCs made often required a dice roll to see if they succeeded. One PC managed to fast talk his way out of a seemingly impossible diplomatic situation with an improbably high dice roll, yet the bookkeeper’s embezzlement plot was found out because his roll total was a single point short. His failure set up other tensions for his PC for the rest of the semester and it became the main theme in his stories.

Students were encouraged to take the most stressful, impactful, or interesting moment from their session for their 1000-word vignettes. These stories linked to relevant people, places, and things on the wiki, and were steeped in their PC’s perspective. Students wrote a vignette each week, and for each one they wrote, they needed to provide two critiques to their classmates. Between their wiki entries, their PC’s profile, the vignettes, and their critiques, students wrote approximately 10,000 words over the course of the semester and received 10 to 12 peer critiques of their writing. This amount of production and interaction with each other’s work far exceeds the amount of writing in the traditional workshop format.

Conclusion

This experimental course was a success in that it achieved a number of specific learning objectives: students participated in collaborative writing project using digital tools; they were encouraged to incorporate images and other media into their work; the RPG sessions provided simulated scenarios for them to problem solve and perform in character, if they so wished; they negotiated the building of their houses and characters with their peers; and, through the vignettes and critiques, learned about craft aspects of fiction writing and received peer feedback on their work.

The RPG-based course offers many benefits in terms of student engagement, their sense of ownership in course content, and their role in transforming the classroom into a dynamic space. Significant challenges still remain, however, in that the burden for producing compelling scenarios is time consuming and resides solely with the instructor, and the RPG sessions don’t lend themselves to the blocks of institutional space and time typically given for a semester-long course. Further research needs to be done to see how much of the narrative design could be transferred to the students. Ultimately however, using an RPG set in a preexisting world proved to be pedagogically

References


Exploring the Effects of Dynamic Avatars on Performance and Engagement in Educational Games

Dominic Kao (Massachusetts Institute of Technology) & Fox Harrell (Massachusetts Institute of Technology)

Abstract

Avatar research has almost exclusively explored avatars that remain the same regardless of context. However, there may be advantages to avatars that change during use. A plethora of work has shown that avatars personalized in one’s likeness increases identification, while object-like avatars increase detachment. We posit that in certain situations within a game it may be more advantageous to have increased identification, while in other situations increased detachment. We present a study on dynamic avatars, or avatars that change types based on game context. In particular, we investigate what we term the successful likeness avatar. The successful likeness is an avatar that is only a likeness when the player is in a win state and at all other times an object. Our goal is to determine if this type of avatar can foster an increase in user performance and engagement. Our experiment (N=997) compares four avatars: 1) Shape, 2) Likeness, 3) Likeness to Shape, and 4) Shape to Likeness (successful likeness). We found that players using a successful likeness avatar had significantly better performance (levels completed) than all other conditions. Players using a successful likeness avatar had significantly higher play time (minutes played) than all other conditions. We propose a theoretical model in which identification facilitates vicarious outcomes and in which detachment facilitates outcome dissociation. As performance and engagement are correlated to learning (Harteveld, 2015), successful likeness avatars may be crucial in educational games.

Introduction

Over twenty years of research on virtual agents and avatars has revealed that our understanding of how their appearance affects us is still limited. The persona effect was one of the earliest studies that revealed that the mere presence of a life-like character in a learning environment increased positive attitudes (Lester et. al, 1997). A wealth of empirical research since then has demonstrated that virtual characters are more influential when they have similar competencies (Kim & Baylor, 2006), a similar gender (Baylor & Kim, 2004; Guadagno et. al, 2007), and a similar ethnicity/race (Pratt et. al, 2007; Rosenberg-Kima et. al, 2010). However, research on the visual form and look of animated agents is sparse; it has been proposed that the following five dimensions are understudied: 1) the degree of “humanoidness,” 2) the degree of stableness versus changeability of appearance (morphing), 3) the degree of animation, 4)
the degree of 3-dimensionality, and 5) the degree of realism (Gulz & Haake, 2006). The reason for the sparsity of research in this area has been attributed to two possible causes: 1) these questions are difficult to answer using existing methodologies, and 2) people do not readily accept the idea that appearance affects our intellectual processes (e.g., “Don’t judge a book by its cover”) (Gulz & Haake, 2006). In this work, we propose to explore the changeability of appearance aspect of avatars.

In particular, our work is based on increasing evidence that demonstrates that abstract avatars increase player-avatar detachment via low identification (my avatar is not me), high sense of control (my avatar is like a tool), low sense of responsibility (my avatar has no needs), etc. (Banks & Bowman, 2013; Bowman, Rogers, & Sherrick, 2013; Kao & Harrell, 2015c). Work in human-computer interaction, psychology, and marketing suggests that within virtual environments, success and failure is attributed to avatars and through them also affects users (Campbell & Sedikides, 1999; Moon, 2000; Wolfendale, 2007; Whang & Chang, 2004; Huff, Johnson, & Miller, 2003). These effects are more powerful with avatars with whom we identify (Vasalou, Joinson, & Pitt, 2007; Duval & Silvia, 2002). Here, we perform the first study to our knowledge on dynamic avatars. More specifically, we study what we call the successful likeness avatar, an avatar that is normally abstract (e.g., a shape), but that becomes a likeness in win states. Our goal is determining if selectively increasing and decreasing user identification with the avatar during key moments of the game experience can result in increased performance and engagement. We found that participants did not significantly differ in reported engagement between conditions. However, participants using a successful likeness avatar both completed significantly more levels, and played the game for a significantly longer period of time, suggesting greater performance and engagement (see Bauckhage & Kersting (2012) for predicting engagement via play time). Since both performance and engagement have been correlated to better learning outcomes in educational games (Harteveld, 2015; Blumenfeld, Klemper, & Krajcik, 2005), our work has important implications for avatar design in educational environments.

Motivation

The work here is based on the premise that, along with factors such as subject mastery and affect toward the subject, a sense of identity as a STEM learner and doer is necessary for developing literacy and agency in computing (S. Veeragoudar Harrell & D.F. Harrell, 2009). The standard paradigm of computer science education research traditionally focuses almost exclusively on cognitive challenges apparently inherent to particular computational concepts, e.g., (Ben-Ari, 2001). Veeragoudar Harrell states that developments in the learning sciences suggest that computer science curricula should embrace a broader conceptualization of learning: human reasoning, it is proposed, is embodied, distributed, and situated, and learning must be accordingly perceived as inherently collaborative, contextualized, and instrumented (Dourish, 2001; Greeno, Collins, & Resnick, 1996; Hutchins, 2000; Lave, & Wenger 1991). A result of this broader view of human reasoning and learning in the STEM disciplines is the emergence of research on relations between student identity and learning (Gresalfi et al, 2009; Lave, & Wenger, 1991; Nasir, 2002). For example, stereotype threat is the phenomenon in which triggering awareness of a learner’s identity results in his or her performance conforming to social stereotypes regarding that identity (Steele, & Aronson, 1995; Shih, Pittinsky, & Ambady, 1999; Gibson, Losee, & Vitiello, 2014; Good, Rattan, & Dweck, 2012). Digital manifestations of such phenomena are important areas for investigation since virtual identities are now frequently used as avatars in videogames, avatars in MOOCs and forums, intelligent tutors, and more.
The Game

The experiment takes place in a STEM learning game called Mazzy (Kao & Harrell, 2015e)\(^1\). Mazzy is a game in which players solve mazes by creating short computer programs. In total, there are 12 levels in this version of Mazzy. Levels 1-5 require only basic commands. Levels 6-9 require using loops. Levels 10-12 require using all preceding commands in addition to conditionals. See Figures 1 and 2. Mazzy has been used previously as an experimental testbed for evaluating the impacts of avatar type on performance and engagement in an educational game (Kao & Harrell, 2015a-d; Kao & Harrell, 2016a-c).

![Figure 1. Level 1 in Mazzy introduces the basic game mechanics.](image1)

![Figure 2. Level 6 introduces looping.](image2)

Theoretical Framework

Our work is based on research on avatars, agents, and “blended identities” (Harrell, 2010). Although in this work we are studying avatars, an abundance of work on agents (i.e., virtual pedagogical agents, teaching agents, etc.) helps to guide our study. In particular, a large body of work has shown that avatars and agents that share users’ external characteristics (e.g., age, gender, race, clothing, etc.) are more influential and are linked to better learning outcomes (Kim & Baylor, 2006; Baylor & Kim, 2004; Guadagno et. al, 2007; Pratt et. al, 2007; Rosenberg-Kima et. al, 2010; Johnson, Didonato, & Reisslein, 2013; Arroyo et al, 2009; Bailenson, Blascovich, & Guadagno, 2008). This is posited to be a result of similarity-attraction, the theory that people are attracted to similar others (Byrne, & Nelson, 1965; Isbister, & Nass, 2000). Functional neuroimaging has found that perceived similarity is an important factor in a person’s ability to simulate the internal state of another person (Mitchell, Macrae, & Banaji, 2006). Likewise, Mobbs et al (2009) found that when a participant watched a game show contestant with high perceived similarity, the participant experienced significant increases in both subjective and neural responses to vicarious reward. Other work suggests that what is experienced by an avatar is also experienced by its user (Campbell & Sedikides, 1999; Moon, 2000; Wolfendale, 2007; Whang & Chang, 2004; Huff, Johnson, & Miller, 2003). This effect is more powerful via avatars that we identify with (Vasalou, Joinson, & Pitt, 2007; Duval & Silvia, 2002), identification being positively correlated to such factors as representation of emotions and intent (Hamilton, 2009), physical resemblance (Maccoby, & Wilson, 1957), and avatar customization (Turkay, 2014).

In the past decade, it has become apparent that avatars play an important role in affecting our behaviors.

---

The Proteus effect describes an individual’s tendency to conform to behavior typically associated with how an avatar appears (Yee & Bailenson, 2007). For example, two of the earliest studies found that participants with taller avatars were more aggressive, and that participants with more attractive avatars were more confident. Since avatars affect us in a subtle way, they are a form of “embedded content” (Kaufman, Flanagan, & Seidman, 2015), which studies have shown is more effective than “message-driven” agendas (Brehm, 1966). Avatars, or “blended identities,” (Harrell, 2010), can be pivotal in enabling our capacities to put ourselves inside other identities. However, the unfortunate consequence is avatars can also be used to reinforce stereotypes, perpetuate hegemonic views, etc., e.g., women as victims of violence, etc. Fortunately, some representations can begin to combat these stereotypes, e.g., playing a computer science learning game as Marie Curie (Kao & Harrell, 2016a). For instance, research has shown that abstract (or object-like) representations, such as a geometric shape, lead to detachment with the avatar and outcomes associated to the avatar (Banks, & Bowman, 2013; Bowman, Rogers, & Sherrick, 2013; S. Veeragoudar Harrell, & D.F. Harrell 2009; Kao & Harrell, 2015c). Because of the potential usefulness in exploring the dichotomy between identification and detachment, we investigate the successful likeness. This avatar is abstract (shape) when the player is not in a win state (to facilitate detachment), and a likeness (Mii) when the player is in a win state (to facilitate identification). Our goal is to test if this type of avatar can enhance player performance and engagement.

Experiment

Our experiment consisted of a between-subjects design. Our goal was to measure performance and engagement across conditions.

Conditions

Our four avatar conditions were:

1. Shape
2. Likeness
3. Likeness to Shape
4. Shape to Likeness

Participants were all told that they would be playing a game. No other details were specified. Players were asked to use a publicly available customization system to create a Mii (the Likeness). A Mii is a type of avatar developed by Nintendo, chosen since Miis were designed with the intention that most users would create likeness avatars (the word “Mii” is a blend of “Wii” and “me”). Furthermore, players were told to create an avatar that looked like themselves. Players then picked out of eight possible geometric shapes (the Shape). Every player created a Likeness avatar and selected a Shape avatar (see Figure 3). If a participant was assigned to Condition 1, their avatar was always a shape. In Condition 2, their avatar was always a Mii. In Condition 3, their avatar was normally a Mii, but when a level was successfully won, the avatar became a shape. In Condition 4, their avatar was normally a shape, but when a level was successfully won, the avatar became a Mii (successful likeness). The ‘winning’ avatar (a shape in Conditions 1 & 3, and a Mii in Conditions 2 & 4) was displayed centered in the middle of the screen. All other aspects of the experiment were identical across conditions.

Measures

Our performance measures consist of levels completed and time played, while our engagement measure is the Game Experience Questionnaire (GEQ) (IJsselsteijn et al, 2007).

Participants

997 participants were recruited through Mechanical Turk. The data set consisted of 560 male, and 437 female participants. Participants self-identified their races/ethnicities as white (665), Asian Indian (163), black or African American (55), American Indian (14), Chinese (13), Filipino (13), Korean (10), Japanese (6), Vietnamese (4) and other (54). Participants were between the ages of 18-72 (M = 30.1, SD = 8.2). Participants were reimbursed $1.50 to participate in this experiment.

Design

Our design was a between-subjects design: avatar condition was the between-subjects factor. Participants were randomly assigned to a condition.

Protocol

Prior to starting the game, players were informed that they could exit the game at any time via a red button in the corner of the screen. When participants were done playing (either by exiting early, or by finishing all 12 levels), participants returned to the experiment instructions, which prompted them with demographics.
Analysis

Data was analyzed in SPSS using analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA). We ran one ANOVA using levels completed as the dependent variable, and one ANOVA using time played as the dependent variable. Our MANOVA used GEQ items as the dependent variable. In all cases, our independent variable is avatar condition. To be aligned with our research question, we asked participants after the experiment to rate how similar they felt their Mii was to themselves (1: Very Dissimilar to 5: Very Similar). We removed participants that reported a similarity less than 3 (189). Additionally, we removed 35 outliers according to the criteria in Hoaglin (1987). These 224 participants were excluded from further analysis. Prior to running our MANOVA model, we checked the assumption of homogeneity of variance by Levene’s Test of Equality of Error Variances, and the assumption was met by the data (p>.05). All reported p-values are two-tailed.

Results

An ANOVA revealed that levels completed was significantly different across avatar conditions, F(3, 769) = 3.02, p<.05. Post-hoc comparisons (LSD) revealed that the condition Shape to Likeness significantly outperformed Likeness, p=.017. The condition Shape to Likeness also significantly outperformed Likeness to Shape, p=.007 (see Figure 2).

![Figure 2. Levels completed (left); total time played (right.)](image)

Similarly, an ANOVA revealed that time played (seconds) was significantly different across avatar conditions, F(3, 769) = 2.69, p<.05. Post-hoc comparisons (LSD) revealed that the condition Shape to Likeness had significantly longer play time than Shape, p=.019. The condition Shape to Likeness also had significantly longer play time than Likeness to Shape, p=.010. The condition Shape to Likeness had marginally longer play time than Likeness, p=.072 (see Figure 2).

A MANOVA revealed that there was no statistically significant difference in GEQ responses across avatar conditions, F(126, 2190) = 1.02, p=.43; Pillai’s Trace = .17, partial η2 = .055. See Figure 3.
Discussion

We first summarize our findings:

- Shape to Likeness participants were **highest performing**.
- Shape to Likeness participants spent the **most time in game**.
- **No significant differences** in GEQ responses.

We found that the Shape to Likeness (successful likeness) condition had significantly increased **Levels Completed** and **Time Played**. GEQ responses did not significantly differ. These results support our initial hypothesis that having a shape avatar (greater detachment) when the player is not in a win state, and having a likeness avatar (increased identification) when the player is in a win state, would outperform other avatar types. The worst performing condition was the inverse condition: Likeness to Shape.

**What do these results mean?**

For example, the successful likeness condition participants on average completed about 1 more level and played for about 3.2 minutes longer than Likeness to Shape condition participants. Longer game playtime can be used as a measure of engagement (Bauckhage & Kersting, 2012). Moreover, both increased game performance and engagement have been correlated to better learning outcomes in educational games (Harteveld, 2015; Blumenfeld, Kempler, & Krajcik, 2005). Therefore, these results are suggestive that, over longer periods of time, dynamic avatars could have beneficial effects on players.
Why did this happen?

Multiple disciplines have independently demonstrated that avatars with a higher degree of perceived similarity may better facilitate vicarious experiences, positive or negative (Campbell & Sedikides, 1999; Moon, 2000; Wolfendale, 2007; Whang & Chang, 2004; Huff, Johnson, & Miller, 2003; Vasalou, Joinson, & Pitt, 2007; Duval & Silvia, 2002; Kim & Baylor, 2006; Baylor & Kim, 2004; Guadagno et al., 2007; Pratt et al., 2007; Rosenberg-Kima et al., 2010; Johnson, Didonato, & Reisslein, 2013; Arroyoet al., 2009; Bailenson, Blascovich, & Guadagno, 2008; Byrne, & Nelson, 1965; Isbister, & Nass, 2000). Moreover, neural imaging has demonstrated that watching a similar person experience a reward also increases our own vicarious reward (Mobbs et al., 2009). Effects of an avatar similar to oneself may persist even after the experiment. Fox & Bailenson (2009) found that watching one’s avatar exercising resulted in significantly more exercise on the part of the participant, 24 hours later, as compared to participants that watched one’s avatar loitering or a virtual other exercising. Lastly, abstract (or object-like) avatars can better facilitate detachment and may play a role in helping users dissociate from failure outcomes, such as in cases requiring “debugging” (Banks & Bowman, 2013; Bowman, Rogers, & Sherrick, 2013; S. Veeragoudar Harrell, & D.F. Harrell 2009; Kao & Harrell, 2015c).

How generalizable are these results?

The work here was a single study of how dynamic avatars affected engagement and performance for 997 participants in a coding game. While we feel the results are well supported by the literature, there should be additional investigation of the specific physiological effects of dynamic avatars. While one possible approach is to ask participants questions from, e.g., the Player-Avatar Interaction (PAX) questionnaire (Banks, & Bowman, 2016), we feel that post-game surveys will be a difficult approach given the rather subtle differences in the experience between conditions. While these subtle differences manifested as tangible differences in performance, they did not manifest in tangible differences in reported engagement. Even if players differed on some self-report (e.g., “This avatar understands me.”), it’s not readily apparent how we can disambiguate, in the dynamic avatar case, between the non-win state avatar, the win state avatar, or some combination. Because these avatars are different than any avatar previously studied, we will need new methods to study them. We find some parallels in work on multiple agents; for instance, it has been found that multiple virtual pedagogical agents with ‘compartmentalized’ roles (e.g., one agent provides confidence-boosting messages, another provides information support, etc.) provide significantly better learning outcomes than a single agent (Baylor & Ebbers, 2003; Baylor & Kim, 2005; Odell, Parunak, & Fleischer, 2003). Here, we instead have multiple avatars, and we are facilitating either greater identification or greater detachment depending on the game context. We plan to further investigate this phenomenon in the near future. We are partnered with a non-profit and will be studying Computer Science learning using these avatars in Cambridge schools. We aim to use EEG devices, e.g., the EPOC, to measure brain activity of participants over the course of game play. Ultimately, such an approach would help us determine the specific physiological influences of these dynamic avatars.

Conclusion

Increasingly, there has been research on the different external characteristics of avatars and agents and how they affect users in educational environments (Lester et. al, 1997; Kim & Baylor, 2006; Baylor &
Kim, 2004; Guadagno et. al, 2007; Pratt et. al, 2007; Rosenberg-Kima et. al, 2010). However, their visual form and look has been understudied, including avatars that change from one form to another (morphing) (Gulz & Haake, 2006). Here, we provide the first study to our knowledge on dynamic avatars, or avatars that are different depending on whether the user is in a win state or not. We found that the dynamic avatar, successful likeness, outperformed all other conditions in terms of levels completed. These same participants also played the game significantly longer. We posit that this is a result of shapes (abstract) as avatars leading to more detachment and Mii avatars (likeness) leading to more vicarious experience. Educational systems and games could benefit greatly from such a model of representation, shielding users from internalizing failure, and basking them in self-success-identification.

Acknowledgements

We thank the anonymous reviewers for their valuable feedback. This work is supported by NSF STEM C Grant #1542970 and a Natural Sciences and Engineering Research Council of Canada (NSERC) fellowship.

References

Bowman, N. D., Rogers, R., & Sherrick, B. I. (2013). In Control or In Their Shoes?


Computational Fluency as Argumentation Support at the Community Level in Scratch

Crystle Martin (University of California, Irvine)

Abstract

In this paper I explore findings from an ethnography of the online Scratch community. Through the observations of the Scratch forums, I propose that aspects of computational thinking, which has been studied previously in Scratch, are used by Scratchers (i.e., people who participate on Scratch) as a way to strengthen arguments for topics about which Scratchers feel passionately. The analysis takes a social argumentation approach, which emphasizes context. The focus on context is important for a community like Scratch where the participants of the community feel strong connection and ownership over the activities and structure of community. This paper demonstrates at a community level how aspects of computational thinking are used to strengthen arguments, and what this does for Scratchers who use it.

Introduction

This paper focuses on an ethnography for the online coding community, Scratch. Scratch is a free, online multimedia authoring tool with over ten million registered members and over 13 million projects (Scratch, n.d.). Scratch, a visual coding language, was originally designed for middle school students but the online community currently has users that are younger than 8 and older than 70, with the majority of Scratchers between 9 and 16 years old. The volume of conversation in this community is equally large, with participants communicating in the studios, where Scratchers (i.e., people who participate on Scratch) curate projects; commenting on projects; and participating on the forums. At the time of writing, there are nearly 71 million comments across the site (Scratch, n.d.). Scratch supports a variety of learning related activities (Fields, Giang, & Kafai, 2013; Koh, 2013; Burke & Kafai, 2012), but it strongly supports the development of computational thinking (Brennan & Resnick, 2012). Computational thinking permeates the activities of the Scratchers, whether commenting on a project or arguing their position on the forum. As described by the Center for Computational Thinking (n.d.) at Carnegie Mellon, “Computational thinking is a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science. To flourish in today’s world, computational thinking has to be a fundamental part of the way people think and understand the world.” This paper explores how computational thinking is used in argumentation in the online Scratch community.
Argumentation and Computational Fluency

Discussion and debate is common in online communities, especially those that have passionate participants, access to large amounts of information pertaining to the topic of the community, and that experience change and iteration. Argumentation has deep roots in research. One of the most prevalent frameworks in argumentation is Toulmin’s model. Toulmin (1958) identified six parts that a strong argument should include: claim, data, warrants, rebuttals, backings, and qualifiers. This structured view of argumentation was developed long before the internet and takes a one side winning over the other approach, over a more consensus building view, which could be found in a collaborative online community. Toulmin’s model was also created to study argumentation in real time and usually between a limited number of piece, unlike online communities.

Scholars are pushing back against this structured approach. They posit that individuals should build on the collective knowledge of the group, instead of taking a more adversarial approach of convincing others of their own viewpoint using argumentation (Andriessen et al., 2003a, b), and approaching argumentation from a constructivist approach (Leitão, 2000). Leitão (2000) contends that knowledge development is an important part of argumentation and should play a prominent role in analysis. She also criticized work like that of Toulmin’s for not accounting for how participants’ arguments transform over the course of a discussion.

Social argumentation in online communities functions differently than that of face-to-face situations, because of the recorded nature of the medium, the amount of time an argument can cover, and the number of individuals that can participate, which is a much greater number than can conceivably participate in a face-to-face argument. Social argumentation in general relies heavily on context (Walton, 1996). It is not enough to analyze a single excerpt of an argument, instead the type and goal of the argument must also be considered in order to have adequate context for analysis. De Moor and Efimova (2004) demonstrate how interest-driven spaces, as a context, promote argumentation, as well as learning (Martin, 2014; Steinkuehler, 2007). In the online game community of World of Warcraft, Alagoz (2013) found that the youth engaged in quality argumentation in a majority of their exchanges. She creates a streamlined approach with four elements: argument, counter-alternative, counter-critique, and other. Argument includes claim and evidence. Counter-alternative includes counter-claim and alternative evidence, which weakens an opponent’s position by introducing new criticism rather than attacking the opponent’s argument. Counter-critique includes counter-claim and refuting evidence, which is a more skilled attack that directly addresses an opponent’s argument. Alagoz uses Other to encompass agreement, disagreement, submission, restatement, etc.

Creating a sound argument is difficult for both individuals and groups to master (Rourke & Kanuka, 2007). In certain situations, especially where the goal is knowledge growth as much as winning a point (Andriessen et al. 2003a, b), strong argumentation in online communities can support and be supported by other types of problem-based learning like computational thinking. Brennan and Resnick (2012) created a computational framework (Table 1) that breaks down into three main parts: computational concepts, computational practices, and computational perspectives. What is demonstrated in Table 1 is that computational thinking is problem-based, contextual learning, which can be developed in interest-driven spaces. Computational thinking is knowledge building, and in fact could be the knowledge building that Leitão (2000) and Andriessen et al. (2003a, b) name as an important goal of argumentation.
Table 1. Brennan and Resnick’s (2012) computational thinking framework.

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Sequences</th>
<th>a particular activity or task is expressed as a series of individual steps or instructions that can be executed by the computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loops</td>
<td>a mechanism for running the same sequence multiple times</td>
<td></td>
</tr>
<tr>
<td>Events</td>
<td>one thing causing another thing to happen</td>
<td></td>
</tr>
<tr>
<td>Parallelisms</td>
<td>sequences of instructions happening at the same time</td>
<td></td>
</tr>
<tr>
<td>Conditionals</td>
<td>the ability to make decisions based on certain conditions, which supports the expression of multiple outcomes</td>
<td></td>
</tr>
<tr>
<td>Operators</td>
<td>provide support for mathematical, logical, and string expressions, enabling the programmer to perform numeric and string manipulations</td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>involves storing, retrieving, and updating values</td>
<td></td>
</tr>
<tr>
<td>Practice</td>
<td>Being Incremental and Iterative</td>
<td>an adaptive design process, one in which the plan might change in response to approaching a solution in small steps</td>
</tr>
<tr>
<td>Testing and Debugging</td>
<td>it is critical for designers to develop strategies for dealing with – and anticipating – problems</td>
<td></td>
</tr>
<tr>
<td>Reusing and Remixing</td>
<td>Building on other people’s work has been a longstanding practice in programming, and has only been amplified by network technologies that provide access to a wide range of other people’s work to reuse and remix</td>
<td></td>
</tr>
<tr>
<td>Abstracting and Modularizing</td>
<td>Abstracting and modularizing, which we characterize as building something large by putting together collections of smaller parts, is an important practice for all design and problem solving.</td>
<td></td>
</tr>
<tr>
<td>Perspective</td>
<td>Expressing</td>
<td>computational thinker sees computation as more than something to consume; computation is something they can use for design and self-expression</td>
</tr>
<tr>
<td>Connecting</td>
<td>wide variety of ways in which an individual Scratcher’s creative practice benefitted from access to others, through face-to-face interactions or online</td>
<td></td>
</tr>
<tr>
<td>Questioning</td>
<td>computational perspective of questioning, we look for indicators that young people do not feel this disconnect between the technologies that surround them and their abilities to negotiate the realities of the technological world</td>
<td></td>
</tr>
</tbody>
</table>

Methods

This research is rooted in the framework of the sociocultural perspective (Vygotsky, 1978; Wertsch, 1991). This study is part of a three-year ethnography (Hammersely & Atkinson, 2007) of both the online Scratch community and a three-year ethnographic study of Scratch workshops conducted in libraries in underserved neighborhoods in Los Angeles county. This paper focuses on the data collected from the online Scratch community. Observations were undertaken by two researchers. The researchers read both the data on the forums and the data in the studios and projects. The data collection of observational fieldnotes (Emerson, Fretz, & Shaw, 2011) for the online community took place from October 2014 to
October 2015, with roughly 500 hours of observation of the community. Data snippets of conversations were collected that illustrate learning and development within the community, this was along with descriptive fieldnotes. The long length of data collection was intended to get a large sample due to the immense size of the Scratch community and the amount of data available. The data was coded using qualitative coding (Saldana, 2012), using an a priori coding scheme made up of computational thinking perspective – expressing, connecting, and questioning (Brennan & Resnick, 2012) and Alagoz’s (2013) argumentation framework. This analysis does not look at computational thinking of each individual participant but looks at the community at a collective intelligence (Levy, 1999) level, taking a holistic view of the community. Collective intelligence is used as a lens for conceptualizing the community interactions as a whole.

Discussion

In Scratch, argumentation is used in a variety of situations, including in the forums, projects comments, and studios, with many Scratchers participating in all three settings. The forums are on average longer-form communication than the studio comments, which creates an atmosphere more conducive for quality argumentation. This analysis focuses on a lengthy and heated discussion that took place in the community in 2014, which started with a new thread that detailed a change to the community posted by a Scratch team member. This thread was selected because it was a polarizing event in the community, which made it very active and passionate. The first post in this thread announces that the numbers of Followers (those who a Scratcher follows) and of Following (those who follow a Scratcher) would no longer show on the profile page of Scratchers, with the exact number of followers still available by clicking “View All”. The Scratch team member adds to the description “We want to make sure people see someone’s projects, studios, and connections and not focus too much on the numbers. After all, it doesn’t matter if you have 10 followers or 10,000. Scratch is a place for creating, collaborating, and supporting fellow Scratchers.” This is the argument in support of the change made by the Scratch team, which set up the following argumentation from the Scratch community. The thread created a total of 769 posts before it was closed. The Scratch community was divided as to whether or not they supported the change. The reasoning for the divide and for their use of argumentation was influenced by their development of computational thinking. These are samples of the most common arguments for and against the change.

Scratcher1: Ah, hopefully it will discourage follow4follow accounts. ? [Other]

Scratcher2: That may be the whole point of removing the following/follower count.

I also want to add that the comment count maybe have been removed to get discourage messages like these: “800th Comment!” [Other]

These first two examples illustrate Other (which encompasses agreement, disagreement, submission, restatement, etc.), but they have an undertone of Expressing from computational thinking. This is because those who are interested in stopping follow4follow accounts (accounts that are willing to follow others in order to be followed) and number driven commenting, are part of a larger overarching argument in the Scratch community that these types of activities actually limit self-expression and creativity, because follow4follow accounts and number driven commenting decrease the quality of projects and accounts.
Scratcher3: Why I believe that this update is bad:

Taking the follow numbers away from the profile page does nothing. …This means that I’ll hardly know when somebody unfollows me. I like to know if that happens because I don’t want to be advertising something to repeatedly and annoying people, being too active… etc. However, about the people who are obsessed with followers, how will that discourage them? If they have enough time to spam several hundred people with follow requests, how is clicking one little button going to get them to stop? And taking the numbers away doesn’t mean that they don’t want followers any more. [Counter-alternative, Questioning, Connecting]

I like to keep track of everything on my profile and projects so that I know what people like, what types of projects encourage what types of activity, and so on. For example, I can tell you that my Updates project got quite a number of random comments on my profile, love its on my other projects, and not many love its for itself (compared to my other things of course). … If there were no numbers, then how would I know not to do that again? [Counter-alternative, Questioning, Connecting]

When you visit a profile, you usually have no idea how good or bad a user is at Scratch. Should you check out their projects? Should you not? Is the user just getting all of their thumbnails from another user that makes them look better at Scratch? Well, to determine this, many Scratchers look at the number of followers. If there are a lot of followers in a short amount of time, then you know that it’s probably worth checking out their projects! I usually will compare the number of followers to the joined date so that I know if the given Scratch is something new in the world of Scratch. I’m not saying that it’s not worth checking out projects if the user doesn’t have many followers, but I subconsciously do this a lot and it’s really annoying if I need to click twice more to do this! That’s a big waste of time! (Thanks to other Scratchers for reminding me of this). [Counter-alternative, Questioning, Connecting]

Scratcher4: Sure follows for follows can be annoying but being able to see each others followers also can be used as encouragement to try harder to make projects. Seeing someone with more followers than you have can encourage you to make more effort into your projects or at least get close to reaching the amount of follows that that person has. / And also, I don’t want to have to load another page just to check my followers or who I’m following. [Counter-Critique, Questioning, Connecting]

Scratcher5: Well see, sometimes I just want to find a user with really good high quality games when I’m bored, depressed, or needs some relaxing time. I usually check the follower count to know how good the user is. If the user has lots of followers, that usually indicates his games are good and I check out the projects. That might seem biased but it really helps to find good projects. I still check out lower quality projects and low-follow scratchers to encourage them. I’m not trying to discourage others, I’m just saying that some scratchers make better projects than others and follower count helps me to find them. [Counter-Critique, Questioning, Connecting]

As can be seen from these data examples, those that offer critique present quality arguments, and it is these arguments that demonstrate computational thinking. These Scratchers are countering the original argument that was posited the Scratch team, using counter-alternative and counter-critique. In the same argumentation, as demonstrated by the sample, they support their argument with computational thinking using connecting and questioning, which is developed throughout use of Scratch (Brennan & Resnick, 2012). Connecting is the plethora of ways in which “an individual Scratchers’s creative practice benefitted from access to others, through face-to-face interactions or online,” (Brennan & Resnick, 2012). What is happening in this conversation is Scratchers are pushing back against a change to the platform because they perceive it as inhibiting their ability to find other Scratchers to connect to using what they see as a major marker of quality (i.e., the number of followers someone has). Questioning is also seen throughout this argumentation. Brennan and Resnick, explain questioning in computational thinking as looking “for indicators that young people do not feel this disconnect between
the technologies that surround them and their abilities to negotiate the realities of the technological world,” (2012). In this argumentation the Scratchers demonstrate their connection between the technology that the platform offers, in this case the indication of number of followers, and their ability to negotiate the technological world. Scratchers are using both questioning and connecting as a way to support counter-critique and counter-alternative. They are specifically arguing that losing the ability to see the number of followers directly impacts their ability to judge if another Scratcher does quality work and if that Scratcher’s advice is sound. They also posit that the change would affect their creativity, impacting their ability to find quality projects to be inspired by, thus connecting computational thinking with argumentation.

Conclusion

Computational thinking being demonstrated within the Scratch community is not a surprise given that computation thinking was included in the design of Scratch, however the connection between argumentation and computation thinking was a surprise. As a result, I had to consider how computational thinking can improve argumentation. Using the Center for Computational Thinking’s (n.d.) conception of computational thinking as a whole life not solely a computer science framework, this study sheds light on the Scratch community utilizing computational thinking that they develop in their use of Scratch to contextualize and support their argumentation. For Scratchers, the forum offers them a place to actively engage in a community they feel strongly about. The forum functions as a place where the Scratch community can express their opinions, argue for and against features of the community, and take an active role in the functioning of the community. These findings inform and expand the current understanding of computational thinking and how it is used by youth to support argumentation.

Acknowledgments

This research has been funded by the National Science Foundation Cyberlearning grant “Coding for All: Interest-Driven Trajectories to Computational Fluency”.

References


How Do Presence, Flow, and Identification Affect Players' Empathy and Interest in Learning from a Serious Computer Game?

Christine Bachen (Santa Clara University), Pedro Hernandez-Ramos (Santa Clara University), Chad Raphael (Santa Clara University), & Amanda Waldron (Brookings Institution)

Abstract

This study develops and tests an integrated model of how several psychological aspects of serious game play contribute to interest in learning and empathy with people from other cultures. Data are drawn from a study of U.S. college students’ experience of playing one of two roles (an American journalist or Haitian survivor) in Inside the Haiti Earthquake, a simulation game that allows players to experience the aftermath of a recent disaster in a foreign land. Our results suggest that serious game designers should prioritize inducing empathy and immersive presence in players, giving secondary attention to designing for flow and character identification. To overcome barriers to empathy, educators should supplement games that challenge students to play characters from distant cultures and social backgrounds with additional lesson planning and instructional materials.

Introduction

To better understand the impact of serious games and more effectively design games for learning, we need to know more about how the psychological dynamics of play affect motivation to learn. This study tests a broad array of relationships among multiple variables of interest to educational game researchers by combining them into a single model, contributing to a more integrative understanding of the psychology of engagement in game play. We test this model using data from a study of U.S. students’ reaction to Inside the Haiti Earthquake (PTV Productions, 2010), which uses actual video footage of survivors and rescue efforts to simulate conditions in the immediate aftermath of the disaster that struck the country in 2010. Figure 1 contains the main variables of the model and the relationships we propose based on the research literature.
Presence is “the perceptual illusion of nonmediation” felt by media users when they project themselves into the physical or social space of the medium (Lombard & Ditton, 1997). Although the dimensions of presence have been defined and measured in multiple ways, we focus on one dimension in this study: immersive presence.

Flow is the state of profound enjoyment and concentration experienced during activities in which a person’s skills match the challenge of the task (Csikszentmihalyi, 1990). According to flow theory, we experience flow when an activity’s challenges fully engage our skills, without overwhelming them. Tasks that are too simple to engage our capacities result in boredom; challenges that outstrip our skills produce anxiety. If presence describes immersion in the physical and social relations of the game world, flow accounts for immersion in the tasks required by the game.

Identification is “an imaginative process through which an audience member assumes the identity, goals, and perspective of a character” (Cohen, 2001, p. 261). This is distinct from empathy, which is an “other-oriented emotional response elicited by and congruent with the perceived welfare of someone else” (Batson, Ahman, & Lishner, 2009, p. 418). While most measures of empathy have been quite general, Wang et al. (2003) developed a pioneering measure of ethnocultural empathy to account for empathetic responses directed toward people from racial and ethnic cultural groups different from one’s own group. This form of empathy is particularly relevant to the present study, which focuses on U.S. students’ responses to a game about the experiences of Haitians.

Interest in learning is probably the most consensually-accepted and well-supported outcome of educational game play in the literature (Young et al., 2012). Interest is also strongly predictive of other learning outcomes (Hidi & Ainley, 2008). We focus on post-game interest in learning as one way of testing whether game-based learning transfers to the world beyond.

Gender has often been a subject of research on several aspects of our proposed model but because results are inconclusive, we include gender as a control. For example, while females sometimes report that game-based learning is less interesting and enjoyable than males do (e.g., Bonanno & Koomers, 2008), these differences may be explained by other factors, especially amount of prior experience with game play and whether games are perceived as easy to use (Bourgonjon et al, 2010). Because participants played two different roles in the game used in this study, game role was also included as a control.
While the research has produced some mixed findings about certain relationships (e.g., between flow and learning) or has varied in its explication and measurement of key constructs (e.g., presence and empathy), the hypothesized relationships within the model shown in Figure 1 have received some support or can be extrapolated from theory.

- **H1:** Pre-game levels of empathy will positively influence presence and in-game empathy for the Haitian people. Research has documented the importance of prior empathy’s impact on presence (e.g., Nicovich, Boller, & Cornwell, 2005), and it is reasonable to expect that more empathetic people will continue to be so during game play.

- **H2:** Presence will positively contribute to flow, identification, in-game empathy, and interest in learning. The more that participants feel immersed in the simulation experience, the greater the likelihood that they will enter a state of flow as they complete game tasks (e.g., Jin, 2011). As players feel more involved and absorbed, it follows that they will identify more with their character (e.g., Jin, 2011), express greater empathy for the people represented in the game after playing (Greitemeyer et al., 2012), and be more interested in learning about the issues these people face (Weibel & Wissmath, 2011).

- **H3:** Flow will positively influence identification (Jin, 2011), in-game empathy (Raphael et al., 2012), and interest in learning (Fu et al., 2009; Raphael et al., 2012).

- **H4:** Identification will positively contribute to in-game empathy and interest in learning (Bachen et al., 2012).

In addition to these hypothesized relationships among individual variables, we propose that taken together they will significantly contribute to a model explaining in-game empathy and interest in learning more about the subject matter of the game. In that model we will be able to see more clearly the relationships among independent variables and identify the relative contributions of each in explaining in-game empathy and interest in learning. Within that model, we also examine the following research questions:

- **R1:** What is the effect of players’ gender on the relationships in the model?
- **R2:** What is the effect of the role played in the game on the relationships in the model?

**Method**

Data were collected at a private California university from 146 undergraduates (54 male, 92 female) ranging in age from 18 to 24 (Median = 20), with the exception of one older student. Participants were recruited voluntarily from 13 different sections of five different communication courses.

Participants played *Inside the Haiti Earthquake*, in which players performed the roles of an American journalist (a white, male professional from the developed world) or a survivor (Haitian, low-income, and female) of the real-world tragedy that struck the country in 2010. Thus, these two roles offered opportunities to test whether players could identify with one character who was culturally distant from their experience (the survivor) and another that was more similar (the journalist, especially because the participants were enrolled in communication courses). In each role, players traverse a branching narrative in which they must decide how to cover the story accurately and from multiple perspectives (journalist) or find medical attention and food (survivor).
Haiti is a simulation game (Warren et al., 2012). Like a simulation, it models a set of conditions and rules, in this case for journalists and survivors of a natural disaster in the developing world. Like a game, it has specific win/loss conditions. For example, as the journalist, if you file stories that are framed inconsistently, you get fired. Haiti is also a documentary game (or docugame), which provides a historical record of an event and those who experienced it. Docugames aim to create a sense of social realism by representing real-world environments and narratives, and affording player actions that seem true to life (Bogost, Ferrari, & Schweizer, 2010). Unlike many previous docugames, the Haiti interface represents events entirely through news photographs and especially through journalistic video footage, not computer graphics.

The game was chosen because of its potential to induce the psychological states relevant to the study. We anticipated that the realism of the game genre, subject, and interface would inspire a sense of presence. The video footage of recognizable, individual people, including many who are struggling to survive the aftermath of the quake or to help its victims, suggests the game may provoke empathy. The challenges posed seemed appropriate to college students, favoring flow. The game affords character identification and interest in learning because players are confronted with morally-charged dilemmas in each role, such as whether to focus on the sometimes chaotic and ineffectual nature of the aid effort even if this might dampen donations (journalist), or to join others in “salvaging” food from a ruined grocery or shun “looting” from the store (survivor).

The study was introduced as a research project about games and learning. As incentives, students were offered a $20 gift card and the satisfaction of assisting senior thesis students (with whom the data were gathered) with their research. Thus, there was a self-interested and an altruistic incentive. A pre-game survey to measure global empathy and demographic variables was administered via computer in a lab about a week prior to playing the game. Two guest professors, one male and one female, administered the initial survey and game play sessions to about half of the sample apiece. Game play occurred in students’ regular classrooms during class time. Males and females in each course were randomly assigned to the journalist role (N=71) or survivor role (N=75). Participants were briefed on how to navigate the game, and then played it using headphones. All participants were able to reach the game’s conclusion at least once; most students played more than once, exploring different choices in the same role. The post-game survey, which measured presence, flow, identification, in-game empathy, and interest in learning was administered via computer in the classroom immediately after game play.

To strengthen internal validity of the study, all game play occurred in the same classroom and all students played on computers with similar-sized screens, resolution, and mice. Students played for 20 to 25 minutes. The fact that students played in their own classroom as part of a regular course strengthened the external validity of the study’s conclusions about effects on interest in learning.

Presence was measured using all six items from the engagement (mental immersion) subscale from the Temple Presence Inventory (Cronbach’s α = .919), developed by Lombard, Ditton, and Weinstein (2004). The 15-item scale measuring all eight dimensions of flow originated in Fu, Su, and Yu (2009) and was adapted and validated in Bachen et al. (2012) and Raphael et al. (2012) (Cronbach’s α = .815). Identification with the character played in the simulation was measured using a six-item scale developed and validated in Bachen et al. (2012) (Cronbach’s α = .843). Because the game used in this study challenged U.S. college students to empathize with people in a less developed country, the initial survey measured empathy using a 10-item version of the scale of global empathy adapted and validated in Bachen et al. (2012) and Raphael et al. (2012), based on Wang et al. (2003) (Cronbach’s α = .778).
This scale was modified for the post-game survey to measure players’ in-game empathy with Haitian people (Cronbach’s α = .820). On the post-game survey, a five-item scale measured interest in learning more about game topics, including “how aid organizations help survivors of natural disasters,” “how disasters are reported in the media,” “how disaster survivors cope,” and “what’s happening in Haiti after the earthquake” (Cronbach’s α = .907).

Results

Table 1 presents the means, standard deviations, and correlations among all key variables included in our analyses. These data show that the game successfully induced high levels of flow, presence, and identification (with means generally well above the midpoints on each scale for these variables), although there was a good deal of variation in the sample. The means also show that the sample had high initial levels of global empathy and expressed almost equally high levels of empathy for the Haitian people after playing the game, as well as moderately high interest in learning more about the game topics, despite substantial variation among players.

Table 1. Means, standard deviations (S.D.), and correlations for key variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>Range</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender [1 = M 2 = F]</td>
<td>1.63</td>
<td>.48</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Role [0 = Survivor 1 = Journalist]</td>
<td>.49</td>
<td>.50</td>
<td>.036</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Flow</td>
<td>66.40</td>
<td>10.83</td>
<td>15 - 90</td>
<td>.042</td>
<td>.013</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Presence</td>
<td>31.26</td>
<td>6.66</td>
<td>6 - 42</td>
<td>.105</td>
<td>.038</td>
<td>.530***</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Identification</td>
<td>26.95</td>
<td>5.97</td>
<td>6 - 36</td>
<td>.051</td>
<td>-.133</td>
<td>.428***</td>
<td>.692***</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Global empathy</td>
<td>44.17</td>
<td>7.16</td>
<td>10 - 60</td>
<td>.011</td>
<td>-.028</td>
<td>.245**</td>
<td>.354***</td>
<td>.323***</td>
<td>–</td>
</tr>
<tr>
<td>In-game empathy</td>
<td>44.32</td>
<td>8.05</td>
<td>10 - 60</td>
<td>.012</td>
<td>-.063</td>
<td>.440***</td>
<td>.653***</td>
<td>.496***</td>
<td>.548***</td>
</tr>
<tr>
<td>Interest in learning</td>
<td>18.14</td>
<td>5.12</td>
<td>5 - 30</td>
<td>.079</td>
<td>.049</td>
<td>.129</td>
<td>.298***</td>
<td>.298***</td>
<td>.210*</td>
</tr>
</tbody>
</table>

Note: * = p < .05; ** = p < .01; *** = p < .001

First, we will provide results for each of our hypotheses and research questions using correlations and linear regression, and then report the structural equation modeling (SEM) analyses that considered the model as a whole, including the control variables of gender and role in the simulation.

**H1:** Pre-game levels of global empathy will positively influence presence and levels of in-game empathy. Participants’ levels of global empathy correlated strongly with presence (r=.354, p=.000; R² from linear regression =.1253) and with in-game empathy (r=.548, p=.000; R² from linear regression =.3005). **H2:** Presence will positively contribute to flow, identification, in-game empathy, and interest in learning. There was a strong positive correlation between presence and flow (r=.530, p=.000); presence explained 28.09% of the variance in flow. Presence and identification were positively correlated (r=.692, p=.000), with presence explaining 47.84% of the variance in identification. The relationship of presence to in-game empathy was also strong (r=.653, p=.000, 42.59% of variance explained), but much weaker (although still positive) to interest in learning (r=.298, p=.000, 8.9% of variance explained). **H3:** Flow will positively influence identification, in-game empathy, and interest in learning. Flow is significantly correlated with identification (r=.428, p=.000, 18.27% of the variance explained) and in-game empathy (r=.440, p=.000, 19.38% of variance explained) but not with interest in learning (r=.129, n.s., 1.66% of variance explained). **H4:** Identification will positively contribute to in-game empathy and interest in learning. Identification was significantly related to in-game empathy (r=.496, p=.000, 24.56% of variance explained) and to interest in learning (r=.298, p=.000, 8.9% of variance explained).
We now turn to structural equation modeling to analyze the impact of all variables together in the model and address the research questions. First, considering the entire sample (n=146), the data were a good fit for the model (\(\chi^2(3) = 2.53, p=.469, \text{RMSEA} = .000, \text{SRMR} = .020\)). Results (see Figure 2) showed that only in-game empathy for Haitians had a significant effect on interest in learning (Std. Coeff. = .27, \(p=.007\)). Flow, identification, and presence had no significant direct effect on interest in learning, although the hypothesized positive influence of presence on both flow (Std. Coeff. = .53, \(p=.000\)) and identification (Std. Coeff. = .65, \(p=.000\)) was confirmed (see results for H2 and H3, above). Presence also had a significant effect on in-game empathy (Std. Coeff. = .46, \(p=.000\)). Thus, for the sample as a whole, any influence of presence on interest in learning was mediated mainly by in-game empathy. Post-hoc analysis of direct and indirect effects confirmed this: While the total effect of presence on interest in learning was .2459, the direct effect was only .0529 (\(p=.651\)) but the indirect effect was .193 (\(p=.000\)).

While males and females, and players of the journalist and survivor, ended with indistinguishable levels of in-game empathy and interest in learning (as shown by t-tests), we wanted to know whether they arrived at these similar levels through the same combination of psychological influences. These next analyses allow us to see whether our model accounts equally well for the experiences of players of each gender and role when all variables are looked at simultaneously.

**R1: What is the effect of player’s gender on the relationships in the model?** Overall, the data were a good fit for the model (males n=54, \(\chi^2(3) = 3.78, p=.286, \text{SRMR} = .052\); females n=92, \(\chi^2(3) = 1.732, p=.630, \text{SRMR} = .018\)). Four major differences are worth noting when comparing these analyses (see Figures 3a and 3b). First, in both groups presence is a significant predictor of both flow and identification, but only for females did flow significantly predict identification (Std. Coeff. = .17, \(p=.038\)). Second, for females, in-game empathy was significantly influenced by presence (Std. Coeff. = .63, \(p=.000\)), but not for males (Std. Coeff. = .16, n.s.). Third, for males, flow (Std. Coeff. = .35, \(p=.003\)) influenced in-game empathy, but not for females (Std. Coeff. = .01, n.s.). Fourth, none of the hypothesized influences on interest in learning were significant for males, whereas for females both in-game empathy (Std. Coeff. = .36,
and identification (Std. Coeff. = .29, \( p = .042 \)) were significant predictors. Post-hoc tests for group invariance of parameters confirmed that the influence of presence (\( \chi^2 (1) = 6.621, p = .010 \)) and flow (\( \chi^2 (1) = 6.046, p = .014 \)) on in-game empathy operated in significantly different ways for males and females in this study.

*Figure 3a. SEM results for males (n=54).*

*Figure 3b. SEM results for females (n=92).*

In sum, these models showed notable gender differences. For males, experiencing flow in the game influenced in-game empathy toward the people affected by the Haiti earthquake, but did not influence their interest to learn more about the situation. In contrast, females’ in-game empathy was not influenced by a sense of flow in the game, but identification affected their interest in learning more about the situation after the disaster along with in-game empathy. It is worth remembering here that individual t-tests showed no significant differences by gender on any of the variables in the model tested in this study, so one benefit of SEM in this case is that it allows us to better understand the subtle differences in how males and females experienced the game.
R2: What is the effect of the role played in the game on the relationships in the model? As was the case with gender, overall the data were a good fit for the model for both roles (see Figure 4a for journalist, \( \chi^2 (3) = 1.315, p = .725, \) SRMR = .025; see Figure 4b for Haitian survivor, \( \chi^2 (3) = 4.991, p = .172, \) SRMR = .037). However, among Haitian survivors, global empathy (Std. Coeff. = .55, \( p = .000 \)) was a significant influence on presence, but not among those playing the journalist (Std. Coeff. = .08, n.s.). Additionally, among participants who played as a survivor none of the predictors of interest in learning (in-game empathy, flow, identification, or presence) were significant, whereas for players in the journalist role both in-game empathy (Std. Coeff. = .48, \( p = .000 \)) and identification (Std. Coeff. = .27, \( p = .029 \)) were significant predictors. Post-hoc tests for group invariance of parameters confirmed that those who played as the journalist (Std. Coeff. = .077, n.s.) and those who played as the survivor (Std. Coeff. = .55, \( p = .000 \)) differed significantly on how global empathy affected presence (\( \chi^2 (1) = 16.344, p = .000 \)).

![Figure 4a. SEM analysis for participants who played as journalist (n=71).](image)

![Figure 4b. SEM analysis for participants who played as Haitian survivor (n=75).](image)
In summary, there were also notable differences in the results by role played in the game. While presence and global empathy influenced in-game empathy for both groups, their pathways to interest in learning differed. For those who played as the journalist, identification and in-game empathy positively influenced interest in learning, whereas for those who played as the survivor none of the predictors were significant.

Discussion and Conclusion

This study set out to explore the inter-relationships among a set of factors that can influence empathy and interest in learning more about a topic of study. Our analyses of sets of pairs of relationships confirmed some patterns we had seen in previous research cited above. Presence, flow, and identification were significantly related and were linked to two outcomes: empathy for people represented in the game and interest in learning.

Structural equation modeling allowed for comparing the relative power of a unique set of variables, showing that some factors played a more important role in explaining game outcomes than others. When testing the model with the whole sample, we found that interest in learning was only directly influenced by in-game empathy and not directly by any of the other game play variables (presence, flow, identification). This suggests that designers of serious games would be wise to prioritize creating interfaces and game play that encourage players to engage with the cognitive, emotional, and communicative experiences of peoples from other cultures. In this light, empathy for others is not just a worthy disposition for global citizens, but a powerful key for unlocking interest in other cultures.

Immersive presence emerged as an important state that is both influenced by a player’s base level of global empathy but that also enhances empathy for people from other cultures in a game. Both findings align with prior research (Greitemeyer et al., 2010; Nicovich et al., 2005). The fact that immersive presence also had a strong positive influence on both flow and identification regardless of player gender or game role reinforces that presence is also a crucial dimension of serious game design. Deep immersion in the game world seems to have allowed players to experience Haitians’ lives as real and achieve empathy with them. Presence may be especially helpful to female players, given our finding that this state had a direct positive effect on females’ experience of in-game empathy for Haitians. The use of video footage of actual historical events in this game may be particularly effective at inspiring perceptual and psychological immersion in the game environment.

The fact that flow and identification made secondary contributions to our outcome variables, both of which varied by players’ gender, suggests that fostering these states may be valuable but insufficient goals for educational game design. For males, flow mediated the contribution of presence to in-game empathy, while for females identification emerged as a positive influence on both flow and interest in learning. It may be that males are somewhat more likely than females to develop cognitive and emotional connections to people represented in games by engaging in tasks posed by game play. Females may be more likely than males to have their interest in other peoples piqued by inhabiting a game character from another culture, which jibes with many females’ greater interest in role-playing fantasy games than in first-person shooter games that largely appeal to males (Bourgonjon et al., 2010). If so, the goal of designing gender-inclusive educational games and simulations might be served well by striving to induce both flow (especially to engage males empathetically with other cultures) and identification (to interest females in other peoples).
However, the students in our study related better to the virtual experience of the American journalist covering the disaster: the combined effects of identification with the journalist role and in-game empathy for the Haitian people made a significant contribution to interest in learning more about the game topics, which was not the case for those who played as the survivor. We suspect that the cultural barriers to empathy identified by Rasoal, Eklund, & Hansen (2011) may also help to account for the diminished role of identification among players of the survivor role. Lack of knowledge and experience of a different culture, and inability to perceive similarities and differences between another culture and one’s own, may be obstacles to identifying with a character from another country, ethnicity, or social class. One implication is that game designers and educators may need to acknowledge that developing identification with people who are perceived as psychologically or geographically distant requires more extended interventions in surrounding lesson plans and supplementary materials that prepare students to immerse themselves in a different culture.

References


35.

**More Than Making Games**

Exploring the Professional Pathways of Women in the Game Industry

*Amanda Ochsner (University of Southern California)*

**Abstract**

Many educators, researchers, and industry stakeholders share the common goals of fostering inclusivity in game communities and seeking ways to support young women in games and technology. This paper reports findings of a qualitative research study investigating the learning pathways, experiences, and expectations of women who work in the game industry. Interview data reveals that women in games share a common interest in making game communities and workspaces better for the next generation of game designers. Overall, participants’ contributions to these efforts fall into four primary roles: educators, advocates, role models, and leaders. Findings offer insights about how game industry professionals understand their personal and professional pathways, and reveal how participants approach solutions for common barriers. This research hints at a number of possible research directions for researchers and educators looking to design better programs, curricula, and interventions that support young women along their learning pathways in games.

**Girls in Games and Women in Tech**

Topics such as the marginalization of women in technology and problematic representations of female characters in games have become part of the mainstream discourse. To people who work in and research the game industry, these issues are not new: the number of women graduating with degrees in computer science has been going down for decades (Hayes, 2010); female characters have long been underrepresented in games (Williams, 2009); and girls and women who play games at public events and online have been constant targets for harassment. Controversies such as the Gamergate movement—in which a hostile subset of gamers used Twitter and other media platforms to harass and threaten women who work in games—have been widely covered in the mainstream media. Academics and game industry leaders alike are motivated to improve conditions for women in games and technology. This momentum creates opportunities to design and research strategies that will empower girls with the tools and skills they need to be confident programmers, designers, and creators of games. As more scholars and educators pursue these goals, it is important that they draw from the expertise of women in the industry. What could be learned from the experiences of women who currently work in games to inform the design of better programs, more effective curricula, and ultimately, to support women on a pathway to successful careers in games and technology?

In this paper, I report on findings from a qualitative research study investigating the learning pathways, contemporary experiences, and expectations of women who work in the game industry. Findings
are based in in-depth interviews with 20 women, and one gender queer participant, who identify as game industry professionals. Questions to participants addressed, what has defined and influenced their learning pathways? What does it mean to the participants to be a woman working in the game industry? How did they come to a professional career in games and what were defining points along that pathway? Knowing more about the pathways that women take to game careers and the experiences they have in those roles may provide insights about what kinds of resources, support structures, and learning environments can be put into place to support more women in pathways to game design. I discovered that each of the women she interviewed contributes to efforts to achieve these very same goals. Findings revealed not just insights about participants’ trajectories, but also brought to light their work as educators, advocates, role models, and leaders. Each of the participants in this study plays their own part in fostering diversity and inclusivity in the industry they love.

Getting Girls Into the Game

Over the past few decades, a variety of research-based programs and interventions have sought to engage girls in game design. Kafai (1996) evaluated the differences between games made by boys and girls, finding more variability in games made by boys compared to girls, suggesting that boys had more commercial game influences to draw from. Game designer Brenda Laurel (1998) has made a similar argument, explaining that video games give boys an edge in becoming comfortable with computers. Hayes and King’s TechSavvy Girl’s Club (2009) sought to help girls develop tech fluency by playing and modding The Sims 2. The program supported girls in leveraging their existing play practices to develop tech fluencies and challenged traditional paradigms of technology by re-envisioning them to incorporate values traditionally aligned with feminine frameworks. Game developer Mary Flanagan and colleagues designed a game called RAPUNSEL to teach programming to middle school girls. The work was motivated by a desire to address prior failures to attract women to careers in IT fields and the team prioritized including girls’ perspectives in their design (Flanagan & Niseenbaum, 2008). A program called Girls Creating Games paired middle school girls together to collaborate on designing a game with the goal of increasing their interest and confidence in becoming producers of technology (Denner, 2007; Denner, Bean, & Martinez, 2009).

A theme that spans across these game-based programs and interventions is a struggle over values. The designers and academics who develop these programs want to respect girls’ interests and preferences. Kafai wondered, what kinds of worlds and characters do girls design into their games? Hayes and King took The Sims 2, a game immensely popular with female audiences, as their starting point for exploring, how could we get girls engaged in trajectories of IT fluency? The RAPUNSEL team put the question, ‘what do girls value?’ at the center of their design. Finally, Denner and the Girls Creating Games team conducted extensive research asking, what kinds of experiences did the girls have in pursuit of their goal of increasing girls’ confidence as producers of technology. Each of these projects encountered struggles—whether technical constraints, ideological tensions, or otherwise—in their efforts value what girls care about. These kinds of issues come up across all kinds of learning interventions, but can require a special sensitivity when developers want to take care not to reject or ghettoize the things their participants care about. All of these programs and interventions were designed with change in mind. These efforts were meant to challenge the status quo and to bring more girls to the playing fields of technology and media. Much can be learned from the struggles that these scholars and designers faced, and from the choices they made when faced with them.
Supporting Positive Learning Pathways

Learning from the collective wisdom of the educators and scholars who have created programs to engage girls in game design is a critical component in understanding how we can help level the playing field for girls in games and technology. But learning such complex skills and developing identities as technologically competent and capable designers is a longitudinal process, spanning over many years and many learning contexts. Even with a vibrant history of great programs and research studies, scholars of games, technology, and learning still struggle to fully understand the complexities of the learning ecologies (Barron, 2004; 2006) that girls and women encounter throughout their educational trajectories. To identify what kinds of experiences will support girls in developing identities as capable producers of technology or games, additional research is needed on the paths of development undertaken by women who came before them. Barron (2006) describes a “multiplicity of pathways among learning contexts that learners might take” (p. 200) depending on the learner’s unique configuration of interests, which are determined by the combination of ideational, social, material, and identity resources that the learner has access to. Her research shows that learning involves a process whereby learners appraise the fit of a potential learning direction by examining it against their sense of self and perception of their values. This study applies the learning ecologies framework to examine the pathways of women who work in games. By understanding how female game professionals have navigated this process for themselves, researchers and educators can better understand how to foster positive pathways for future cohorts of women in games.

Methods

Methodological Rationale

The interviewing strategy for this study was based on the open interview used in person-centered ethnographies (Levy and Wellenkamp, 1989; Hollan & Wellenkamp, 1994) and Seidman’s three-part interview series. Levy and Wellenkamp argue that person-centered research methods are ideal for enabling participants to share “rich material bearing on feelings and understandings about feelings and their transformations throughout various stages of life, on learning…on self-concept and on other such personally centered dimensions of experience” (p. 224). Sediman’s (2013) interviewing technique emphasizes understanding “lived experience of other people and the meaning they make out of that experience” (p. 9), prompting participants to talk about how they make meaning of their past, present, and future selves.

Participants

This research is based on interviews with 21 participants—20 women and one participant who identifies as gender queer. Based on my previous role as a game journalist and editor, I reached out to my personal network of game industry contacts to recruit an initial group of participants and then identified additional participants through snowball sampling. Rather than focusing on only designers, producers, or programmers, I opted to speak with women who work in various roles across the industry. As part of the selection criteria, participants had to self-identify as a game industry professional and have worked in games as their primary professional affiliation for at least a period of two years. The demographics
of the participants in this study align closely with the overall race and age demographics of the game industry (Westar & Legault, 2015). To best understand the diverse trajectories of women in games, I purposively recruited participants with diverse histories, experiences, and values.

 Interviews & Data Collection

The data for this study was collected over a period of six months, in four different states, including two game events—one academic conference and one industry focused conference. The majority of the interviews were conducted in-person, though a few were conducted online over Skype. Interviews ranged from 40 minutes to nearly 4 hours in length. I recorded and transcribed each interview personally, ultimately generating nearly 500 pages of transcripts for analysis. All participants have been assigned a pseudonym and all identifying information such as company names and locations has been removed.

 Analysis Procedure

For analysis, I first completed one round of descriptive coding (Saldaña, 2013) on each interview before generating a more focused coding scheme in a second round of coding and memo writing. I utilized the qualitative research software MAXQDA for the coding and analysis process. The final coding scheme consisted of two different types of codes—pathway codes about participants’ personal and professional pathways, and value codes (Saldaña, 2013), for sections where participants talk about things and people they value. By coding for major themes in participants’ pathways and by identifying similarities and differences in the values of participants, I was able to identify shared themes and threads in women’s trajectories and experiences in the game industry.

 Data & Findings

In exploring the learning pathways, experiences, and expectations of women in games, one of the predominant themes that came up consistently is that each participant engages in some kind of effort to promote better conditions and pathways for women in games. When talking with participants about their strategies as leaders, their values as developers, and the ways they spend their time, there is a common theme of wanting to leave a lasting positive impact on the game industry, particularly when it comes to making things better for underrepresented groups of designers, particularly women. While there are a variety of other threads and themes across the interviews, in this paper I focus on the ways in which participants are work to contribute to a better industry for women and other minorities in games. This theme aligns with the study’s goal of identifying how we can re-design education spaces to better engage young women in technology and game design.

Just as the participants in this research have diverse pathways to games and diverse roles in games, so too are their contributions to making game-based play and work environments better for women. Some women care about creating educational opportunities, introducing girls to games and promoting professional development opportunities for students. Others have chosen to take on advocacy roles, speaking out publicly about issues around women in games or working behind the scenes on resources for people experiencing online harassment. Some contribute by persistently pursuing the work they love and serving as role models for girls who strive to do the same. Finally, some women are taking leadership
roles in their companies—raising their financial and social capital to make games featuring powerful female characters and changing how they recruit and hire new employees in ways that are more inclusive and welcoming to women. I break these different types of efforts and activity into four primary roles: educators, advocates, role models, and leaders. See Table 1 below for an overview of participants, their industry jobs, and their primary role(s) in supporting other women in games.

<table>
<thead>
<tr>
<th>Participant Name</th>
<th>Primary Industry Job</th>
<th>Role in Supporting Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrea</td>
<td>Director of Programming</td>
<td>Role Model</td>
</tr>
<tr>
<td>Annabelle</td>
<td>Quality Assurance Lead</td>
<td>Advocate</td>
</tr>
<tr>
<td>Bethany</td>
<td>Chief Executive Officer</td>
<td>Advocate &amp; Leader</td>
</tr>
<tr>
<td>Casey</td>
<td>Programmer</td>
<td>Role Model</td>
</tr>
<tr>
<td>Cassie</td>
<td>Game Designer</td>
<td>Role Model</td>
</tr>
<tr>
<td>Debbie</td>
<td>Artist</td>
<td>Role Model</td>
</tr>
<tr>
<td>Erin</td>
<td>Director of a Non-Profit Org</td>
<td>Educator &amp; Leader</td>
</tr>
<tr>
<td>Eva</td>
<td>Game Designer</td>
<td>Educator</td>
</tr>
<tr>
<td>Grace</td>
<td>Game Designer</td>
<td>Role Model</td>
</tr>
<tr>
<td>Josephine</td>
<td>Indie Game Designer</td>
<td>Educator</td>
</tr>
<tr>
<td>Kate</td>
<td>Game Journalist</td>
<td>Role Model</td>
</tr>
<tr>
<td>Kim</td>
<td>Director of a Non-Profit Org</td>
<td>Advocate &amp; Leader</td>
</tr>
<tr>
<td>Maggie</td>
<td>Chief Executive Officer</td>
<td>Advocate &amp; Leader</td>
</tr>
<tr>
<td>Margaret</td>
<td>Game Developer</td>
<td>Advocate</td>
</tr>
<tr>
<td>Marie</td>
<td>Industry Recruiter</td>
<td>Educator</td>
</tr>
<tr>
<td>Mia</td>
<td>Chief Executive Officer</td>
<td>Leader</td>
</tr>
<tr>
<td>Natalie</td>
<td>Artist</td>
<td>Role Model</td>
</tr>
<tr>
<td>Naomi</td>
<td>Game Designer</td>
<td>Role Model</td>
</tr>
<tr>
<td>Savannah</td>
<td>Producer &amp; Localization</td>
<td>Role Model</td>
</tr>
<tr>
<td>Sera</td>
<td>Quality Assurance</td>
<td>Advocate &amp; Educator</td>
</tr>
<tr>
<td>Teagan</td>
<td>Game Designer</td>
<td>Advocate</td>
</tr>
</tbody>
</table>

Table 1. Interview participants, their primary industry jobs, and their roles to support women in games.

Creating Educational Opportunities

Several participants emphasized the need to create safe, inclusive, and supportive environments for girls that span from middle school to up through their first years in the game industry. One person who was particularly articulate about this was Sera, who volunteers several out-of-school youth programs. She explained, “the key is reaching the girls when they’re in middle school and junior high to combat the
culture that says the engineering and math stuff is for boys.” She described what happens when young girls go through the process of making their own game:

It opens them up to, ‘If I’m gonna do a class project, I could do a poster. I could do a website. Or I could make a game.’ And when that’s a part of their possibility space, the change is big.

Josephine, an indie game developer who did not grow up playing, also believes that early exposure to games as a possibility space is a critical component to recruiting more girls. “I never thought that I could make games,” she said. “I didn’t grow up with a console and I didn’t have a personal computer until I was 17.” She was diagnosed with a learning disability early on and was assigned to classes that only covered basic word processing skills. She explained, “A lot of the tech stuff was for the gifted kids. I was shut out of a lot of that. I thought, I can’t do that because they have the gifted kids doing that.” Because of her own late start with technology, Josephine cares deeply about creating opportunities for young girls. When showing off their games at games festivals, Josephine and her husband make sure girls get equal play time.

Erin is the executive director of a group that organizes professional development events and early career opportunities for students at a university in the Midwest. She feels strongly about creating opportunities for students in her home state, where there are not many jobs in game development. By bringing together people with different backgrounds, her group is able to foster diversity and help students gain confidence. She described, “For students, and for female students especially, finding a space where they feel like they have a support system and a safe space is tough.” Though it has not been easy, Erin’s organization has aimed to provide that space and that support network, and she hopes the students will continue to embody those values in the future. Erin summarized, “This is how we feel like we can impact the industry, through students and student development.”

**Advocating for Women & Diversity in Games**

Kim works as an advocate for women and other under-represented groups in the industry by serving as the executive director a game industry advocacy group. “I want to see change happen,” she described. “That’s my thing. I think we’re change agents. Every single one of us. That’s what we’re here for. And that’s what I’m trying to do.” Kim has been working on several new diversity initiatives, building new partnerships for her organization to advocate for greater diversity in games and the industry.

Teagan is a gender queer indie game developer and advocate for marginalized game players and developers. Observing that gaming communities tend to marginalize the types of players they care about, Tegan spoke about the “death of a thousand paper cuts and micro-aggressions” that has become a part of the rhetoric around women in technology. Teagan’s approach is to empower people to tell their own stories through interactive narrative. They explained:

Part of building a community is to empower, to create the community that you want to see. So if I empower the voices I want to see more of in my community, then educating them and giving them the tools to learn this stuff is really important.

For Teagan, learning about game developers who grew up in poverty has been a powerful experience and they encourage others to educate themselves too. “Being a good ally takes a lot of work,” Teagan said. “It’s a process. I don’t believe in the idea of a good person or a bad person. But I believe that making
the world a better place for everyone takes work.” Teagan believes games can be a powerful medium for people to tell their stories and for privileged individuals to learn about the struggles and experiences of those who are marginalized.

Growing up in a household that valued involvement with non-profit organizations and giving back, Sera says she never learned how to say no to volunteering. Currently, she is involved with anti-harassment campaigns, training for speakers, mentoring for girls, and what she calls general advocacy work for women in games. Many of Sera’s efforts involve behind the scenes work with organizations, campaigns, and special interests groups, but she said she also continues to speak out and “give voices for those who are voiceless.” Sera thinks that many women would benefit from joining sponsorship programs with groups like the International Game Developers Association’s Women in Games Special Interest Group.

“It’s a million little messages,“ said game developer and industry advocate Margaret as she spoke about her frustration with how women in technology fields are treated. In a recent meeting, a company leader ended a meeting by laughing at her work for women in technology. “It was just a small moment for him,” Margaret explained. “Just something that felt like a joke to him. But it hurt me so deeply. And our careers have a thousand moments like that.” Margaret’s style of advocacy involves speaking out publicly in the press and social media. Her advocacy work has made her a target of Gamergate and she has received numerous threats to her safety and her life. This is worth risking your life for,” she explained. “I feel like the question of if women can work in games is a question of if we can work in technology. This is where the human race is going. And if we don’t get this problem under control now, it’s going to really be bad in the future for women.” Margaret believes it is imperative that women stick together. She expressed that one of the ways that feminism fails is when people start to believe that their version of reality is the only reality. “We need to be ruthless about promoting each other. I feel so strongly about that.”

**Being a Role Model**

Kate is an avid game player and a game journalist. Her love for games is a core part of her personal and professional identities. Because she is also a woman and a lesbian, Kate feels that sometimes she is pressured into taking on advocacy roles that she sees as distracting from her professional goals. She explained:

I get pigeon holed into the advocacy track and I’m like, okay, yes, I can bring an interesting perspective from being a woman and a lesbian in this field. But I’m going to be perfectly honest, being a lesbian is very personal to me. I get a little self conscious and embarrassed when I’m asked to write about it. I don’t want to write about it. I got into the industry because I like writing about video games from an artistic perspective, from a critical perspective. I like games. Please don’t define me by my gender.

Though many participants in this study opted not to take on groups like Gamergate directly, neither are they passive about the future for women in games. Kate and many others have found other ways to have a positive impact without the same risks to their physical, mental, and emotional health. Casey makes games with her little sister, showing her how she can use her passion for art to create interactive stories and games. Savannah mentors a young woman in high school who is interested in pursuing a career in games. Andrea is involved with technology-based programs at her son’s school and visits local schools to give talks about being a game developer. Kate takes solace in the fact that her role as a successful female game journalist makes her a role model to girls who want to pursue a similar trajectory. She said:
If I can be a role model for other girls who want to get into the industry, who don’t want to be judged on their gender, who want to be taken seriously, I hope that I can be that person. I like to hope that girls can look at me and go, ‘Kate is awesome and I want to be just like her.’

Kate and some of the other women in this study are contributing to the future for women in games simply by being in games. Through their continued commitment to doing the work they love, these women act as role models to other young women who aspire to a career in games too.

**Women as Game Industry Leaders**

Of the twenty-one women interviewed for this research, three are current or former CEOs of their own game companies. While their experience and their leadership strategies differ, each of these three women had one thing in common—they are committed to having their companies make games that empower girls and women. Maggie is the former CEO of one of the first companies to market games to girls. Explaining her exasperation with the fact that most games at the time were made by men and for men, Maggie and her team aimed to “tell stories about girls and women that shatter the stereotypes of being one-dimensional.”

Mia is the CEO of a start-up game company making free-to-play games that feature empowered female characters. Unlike many companies that target women for a quick and easy profit, Mia describes wanting to release free-to-play games to make them more accessible to the audience she wants to reach and empower. Her company’s games reverse many of the common tropes and stereotypes of female characters in games.

Indie studio CEO and game developer Bethany is bored with the game industry. In her interview, she made an observation identical to something that Maggie said—that the industry is “made by men for men.” She described the norm where “violence is the primary mechanic and games cater to adolescent fantasies about empowerment.” Craving something different, Bethany is interested in stories and in games that connect emotionally with characters. She explained, “I wanted to do a game that showed women being awesome and it’s not questioned that they can be competent. They’re not put into a girlfriend role or anything like that. They’re out there and they’re awesome.” In her game, women fill a variety of roles. A woman is a commander. A woman is the techie. A woman is the villain. A woman is the hero. For her, it is important that her games “let women be a range of things rather than girl being a personality.” Bethany said she despises media that feature girl as a personality type.

Maggie, Mia, and Bethany are all committed to making games that place girls and women in powerful roles and that combat stereotypes about them being damsels or one-dimensional. However, each of these women has a unique strategy and set of goals around running their companies. Maggie works to foster collaboration and collective creativity among the people who work for her company. Mia is passionate about supporting venture capital funding for female-led companies. Bethany is also seeking venture capital funds for her company, but she is more focused on her acquisition strategy of recruiting and retaining employees who are otherwise under-appreciated by the game industry. In many ways, the myriad strategies that each of these women employ to make game industry spaces more diverse and inclusive are about investing in people. Whether it showing girls that games can be a part of their possibility space, empowering marginalized groups, or one of the many other strategies, an overarching theme is investing in people to invest in positive change.
Conclusions

This study investigating the trajectories and experiences of women in game design reveals that many women in games dedicate a significant amount of time and effort to making the game industry better, for themselves, their colleagues and employees, and the next generation of game developers. For some, being successful in their careers, and therefore being a role model to girls in the future, is a way to contribute. Others commit further time and resources to empowering women in additional ways, such as advocating for those whose voices often go unheard, helping marginalized groups share their stories, or empowering girls and women with professional development tools and funding to build companies. Each of these efforts contributes to making women visible in games and empowering them to share their stories, create inspiring content, and develop as successful professionals and leaders.

These women’s stories serve as a starting place for exploring their efforts in greater detail. Many of the efforts raised in this article deserve greater attention from scholars in games and digital media. For example, what are the specific challenges to women-led companies looking to raise venture capital funds to build their companies? What professional development opportunities are most needed in game design programs? What kinds of early exposure to game design and programming are most effective in engaging girls’ interests over an extended period of time? What we need from future studies is investigations of the specific contexts, spaces, and strategies outlined by the women in this research. Exploring how the participants of this research are doing their part reveals a lot about what educators, researchers, and industry leaders can do to bolster their own contributions toward fostering diversity and inclusivity, but there is certainly more work to be done.

References


Abstract

Boys’ interests, values, and motivations are increasingly at odds with those of traditional classrooms. Video games, which have become an integral part of boy culture (Watkins, 2009), have the capacity to cultivate and develop literacy skills (Steinkuehler, 2010). This qualitative study thus investigates how adolescent boys play and learn within commercial-off-the-shelf game spaces. In particular, this paper reports on the study’s third phase and focuses on how narrative-driven games provide boys with safe platforms to think about and discuss literary moments. Findings suggest that players naturally analyze and critique the games’ narrative structures both during and after regular gameplay.

Introduction and Project Background

When compared to their female counterparts, school-aged boys continue to underperform on national literacy assessments (Rampey, Dion, & Donahue, 2009). They similarly lag behind in Language Arts classrooms—where they feel that their interests and values are at odds with course content and expectations (Steinkuehler, 2010). After all, schools tend to champion narrow definitions of what constitutes reading and writing (Alvermann, 2006; Gee, 2000). Print literacies have remained the focus, and, consequently, teachers often overlook and underestimate the indigenous literary practices and skills of their game-playing boys. As many scholars note, video games themselves can and should be viewed as texts that encourage new forms of reading and writing (Gee, 2007; Jones & Hafner, 2012). They not only have the potential to bridge and complement traditional literacies (Abrams, 2012; O’Brien & Scharber, 2008), but these video games could also serve as academic content in Language Arts classrooms (Gerber & Price, 2011; Ostenson, 2013).

Over the past three years, our work has sought to uncover and describe the meaning-making and learning practices of these adolescent gamers. More specifically, we have investigated how their experiences within popular commercial-off-the-shelf (COTS) games like Call of Duty and Assassin’s Creed can potentially align with the aims and methods of Language Arts instructors. In addition, we have attempted to unpack and understand how boys “morph” school-based literacy practices into more socially acceptable forms (Blair & Sanford, 2004). In earlier phases of our study, we even drew explicit connections between our participants’ gameplay and the Common Core State Standards (CCSS) on literacy (Engerman, MacAllan, & Carr-Chellman, 2014). Now, as we report on the findings of our
project’s third phase, we examine how COTS games provide socially relevant platforms for boys to encounter, think about, discuss, and evaluate literary concepts.

Methodology

Design and Analytical Framework

Informed by Squire’s (2006) understanding of video games as “designed experiences,” our own study set out to capture and analyze the lived experiences of male gamers by adopting a hermeneutic phenomenological approach (Van Manen, 1997). To adequately and thoroughly give voice to those experiences, we relied on a three-interview process (Seidman, 1998). The first round of interviews sought a focused life-history. The second round of interviews targeted the details of the game-playing experiences. The third round of interviews—which were conducted as focus groups—gave participants the opportunity to collectively reflect on the meaning of their experiences. During this third phase—which we now report on—our design embraced reflexivity (Rossman & Rallis, 2011). In alignment with our hermeneutic phenomenological approach (Van Manen, 1997), we thus acknowledged ourselves as analytic tools—inseparable from the data collection and analysis process. Our research team consisted of students and faculty from the Pennsylvania State University’s Learning, Design, and Technology program. This team utilized their professional education expertise under the guidance of an advisor with over 15 years of research experience. As the project developed, we added additional experts to the research team, including a high school English teacher with experience aligning Language Arts content to academic standards.

In an effort to extract meaningful themes from our interview data, the team utilized Cultural-Historical Activity Theory (CHAT) as its analytical framework (Engeström, 1987, 2001). CHAT relies on the notion that individual development is inseparable from social engagement and cultural norms. CHAT thus identifies its subject as the entity conducting the activity (boy learner), the activity (video-game play), and the object as the motivating factors or products produced through the activity (Foot, 2014; Jonassen & Murphey, 1999). Our ongoing study has sought to uncover and describe that object. Games-based learning designers have often relied on CHAT as a lens to understand how learning occurs in designed spaces (DeVane & Squire, 2012), and we now employ it to help make sense of complex social, cultural, and historical factors embedded in modern video-game play.

Participants

Our participants included sixteen boys, ages 11-19, all of whom were athletes in a Northeastern PA school district. While this population represents a particular subset of boys, its focus helped us to highlight the important socio-cultural factors embedded in their video-game play while simultaneously maximizing the affordances of our CHAT framework. These boys all enjoyed and played the same video games. Perhaps more importantly, they actively competed and collaborated with one another during gameplay. These distinctions allowed us to better understand how the boys naturally and collectively thought about and discussed their favorite games. Since one of the authors was a coach in the school district, the research team had access to the boys during afterschool practices and workouts.
Data Analysis

The team relied on Thematic Analysis (TA) to help provide descriptive accounts of boys’ experiences (Braun & Clark, 2006). More specifically, our analyses centered on the pedagogical nature of the participants’ individual and collective game-playing experiences. To this end, our team developed a coding framework grounded in the principles of CHAT (Engeström, 1987, 2001). We then carefully reviewed the data to determine how the boys used various rules and tools, how they interacted with local and global gaming communities, and how their histories with both one another and the games impacted their learning experiences. In addition to applying researcher triangulation and member-checking methods, the research team embraced constant comparative-analysis as a means to ensure consistency between and among data sets (Hewitt-Taylor, 2001).

Findings and Discussion

During the initial phases of our study, we found and reported on the strong links between gameplay experiences and Language Arts and Literacy standards (Engerman, MacAllan & Carr-Chellman, 2014). Our participants repeatedly described being drawn to and motivated by the narrative and literary elements of COTS games like Assassin’s Creed, Skyrim, and God of War. The desire to learn more about their favorite characters, locations, and storylines kept the boys engaged even when gameplay itself would become either stale or overly challenging. Similarly, our participants insisted that text-based reading comprehension was often a deciding factor in one’s ability to progress through the game—and subsequently its narrative. The boys frequently reported having to learn new vocabulary words or to decipher text-based clues in order to find out how to overcome obstacles (Engerman, MacAllan & Carr-Chellman, 2014). These findings not only aligned with existing theoretical work on gaming and literacy-skills development (Steinkuehler, 2010), but they also served as a guiding framework for our study’s third and final phase.

Ultimately, we discovered that narrative-driven video games provided a socially acceptable and culturally relevant platform for boys to think about, discuss, and evaluate literary moments. Throughout our focus group sessions, the boys eagerly shared their experiences with creating and role-playing archetypal characters in games like Skyrim; they described how these games both embraced and altered the conventions of classic literary and film genres; they were quick to critique and praise the ways in which game designers chose to present suspenseful and emotional scenes. We thus argue that—through their exploration of and participation in narrative-driven video games—adolescent boys actually practice thinking like writers and critics. Ostenson (2013) claims that his game-based English lessons challenged his students to see the unique strengths and weaknesses of the video game as a storytelling medium.

Our participants not only exhibited a similar awareness, but they also actively described the various steps game designers and developers could take to make narrative-driven titles even more immersive, dramatic, and memorable. The boys thus proved themselves to be critical consumers, and, over the course of our interviews, the following connections between boy culture, video-game play, and the Language Arts disciplines naturally emerged.

Experiencing Characters

Modern, narrative-driven video games allow players to take control of and interact with diverse
characters, ranging from real-life historical figures to literary archetypes. On the surface, our participants were clearly motivated to play games featuring their favorite characters. For instance, many reported playing the entire Assassin’s Creed franchise simply to learn more about its protagonist, Desmond Miles, and his hired-gun alter-egos, Altair and Ezio. More importantly, however, the boys demonstrated keen understandings of how these characters think, act, and relate to one another within and beyond the game space. In other words, through their game-playing experiences, our participants were able to compare, contrast, and analyze characters in compelling and often literary ways—they were able to unpack precisely what it meant to be a certain type of character. Specifically, when asked to describe how games present the stereotypical “warrior” character, the boys collectively responded:

Ross: He’s a beast—all around. He has all the chicks after him. He has the [biggest] sword. Every guy wants to be like him. He’s just that guy.

Terrance: He’s very tall—very muscular… deep voice.

Ben: He just goes in, guns blazing… no smarts. [makes an exploding noise]

Chase: [He] kind of charges in headfirst, not thinking about what’s behind the wall.

The boys continued to build off of one another, claiming that video game characters like Call of Duty’s “juggernauts”, God of War’s Kratos, and Borderlands’ “gunzkers” all embodied the essential qualities of the warrior. Ross and Terrance added that, when given the choice, warriors were among their favorite characters to play as—even creating their own versions of the archetype in open-world games like Fall Out and Skyrim. Through their detailed descriptions—both physical and metaphysical—of the warrior, our participants demonstrated a deep understanding of how game designers choose to present and utilize archetypal characters. Not only could the boys imagine what a warrior might look like, but they could also make informed predictions about his personality, motivations, and flaws.

We argue that the very rules and mechanics of the games themselves foster players’ abilities to make these connections and associations. Players are incentivized to role-play characters in particular ways based on a game’s underlying design principles. For example, in Assassin’s Creed (2007), players take the role of Altair, a quintessential hitman. From the game’s opening sequences and cut-scenes, they see that Altair is agile, sneaky, confident, and resourceful. However, the medium’s true educational power comes from its ability to reinforce these ideas through meaningful gameplay experiences or, as Squire (2006) argues, by “doing” and “being.” Although players are welcome to try, they are unlikely to progress through the game by treating Altair like the aforementioned warrior. Instead, they must play to Altair’s strengths by hiding in the shadows, stalking their targets from a distance, and fleeing at the first sign of trouble. Consequently, the game rewards players that are able to align their playstyles with the traits and qualities of its characters.

Seeking Thrills and Flexing Agency

While interesting and compelling characters certainly work to draw players into these digital worlds, our participants insisted that a game’s ability to create, build, and maintain a suspenseful atmosphere was the single most important factor for staying engaged in its storyline. Similarly, the boys praised titles that were able to place their players in unique situations with multiple paths forward. Our participants thus shared an intense desire to at once be swept up by a game’s dramatic twists and turns while
simultaneously feeling as if they had some control over how its events would ultimately unfold. The boys noted that *Skyrim* (2011), with its open-world and non-linear structure, was particularly adept at striking this balance. After all, this game carves out spaces for players to align with different in-game factions and to make a variety of moral decisions over the course of their adventure. Several participants even reported playing through the game multiple times to more completely experience its many storylines and expansive universe. Likewise, the boys showed genuine interest in learning about how their peers choose to navigate certain in-game moments—such as the decision to either spare or destroy the town of Megaton in *Fallout 3*.

These discussions often led our participants to compare and contrast suspenseful moments in video games to those found in books or movies. One such conversation centered on the survivor-horror game *Left 4 Dead* (2008) and its Hollywood counterparts:

Interviewer: Tell me a little more about what makes [*Left 4 Dead*] scary? Or, rather, what are the scariest moments when you’re playing that game?

   Trevor: When there’s a whole zombie pack around you, and you’re trying to bat ‘em away.

   Jack: Or when a zombie jumps out in front of your face.

   Greg: And it gets dark… it gets *real* dark.

[…]

   Jack: Or when you walk through a door—you don’t know what’s there.

   Trevor: Yeah. You’ll just be walking and a *hunter* will jump on you.

   Jack: Or a *smoker*.

Interviewer: How is that experience different from watching a scary movie?

   Greg: You can control it.

   Trevor: Yeah. You’re controlling [the characters] so…

   Donavan: You can die or slice [the zombie’s] head off. You can pick.

   Jack: Basically, if you’re watching the same movie five times, it’ll get old and you won’t get scared as much—

   Trevor: Yeah. But if you’ve played a game, you can always be shocked.

In this exchange, the boys’ repeated use of the word “you” underscores the intimate and immersive nature of modern games like *Left 4 Dead*. Moreover, its use suggests that players see themselves as the driving storytelling-agents, capable of influencing a game’s action, pacing, and direction. In addition, the boys also demonstrated a sophisticated understanding of how the horror genre functions—of how it elicits fear in its players, spectators, and readers. According to our participants, horror games—both literally and figuratively—keep their players in the dark. Players never truly *know* what monsters lurk behind the next door until they find the courage to open it for themselves. As Trevor cautions, a vicious “hunter” *could* always be lying in wait.

Once again, we believe it is helpful to consider how a game’s rules actively develops one’s
understanding of these genre conventions. In the case of *Left 4 Dead*, the game relies on an artificial intelligence system called “The Director” to keep its players guessing. Instead of featuring scripted encounters at predetermined locations and times, The Director allows for the action and difficulty to flow and scale organically. Based on players’ health totals, ammunition supplies, and skill-levels, The Director purposely places new and unique challenges in the game world for players to overcome. As Trevor claims, regardless of how many times one has played *Left 4 Dead*, “you can always be shocked.” Therefore, by aligning its mechanics with its overarching themes, a video game can give its players the opportunity to experience the essence of particular genres.

**Thinking like Writers and Critics**

Although our participants reported becoming emotionally invested in many of these game-worlds, the boys nevertheless proved capable—even eager—to critique their favorite games and to theorize about how those titles might be improved. Across all three phases of our study, the boys universally wanted to associate a game’s attention to detail with its quality. The more lifelike and believable a game’s world and its characters felt, the better the product. Specifically, our participants hailed the *Assassin’s Creed, Grand Theft Auto,* and *God of War* franchises as some of the best on the market. While the games’ storylines certainly embrace conventions of science-fiction and fantasy, their environments and characters are nevertheless grounded in real-world history, geography, and mythology. For example, our participants were delighted to cross paths with the likes of George Washington, Leonardo da Vinci, and Captain Blackbeard in the *Assassin’s Creed* games. As one boy explained, “the [game] world is built off of what it was [really like]. That’s the coolest part—that’s what makes it easier for the developers.” In this response, Blake not only expresses how much he, personally, enjoys the real-world references and allusions, but he also demonstrates his ability to think like a writer. He recognizes that building worlds and stories from source material would be more efficient than creating them from imagination.

In a separate focus group, the boys walked interviewers through the process of designing their own dream video games. All of the participants stressed the importance of grounding their games in unique historic moments that have gone relatively ignored by mainstream video game developers. Walter, for instance, pitched a game that would explore the cultures and conflicts of the ancient Mesopotamian empires. Brad, on the other hand, described a hypothetical game set in feudal Japan:

“I’ve always liked samurai and ninjas and stuff like that. So my dream game would probably involve something on the ancient Asian continent—something with a lot of fighting and action and drama—like feudal Japan.

[…]

I would probably try to pull as much from actual historical contexts as possible—from actual books… from, ahh… actual artifacts—pieces of actual history from that time period. And, I mean, there are games that sort of touch on that, like *Dynasty Warriors*… which is OK, but it’s not what I want. Those are more like war games. I’m looking for a narrative-driven [one].

Walter and Brad were both quick to identify trends and gaps in the modern gaming industry. Brad, in particular, felt pressure to distinguish his dream game from similar titles. In other words, he clearly understood his rhetorical situation—to create a game in the tradition of *Dynasty Warriors* while simultaneously carving out his own niche as a developer. In addition, Brad’s commitment to draw inspiration from “actual pieces of history” underscores his capacity to think like a writer. He
understands that designing a realistic video game is a complex and time-consuming task that requires serious research. Walter echoes this sentiment, recalling his reaction to seeing real-world architecture featured in the Assassin’s Creed series:

It’s pretty damn accurate. I knew what it was just from looking at it immediately. It was pretty incredible because I could see the creativity and the thought that went into it… and the time that went into it. It was—it was incredible.

Walter, like many of our participants, is awestruck by the games’ realistic environment. However, perhaps more importantly, he expresses admiration for the designers and for their attention to detail. Thus, in both of these moments, Walter and Brad adopt the mantles of writers and critics. They consider the challenges associated with creating historical games that could meet—or even exceed—their lofty standards.

Conclusion

Our results suggest that boys are indeed experiencing meaningful literary moments through the COTS games that they naturally play and enjoy. Unfortunately, our classrooms continue to champion print literacies at the expense of digital ones. Furthermore, the grand narrative—that “video games are bad for you”—continues to cast its long shadow over students and teachers alike. Both parties struggle to see the literary and academic merits embedded in modern video-game play. Ironically, though, our participants—perhaps without even realizing it—repeatedly and effortlessly engaged in in-depth discussions about their favorite games’ storylines, characters, and themes. Likewise, they proved deeply interested and invested in how developers chose to manipulate source material and to re-imagine classic genres in the effort to create immersive, digital worlds. Referencing literary terms and tropes throughout our focus-group interviews, the boys demonstrated the ability to think like writers and critics; they described and analyzed games much in the same way that English teachers want their students to discuss novels and poems. However, teachers need to do more than simply recognize and value their students’ indigenous sources of literary knowledge. Rather, teachers must be willing to play COTS games for themselves and to devise meaningful, game-based lessons through which they might start to bridge students’ experiences and interests with those of the English classroom.

References


Abstract

Games have the opportunity to provide language learners rich multimodal environments that ground language learning in a situated context. There are now a wide variety of second language learning games in a number of languages for different audiences. In this paper, we examine 68 games across different platforms to evaluate their approaches to pedagogy, proficiency, assessment, skills developed, and complexity. We describe our data collection and analysis procedures and then summarize the major trends in these areas. We found that most games take a didactic pedagogical approach, are targeted toward novices, incorporate assessment systems, focus on vocabulary development, and that average internal rating did not increase with the complexity of the learning within the game. The goal of this analysis is to inform and contextualize future potential efforts in this particular domain.

Introduction

Games are a natural environment for language learning. From simpler titles for young preliterate children like Peekaboo Barn to larger, online immersive social worlds for teenagers and young adults like XENOS, games provide learners rich multimodal environments that ground language learning in the situated context of its meaning and use (Gee, 2010), thereby enabling meaningful language acquisition to take place. This affordance of games to enable situated meaning construction and use is in close keeping with current paradigms for language learning instruction in both formal and informal classrooms (Young et al, 2012). Games allow the grounded use of language in a rich context, both virtually and, in some cases, socially. Thus, it is no surprise that games show dramatic gains in the area of language learning in meta-analyses and reviews to date (Peterson, 2010; Young et al, 2012; Wouters et al, 2013).

Games are also a natural environment for transformative assessment, providing learners with a rich digital context for task engagement on the front end and a large volume of clickstream user data on the back end. With the shift from a print-based educational ecosystem to a digital one, educational researchers and assessment experts can use the “data exhaust” of students’ choices and performances in games and other digital tools to assess learning and improve instruction (Schoettler, 2012). Tracking and modeling student performance better enables the design and delivery of instruction and assessment (Shute & Becker, 2010). Games are no exception: they can be designed to align closely to content standards, give just-in-time feedback on performance, and present data on problem-solving in situ that is superior to those data gathered through traditional paper based measurement instruments (Levy & Mislevy, 2004). Recent developments in machine learning techniques, including both educational data mining and learning analytics, offer compelling means for measuring learning in game-based environments (Dangauthier et al, 2008).
What, then, is the current landscape of games for language learning and assessment? Here, we present a landscape analysis on the subject of games for second language (L2). Here, “second language (L2) learning” is defined to include acquisition of a second (non-native) language by speakers of school age years (6 years of age) through adulthood, including both oral and written communication. “Games” are defined as digital applications with game mechanics or gamification elements. We conducted a broad survey of existing L2 games on the current market and analyzed the corpus in terms of their core game mechanics and features (e.g. platform, languages covered, target age group), pedagogical elements (e.g. didactic, whole language, immersion), and assessment strategy (e.g. level-based summative, problem sequencing, challenge levels), and overall quality. In this report, we detail our data collection and analysis procedures and then summarize the major trends. The goal of this analysis is to inform and contextualize future potential efforts in this domain.

Methods

Data Collection

The games corpus use for this analysis was collected through broad search of academic print publications and online sources, triangulated against one another and recommendations from experts in the fields of games for learning, games for assessment, and L2 learning. Our final source set included 5 popular game distribution sites widely known to feature educational games (iOS App Education Store, Google Play, Steam, DBD Games, and CBeebies); 21 curated websites featuring games for learning, including both commercial sites (e.g. LeapFrog, BrainPOP) and philanthropic/community listings (e.g. Common Sense Media, Serious Games Directory BETA); and finally (4) 12 curated “best of” lists of games for language learning featured on heavily circulated blogs (e.g., Lifehacker.com, App Picker).

Using this source list, we then collected all L2 games described, reviewed, assessed, or referenced that were released after 2005 and developed on a platform still used (i.e. we eliminated DOS games). The final data corpus consisted of 68 game titles. The majority of games included were developed in United States or Europe and were made within the last five years.

Data Analysis

In order to analyze the game corpus, we developed a three-part framework for analysis. The first part of the framework consists of a simple coding scheme designed to capture descriptive characteristics of each title (title, platform, creator, year, cost, target age, source language, target language, genre). The second part of the framework includes an interpretive coding scheme focusing on the instructional nature of the game (pedagogy, proficiency level, skills developed, form of assessment used). The final part of the framework consists of a quality assessment rubric for gauging the overall value of the game; here, we note the public rating of each game in addition to our own 1-to-5 star rating assigned by the internal team.

Four research team members jointly developed the rubric and piloted it on 4 game titles jointly. Once agreement was established, we then piloted use of the framework on 4 games coded individually, then met and discussed the results. Adjustments were made to clarify more any ambiguous categories of the
rubric and then, once all existing uncertainties were addressed, we divided the remaining games corpus among the four researchers and completed all coding over a period of roughly four weeks. During this analysis phase, we met once a week to calibrate our assessments and resolve any additional questions or contentions that arose.

Results

Pedagogy

We classified the L2 games in terms of educational method or pedagogy used using three basic categories. Didactic games were games characterized by a focus on memorization and structure. Games that resemble flashcards are by and large didactic. Communicative games were games characterized by a focus on expressive language and task-based activities. Many educational role playing games that require players to converse with others as a means of completing tasks were categorized as communicative. Immersive games are games characterized by a "whole language" view of L2 learning which does not rely on the learner’s native language. Games can and often do span more than one category, with about a fourth of the corpus (26%) falling into more than one classification. As Figure 1 shows, the majority of games were didactic in nature, featuring flash card like activities for rote memorization of vocabulary within the target language.

![Pedagogy](image)

*Figure 1. L2 learning games by pedagogy.*

Proficiency Levels

L2 games on the current market differ in terms of the level of proficiency targeted (Figure 2). We
analyzed proficiency levels based on the American Council for the Teaching of Foreign Languages Proficiency Guidelines (2012).

Games often span more than one category; for example, when a given title covers material for beginning language learners up through intermediate. As Figure 2 shows, most L2 games focus only on rudimentary language skills (novice only), with rapidly decreasing representation in categories of high proficiency levels (intermediate and advanced). Games that attempt to take a learner from novice through advanced levels of language proficiency are ambitious and the exception. Noteworthy examples include expensive and well-established products like *Rosetta Stone* and its competitor *Voxy*, a subscription-based language teaching application.

![Figure 2. L2 learning games by proficiency level.](image)

### Assessment

For software to be interactive, it must take user input and provide some form of feedback or response. Thus, it is not surprising that nearly all L2 games on the market include some form of assessment of what the user does. After all, without at least tracking user progress through the presented content in some fashion, it would be difficult for a system to appropriately respond to what the user does. Thus, only 5% of the corpus contains no assessment model whatsoever. For the remaining game titles, the question is not whether they assess but to what degree. Figure 3 shows a breakdown of games by assessment type, with increasingly sophisticated models represented along the x-axis:

- **Tracks Progress** – the game tracks the amount of content completed
- **Tracks Performance** – the game tracks the amount of content not just completed but also to what
degree of success

- **Content Sequenced** – the game levels increase in difficulty with successful gameplay
- **Responds to Failure** – the game not only increases difficulty with success but also decreases difficulty with failure
- **Data Dashboard** – the game presents some aggregated representation of user data to the user (or their teacher/parent)

Games can and frequently do span more than one category of assessment – generally, in additive fashion with games in more advanced categories entailing all lower assessment forms. As one can see from Figure 3, as assessment method increases in sophistication, the number of L2 game titles featuring it declines in near linear fashion.

![Figure 3: L2 learning games by assessment model used.](image)

**Skills Developed**

Figure 4 shows the content L2 games are designed to teach based on their developer’s claims and our internal play-thrus. Again, games may span multiple categories; for example, Duolingo teaches grammar, pronunciation, listening, reading and speaking. Note that skills whose instruction and assessment can be accomplished through little or no complex user input appear more frequently in the corpus than skills that require more complex user input: vocabulary is twice as frequent as grammar, listening is twice as frequent as speaking, and reading is twice as frequent as writing. General constraints on natural language processing may be the cause: automatically parsing simple strings of text is, after all, much more tractable than assessing complex paragraphs of prose. Advances in this area appear to be generally underleveraged in L2 games.
Different Pedagogies for Different Content

Different pedagogical styles are used to target different learner groups, with far more didactic materials produced for novices than for more advanced learners (Figure 5). Didactic pedagogy frequently targets vocabulary, listening, and spelling skills (Figure 6).
As Figure 6 shows, when instead speaking and writing skills are of primary focus, you see a decline in didactic approaches to activities and a concomitant rise in communicative approaches. Both communicative and immersive pedagogies appear to target almost all skills examined for this analysis, often in combination as part of authentic tasks conducted in-game such as figuring out the appropriate level of formality when addressing a stranger in a business letter or interacting with a non-player character in the target language to order to buy coffee. There are also nuanced differences between communicative and immersive games: In immersive games, writing and culture is notably more frequently the focus while grammar and spelling is notably less frequently the focus. Such differences are in keeping with the whole language approach that marks immersive games overall.
Although our internal rating system, by definition, overtly paid special attention to comprehensiveness of content, more ambitious games did not necessarily earn higher ratings. Four of our codes consisted of ordinal variables that could be reduced down to a scaling degree of complexity: pedagogy, proficiency level, skills developed, and assessment. Figure 7 shows the average rating of games at different levels of complexity within each of the four variables, represented as separate lines in the graph. Viewed as such, it becomes clear that average rating is more or less the same regardless of complexity, essentially flatlining for all but lowest level on the assessment rubric (designating “none”).

Complexity

Figure 6. L2 game pedagogy by skills developed.
In summary, games that integrate more complex mechanics and content do not necessarily equate better learning. Next, we will give an example of a game that integrates the mechanics that we have discussed thus far in a way that is both engaging and beneficial to the player.

Examples

Supiki (iOS platform) is an interactive textbook designed for English language learners ages thirteen and above who wish to practice English speaking in realistic situations. It offers 50 content units across ten levels of difficulty that spans all three proficiency levels from novice to intermediate to advanced for only 11.99 USD. Supiki tracks user progress throughout each unit and provides a summative “Big Quiz” at the end of each unit to assess learners’ understanding of the expressions just learned. Its graphics are appealing, the interface is easy to use, and its content is thoroughly engaging.

Supiki’s pedagogy spans both communicative and immersive, with each unit framed with a short video clip that introduces the narrative premise of the activity – the background and characters that contextualize the user’s tasks. After watching the video, learners choose from one of two follow up extension activities: idioms or conversation (Figure 8). The idioms section provides definitions of the idioms from the video; users can review parts of the conversation again to see how specific expression are used in real time. They are asked to verbally produce a sentence that includes the selected idiom and then compare their utterance to a native speaker. The conversation section allows learners to practice speaking with characters on everyday topics related to the narrative premise and to receive instant responses to their verbal performances. Throughout both sections, the game content is practical and authentic, encouraging users to improve their fluency and gain more confidence in speaking.
One of Supiki’s more noteworthy features is its smart speech recognition software. While users are practice their language skills, Supiki makes them feel like they are talking with real people. For example, a character from Supiki asked a research team member, “What type of work do you do?” The researcher responded, “I’m a teacher.” Unlike other games, Supiki continued the conversation in a way that built on her previous answer, responding “I think that Education is very important…” After conversing in this way with an in-game character, learners can review their recordings and those of other users, email their recordings to others, or share their scores on Facebook and Twitter (Figure 8).

![Supiki's interface](image)

*Figure 8. Supiki’s interface.*

Overall, Supiki is a beautifully designed and effective tool for practice speaking and listening language communication skills in a naturalistic context, with the game narrative and mechanics working in unison to emulate everyday interpersonal interaction and to codify the overall results of those interactions so that the system is responsive to the core performances targeted. Together, all aspects of the design work together to create an experience that feels genuinely useful and authentic, balanced in terms of difficulty scaling, and easy to use.

References


Abstract

In 2009, Sykes and Holden began working on Mentira, a design-based research (DBR) project and game-based curriculum. Years later, Mentira is gone. In many ways, we would say the project has failed. Consideration of the details illuminates general truths regarding the potential of DBR to result in innovation at scale. Success and failure are not as simple as we typically understand them. Metrics and mechanisms common to researchers describe only a small facet of projects’ lives and deaths, missing most of what looks to be important to sustenance and growth. Without major attention given to broader goals and practices, we overlook likely ways to go from idiosyncratic experiment to meaningful impact. We look at why Mentira died and what lives on in its place, with advice for other practitioners and scholars of educational technology.

Introduction – Mentira and its goals

Mentira was created in 2009 as an augmented reality (AR) game-based curriculum for a fourth-semester Spanish course at The University of New Mexico. Sykes and Holden put it together using an internally funded $10K research grant. It was the first game designed with ARIS, an AR design platform, to be used in a classroom, and a first in many other ways too: the first language learning AR game, first AR curriculum in higher education, and the first AR game to have both field-based, homework, and in-class software components (Holden & Sykes, 2011). A feature of this, and many other DBR projects, is to take on not only the messiness of an existing educational context (Brown, 1992), but also the use of new technologies and alternative pedagogies by participants in those spaces. Consequently, projects like these naturally entertain a wide, perhaps overwhelming, swath of research questions relating to some of the most basic features of game based learning, AR, and mobile technology. This is enough already to encumber a single, small project, but the work also hinges on further issues long debated in relation to educational research generally and about the potential and reality of DBR especially. Generally, “How can educational research proceed and be effective once we agree to a certain level of irreducible complexity in the situation at hand?” More specifically,

- Methods: How can actual evidence about any of the above questions be sought and verified?
- Analysis: Given evidence about outcomes, how can we trace it back to responsible factors?
- Scale: What might this one case imply about any other? How can an intervention scale?
Between our inspiration to make something interesting, and possibly innovative, and all the things we might expect from DBR, there is a lot of unsure ground: using iterative prototypes to simultaneously improve theory and conditions on the ground (Collins, 1992), reconciling issues of epistemology and methodology (Schoenfeld, 1994), creating generalizable knowledge (Barab & Squire, 2004; Bielaczyc, 2006), and doing all of this in a way that is capable of being scaled (Fishman et al., 2004) and sustained (Cole, 2007). The general, though usually unstated, model is: Hope for one of these one-off designs to be proven effective at accomplishing some educational task, where elements of design and implementation can be distilled from the complexity of the original context, both so that the original intervention can be scaled to other similar situations (with Mentira we might imagine other Spanish courses at a similar educational level). Then, apply the demonstrated general insights, hopefully replicated through additional studies, published in academic literature reapplied by designers in other circumstances and referenced by policy makers in an effort to drive adoption and other attention system-wide. Understandably, this is a large effort, and any small team can only be expected to do so much. There is a fair amount of skepticism as to whether small scale projects like these can lead to larger scale change. The first part of our Mentira story, detailed below, demonstrates ways in which these skeptics may be right.

What Happened? The Failures of Mentira

Mentira was, over the course of four years, piloted, implemented in a restricted way, revised, implemented full scale in all sections of the fourth-semester Spanish course it was designed to support, revised again, run again, and then discontinued. Our playthroughs were promising (Holden & Sykes, 2011), but eventually Mentira faded away. A full accounting for the project would take too long, but it’s worth looking at a couple details to help illustrate a central question: “What might it mean for an educational game DBR project to be successful?” There does seem to be an overall skeptical attitude towards research on “failed projects”, but there is a need to better understand and enunciate what divides success and failure. This paper is an attempt to explore these ideas, and simultaneously, make salient the challenges, and the impending hope, that stems from Mentira and many similar projects.

Let us then begin with a simple criterion: can the game actually be played and under what circumstances? As for Mentira, it has not been used for 3 years and has since become unplayable through obsolescence. How might an interested party implement, change, test, adopt, or scale Mentira if they can’t play it? This criterion seems obvious, yet we (education researchers) probably spend too much time debating the merits of games never to be played again—either broken, obsolete, or inaccessible—maybe partly because grants are awarded at the beginning and the fodder for future work are publications and not active user data. There are of course real questions about how many users is worthwhile, how long software needs or can be expected to be viable, and what “accessible” means, but these factors seem to receive relatively little attention. We actually did well with Mentira, bringing it through many major changes in iOS hardware and software, as well as a major revision of the underlying development platform, ARIS (itself a small-scale DBR project), without further funding. Mentira was always free and easily accessible, just as ARIS itself is open source and easy to use. Nevertheless, Mentira is now dead. In our particular case too, chances of an outsider adopting the game in the future is even smaller, as the game is strongly set in both a specific level, dialect, and culture of Spanish language, as well in the particular place in which the game is set. Nonlocal parties could emulate the game’s mechanics but never truly play it. Not only is our game now obsolete, but, in despite design decisions that would have allowed for non-local play, the game has little potential for being directly scaled.
We also ask whether a program of research can be built around the game, yielding general theoretical insights and proven empirical results. Overall, our experimental design with Mentira was open-ended, limiting these contributions to academia through its design and use. We started out with some novel ideas for what data to collect from the play of an AR game (Holden & Sykes, 2011), but like many DBR projects, we collected copious data and only analyzed a limited subset of it. As Anderson & Shattuck worried in their meta-study of DBR projects (2012, p. 24), our data is not accessible to other researchers, and is so contextually bound so as to be nearly useless. When it comes to the traditionally most valuable data, A-B tests of alternate treatments according to short term measures of narrowly identified learning outcomes, we had even less. Worse, we wasted time pretending our exploratory work in poorly known areas (and areas where short term gains on specific learning objectives have only spurious connections to long term educational goals—achievement in a college language course is not a good predictor of lifetime second language use) would yield such data. The high rhetorical value of such data, and hence its high appeal despite its inappropriateness, paralyzed us to some extent. “Is this better than that?” is a good question to answer with an A-B test, but it was not what we were working towards with Mentira. We would have gotten more done had we the courage of our convictions, and simply left the A-B tests for later.

Another implicit metric for the success of DBR, perhaps the most important, is iteration. Mentira was iterated, and through its iterations, the game and our process and knowledge all improved greatly. But here too we stalled. Important findings never made it back into the game. For example:

1. We combined the heaviest reading with the field trip portion of the game. Both are intense activities and should have been separated for better play and more learning.

2. We wanted students and teachers to co-author Mentira. But the teaching assistants were reticent to play the game themselves, limiting their ability to contribute. Involving students in the design took too much time away from the existing course material, and was not something all were prepared or eager for. Instead of hoping all would dig deep into the design, we should have recruited simpler participation generally while retaining openness for deeper involvement.

3. Introducing a game-based learning model within an existing curriculum is not simple from a cultural framing standpoint.

Most students did not play through Mentira in the same way people learn to play videogames (Gee, 2003). We wanted them to see a game, but sometimes, they treated it more like a textbook. We saw few replays and instances of getting help reading from other players, dictionaries, or in-game resources despite difficult vocabulary and a complex story. Though it was a class and students expected homework, play did emerge in places. We could have capitalized on these more. With these examples and more, responding effectively to clear observations whose certain identification did not require detailed methodology, was beyond us. We failed when we could no longer improve Mentira.

What Went Wrong? Roots of Failure

So here we are, with a dead game, a mixed record of use, plenty of unfinished ideas, and a lot of raw “data”. Sounds like a pretty convincing failure. How did we get these things wrong? One big reason is that there was simply too much to do and too few of the right people to do it. People are a critical piece of projects like Mentira. In fact, the proximal reason the game is unplayable today is that Sykes moved to another university and was no longer in a position to directly implement Mentira. When the expertise
and roles of a very small number of people together cover the many facets of development, use, and research, each of those people is very valuable and hard to replace. For instance, our stalled iteration in the game’s story happened when we lacked a motivated graduate student fluent in the appropriate dialect of Spanish. But professors move, students graduate, and teams evolve. We often hear that academics, personality-wise, might not make the best game designers and project managers, but, simultaneously, the structural factors of employment in higher education do much to limit potential collaborations across traditional divides. Even with enough of the right people around, representing multiple stakeholder groups working ideally together as co-researchers on a project like Mentira, that work must compete for attention with other more urgent, mandatory activities. Not only is everyone busy with other things, but incentives among stakeholders are misaligned. A successful game is of little value to assistant professor Principal Investigators (PIs) whose time is limited in terms of design and publication Making games with less money rather than more is similarly skewed in valuation. And what do teaching assistants or part-time instructors care of the experimental model and its data if it tanks their evaluations or makes them uncomfortable? What are the rewards for their fully involved participation on their part?

We had trouble deeply involving students and teachers in certain parts of Mentira (there were some real positives too, but this account is intentionally about our difficulties), highlighting the expectations often placed on co-investigators in DBR (Bielaczyc, 2006), and underlies revisions of DBR itself (e.g, Design Based Implementation Research, DBIR, as described in Fishman et al., 2014). Tradition enshrines the idea that everyone involved gets to be more than a subject of the research. Interventions are co-constructed between all participants, not just PIs. But these other stakeholders may have justifiably little to no interest in working to develop the innovation PIs have in mind. Teachers and students play roles whose scripts emphasize enacting rather than reinventing a curriculum. Co-designing a mobile game as we asked students and teachers to do, or even leaving campus for an hour or two to play a mobile game, falls outside those purviews. Alternative pedagogies or new materials, especially if they run contrary to the cultural beliefs of the teachers or students, may not look like progress (e.g. New Math). The inability to overcome these sorts of mismatch as a matter of course or at scale is another source of broad skepticism regarding educational change generally (Tyack & Cuban, 1995). Reinventing education would seem to require the participation of all stakeholders and requires of each a willingness to step outside their defined role within the system. Expecting exception to be the norm is unrealistic. Our shortcomings in Mentira involved many proximal factors, but underestimating the power of structural realities is central.

To Build or Not To Build

First and foremost in our minds is a question we have often asked ourselves and our colleagues: “To build or not to build?” That is, is DBR worth the time and trouble? Have we altered, with our example, the impression that games developed by researchers soon end up unplayable and inaccessible? Place-based mobile games, often designed for a local context, only seem to exacerbate the notorious problem of scaling DBR. Our initial team has been scattered to the wind. The empirical results obtained from the experiment were minimal. Moreover, these problems seem to reveal not just individual shortcomings, but the persistence and perniciousness of well-known structural challenges to educational innovation. On the whole, what here could support a future scholar who chooses to use a similar approach?

Now, here is where the story continues. In reality, despite the failures around Mentira we describe above, we could not be more optimistic regarding the potential and promise of DBR, especially of place-based mobile game design, to reinvigorate and intensely contextualize diverse educational experiences.
But how can these perspectives be so far apart? The short answer is that so far, we have only seen a narrow point of view: the standard view of the practice, role, and effects of educational research. In fact, we learned a lot about making and implementing AR games for which there was no help in academic literature, and none of this found its way into academic literature either. Even within Games Learning and Society (GLS), an uncommonly open research community, length and format make it difficult to adequately tell deep stories with more than a few words, and a very few pictures. The stories we do tell focus on only our work, where references to others serve as proof of scholarship more than a lived and growing connection. We hide our failures and strain to see successes in the expected form. Our hope is that Mentira is a different kind of story.

First, like all who hope to learn anything from video games, we try to remember that failure is productive. It may be that the things we failed most at are themselves not only what will improve going forward, but also the sources of “generalizable knowledge”. Some of the lessons we might try to recognize and adapt to are the structural features that limit innovation: The double-edged nature of small, multifunctional teams; the misalignment of incentives common in education; the siren’s call of naive empiricism; and the difficulty in attaining sustainability in itinerant conditions. None of these are absolute impediments. Even if DBR had no hope of producing scalable interventions, their diagnostic function—to identify root obstructions to innovation—should be reason enough to keep up with the practice. Failure can thus give us insight into what we can do better next time and why what we’re trying to do is difficult in the first place. Recognizing the role of failure is only a small part of our general optimism. In the course of working on Mentira, we have witnessed the potential and power of multiple forms of communication, usually across informal channels, to supersede the limitations of official mechanisms to facilitate educational innovation. Place-based mobile game design has grown with us as we worked on this game; researchers and other creators are now in a much better place to begin similar work themselves. As we worked on Mentira, we visited colleagues, published websites, ran workshops, staffed email lists to give technical and design assistance, wrote documentation and tutorials for technique, logistics, and design, got involved in the development and outreach of ARIS itself, consulted on new projects, blogged, and worked with other small teams hoping to do better than we did. Our colleagues shared the idea of the Mentira project with their students, and encouraged them to take up DBR and place-based game design themselves. We supported those students, colleagues, and others, as they got their hands dirty. Pretty soon, the creators of Mentira and the design team of ARIS were a small part of something much bigger: a growing community of explorers from diverse stations and interests: researchers, teachers, museum directors, and technology coordinators. Instead of seeing the goal of Mentira being an effective intervention in Spanish 202 at UNM, with a potential to be used in other similar courses, we can look at its impact in helping to create this much larger space. Just as earlier AR experiments (Squire et al., 2007) encouraged us to make our own game in a new area, with the help of many more investigators, we together are finally able to begin directly mapping out some of the total accessible landscape available to this medium: subject areas, educational contexts, locations, instructional paradigms, audiences, design intent, and research methodologies. We would like to share a few examples of what has begun to grow from Mentira.

What Grew from Mentira’s Death

The biggest effect Mentira had was to be the wind in ARIS’ sails. By setting an example for an interesting design that cut to the heart of second language learning pedagogy, by becoming deeply involved with the ARIS project itself, and by seeking to recruit others into the development and use of
place-based mobile games, we were able to provide awareness, motivation, and support to a variety of audiences. Because ARIS centers on storytelling and was easy to use, people who heard about *Mentira* but were not working in the niche of Spanish language learning and higher education in Albuquerque, were able to nonetheless try it themselves. They did not need money, deep technological expertise, or a large, experienced group to get something off the ground. They could be inspired by the designs and programs of other ARIS users, as well as benefit from their experience solving logistical problems. Thousands of people of all ages, backgrounds, and interests gave ARIS a try and became involved in DBR projects of their own. And because of their diverse interests and stations, the breadth of ground covered by the sum of these researches is orders of magnitude beyond what even a large, well-funded research team could ever dream. There has been a proliferation of use cases, design intents, and methodologies, beginning to meaningfully address the myriad possible implications of making and using games to study and improve learning (Holden et al. 2015; Dikkers, Coulter, & Martin, 2012). We succeeded here by joining in this more general effort, at the cost to our own program. The reception of place-based mobile games has been especially strong among those who study language learning. There was already a growing interest in connecting games and language learning, but also the common frustration that empirical work was badly needed but looked to be too expensive and labor intensive. With new means to collaborate across great distances and with new colleagues, this could change. For instance, Sykes leaving UNM was bad for *Mentira*, but a net positive for the cause: she currently directs the Center for Applied Second Language Studies (CASLS) at the University of Oregon. Her team is developing an Android port of ARIS, an open database of place-based language learning experiences (pebl.uoregon.edu), and new games and other DBR projects that iterate on *Mentira’s* mix of local place, culture, language, storytelling, and game design, developing new, deeper content and integrations than would have been possible before. *Ecopod* is a learning game that extends beyond the confines of a single class into college students’ residential experiences, and the *Bridging Project* uses place-based game design to establish real connections between intermediate learners of a target language with native speaker communities. Most recently, these efforts are being extended to use augmented reality as a tool to provide relevant, meaningful, and useful language learning for refugee populations. Through CASLS, Sykes can do far more to support better learning than any careful continuation of *Mentira* could have allowed.

*Mentira* has also helped to recruit scholars, like our third author, to DBR. Steve Thorne is well known for his scholarship on language learning, some of which considers games, and had shared the common skepticism around the academic design of place-based games. But *Mentira* and ARIS, especially as communicated through informal channels, have changed this for him. With John Hellermann, he co-directs the 503 Design Collective at Portland State University, a group of faculty and students who design AR experiences for language learning. Their ARIS game *ChronoOps* is a multilingual introduction to sustainability features of the campus and is the centerpiece of an ethnomethodologically informed research design (Thorne et al., 2015). With a far simpler game than Mentira, and multimodal data collection and analysis, this research investigates how semiotic potential is made meaningful and actionable via talk-in-interaction and embodied deixis. His closer connection to place-based mobile game design has spread even further to new people and new areas within the domain of language learning, illustrating how network effects can work towards scale. For instance, he works with Sabine Siekmann and her graduate students at the University of Alaska Fairbanks, looking for new ways that new technologies might further support native language learning in the region. Natalie Cowley, a master’s student in this program and a teacher in Kasigluk, AK made a game to connect young people there to the traditional ways of life known by the elders of their community. She takes the level of
community-language-culture integration hinted at in *Mentira* to a much deeper level, actually involving community members in the creation of the game.

We begin to see a wealth of variation as well as convergent evolutions—similar successful traits of diverse origins—in the details of this work. For example, another project concerned with Indigenous language revitalization, Partnerships for Indigenous Knowledge and Digital Literacies (PIKDL) led by Jon Reinhardt and Susan Penfield, also involves community members as game authors as a key part of their process in moving forward collaborations with academics in the development of new place-based mobile games. This not only mirrors Cowley’s design but also the thinking of researchers in other areas like Jim Mathews (2010), who described making mobile games as a way to investigate local issues for Wisconsin high schoolers, as well as many who develop and use mobile game engines like ARIS and Taleblazer as vehicles for student design (Klopfer & Sheldon, 2010; Holden et al. 2015). Variations in individual designs are just as instructive: Bernadette Perry’s *Explorez* is a French game which, while mechanically similar to *Mentira*, uses AR in an inverse sense and takes a different approach to embedding the cultural aspects of language within the game (Perry, 2015). Another French game, Terri Nelson’s *Paris Occupé*, ditches ambulatory exploration altogether, using an ARIS mechanic derived from the design of *Mentira* to work both as field trip and homework, to carry out the entire game virtually in France. The shared practices and stories of this new cohort—built mostly through informal interactions—inform practice and theory far beyond any additional attention we could have given to publishing results from *Mentira*.

Onward to Failure

One-off projects are frequently dismissed among researchers as being incapable of effecting large scale, long term change in education. As Anderson & Shattuck write, DBR’s impact has been limited to “small-scale interventions and in the lives of individual teachers and schools” (2012, p. 24). Founding literature and realities of participants in educational settings seem to explain the consistent difficulty in innovating through DBR. Yet this perspective only accounts for individual interventions and is too narrow in other ways too. Too often, we only see the means of communication and collaboration that take place through articles, conferences, and results obtained through a limited range of methodologies. The story of *Mentira* gives us a glimpse of what we’re missing, both impact beyond academics and how true collaboration in practice means that success and sustainability can be seen on a larger scale than a single intervention. To really impact education, researchers can, and need to, mobilize informal modes of communication. This means much more than tweeting or the adoption of a particular format. It means sharing your struggle more broadly and productively with others who might join in themselves. By sharing the struggle, and directly encouraging and supporting others, a one-off project can do better than scale, it can inspire a movement. Identifying similar examples to *Mentira*, Martin et al. (2014) gives this a name: participatory scaling. Grass roots, bottom up educational change has been argued for in many guises in every era (Papert, 1993). In the case of *Mentira*, we see that extensive sharing and communication allowed a failed individual effort to spark a distributed and growing movement that explores the developmental potential of DBR-informed interventions that highlight agency, collaboration, and learning in places.
References


Symposia
Telescope to Tablet

Using Real World Data to Design an Astronomy Game

Jennifer Dalsen (University of Wisconsin – Madison), Kurt Squire (University of Wisconsin - Madison), & Michael Beall (Learning Games Network)

Abstract

Undergraduate students enrolled in astronomy classes often seek to satisfy curiosities about outer space and fulfill a distribution requirement. However, they are rarely prepared to employ the mathematical thinking that is a natural part of the discipline. As a result, astronomy professors are challenged with communicating quantitatively laden subject matter in ways appropriate to their students and context. At Play in the Cosmos is an educational game designed to engage non-science majors by piquing their interest in our modern understanding of the Solar System, Stars, Galaxies and the Universe. It seeks to address this tension between qualitative and quantitative understandings, so that students begin with qualitative intuitions that are then formalized through quantitative representations (see Forbus, 2011). This paper provides a preliminary roadmap to how user feedback contributed to the design process.

Introduction

The majority of undergraduate students enrolled in ASTR 101 have no long-term plans to enter the astronomy field. These students expect to learn about galaxies and black holes, but do not anticipate the level of mathematical representation typically employed by the discipline. Models – from physical depictions to mathematical equations – are central to how we conceptualize astronomical phenomena. Astronomy professors introducing these representational systems (such as scientific notation) are also attempting to teach underlying phenomena. Indeed, the entangled nature between scientific inquiry and representation is at the heart of astronomy. As Frank (1999) writes:

“With mounds of data to sort through and hairy equations to solve, astronomers face issues that are anything but trivial. Some problems, however, are so frighteningly complex they are in a league of their own, problems such as the motions of gas inside stars or the evolution of the universe.”

Norton Publishing, in partnership with the Learning Games Network (LGN) is exploring how a digital game, At Play in the Cosmos, might immerse learners in situations in which they think with scientific tools (e.g. scientific notation, Keppler’s Law) while also leveraging games’ capacity for real-time interactive 3D simulation.
Preliminary Structure

*At Play in the Cosmos* is a game designed to complement a collegiate astronomy textbook. The purpose of the game is to look beyond learned material and think critically about how evidence is applied to real world situations (Squire, 2011). Players are not expected to make any formal scientific calculations in the game itself. However, each scientific equation can be expanded or contracted in order to display what each part of the equation represents, thereby giving users a more in-depth look at the science behind their actions.

Play Testers

LGN facilitated two focus group rounds. The first focus group discussed expectations of an astronomy game. Questions examined game narrative, character development and artistic designs. A second focus group took place roughly six months later. By this point, developers had incorporated player feedback into the game’s structure. The second round looked at engagement, game mechanics and scientific concepts. All participants were undergraduate students from a Midwestern university. A total of 68 undergraduate students participated in these sessions (46 males and 22 females). Only 2 participants identified as an astronomy major.

Design Outcomes

A roadmap of select design items, user feedback and resulting actions are displayed in Table 1.

<table>
<thead>
<tr>
<th>Narrative</th>
<th>Feedback</th>
<th>Resulting Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Earth-bound</td>
<td>Levels were modified to be missions that are also available as easily accessible tools for teaching.</td>
</tr>
<tr>
<td></td>
<td>Involve space exploration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Include challenges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Action storyline</td>
<td></td>
</tr>
<tr>
<td>Character</td>
<td>Ship captain</td>
<td>A computer interface (C.O.R.I.) is an interactive guide and companion. C.O.R.I. narrates the storyline, alerts players to status updates and directions.</td>
</tr>
<tr>
<td></td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Include artificial intelligence or robotic companion</td>
<td></td>
</tr>
<tr>
<td>Presence of</td>
<td>Participants want to see how equations are connected to digital models.</td>
<td>The option to expand or contract the &quot;skeletal structure&quot; of science equations was kept intact.</td>
</tr>
<tr>
<td>Scientific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navigational</td>
<td>Initial controls were hard to identify and manipulate. Participants noticed their hands blocking the screen when navigating the controls.</td>
<td>Navigational controls were restituted to the corners of the screen and reverse thrusters modified to be more sensitive to touch.</td>
</tr>
<tr>
<td>Tools</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 1. Feedback and resulting actions*

Conclusion

*At Play in the Cosmos* is an interactive game created through the collaborative effort of astrophysics and game developers. Through user testing, developers identified key themes and game components to include in the final design. Play testing proved crucial to confirming what type of play and narrative would best engage non-science majors.
References


Designing Educational Games For Early Learners

Competing and Complementary Perspectives of Developers, Researchers, and Learning Experts

Naomi Hupert (Education Development Center), Jillian Orr (WGBH), Camellia Sanford (Rockman et al), & Phil Vahey (SRI Education)

Abstract

This panel includes experts in digital game development, research, child development, and the learning sciences. Together they represent the various stakeholders in the development of games to support and promote learning in early childhood. They will discuss and debate their unique perspectives with respect to the goals and design of educational games as well as the ways their perspectives work in combination and in opposition to each other. For example, game developers often prioritize engagement and the fun features of a game that make children want to continue playing, while a researcher might prioritize the ways we know that young children use technology and the features that are associated with learning outcomes, and a child development expert might highlight the need for developmental appropriateness in content and usability. Thus, they all want the game to motivate and engage, but the way and extent to which learning is prioritized might differ.

Digital Games for Learning in Early Childhood

Recent research suggests that technology and media, when used in developmentally appropriate ways, has unique affordances for improving STEM learning in early childhood (e.g., Clements & Sarama, 2008; Linebarger & Piotrowski, 2009; Neuman, Newman, & Dwyer, 2010; Penuel et al., 2011). However, despite these documented affordances, integration of technology and media in early childhood classrooms is not common, partly due to concerns about the effects of screen time on young children’s cognitive and social development. These concerns certainly contain some merit, but those voicing these concerns often lack information about how media, and especially digital games, are being developed with educational purposes at the core and with interactive and non-digital components integrated into the game play. They may also lack ways of differentiating between effective and non-effective digital educational games. This panel will address these concerns, drawing out the unique ways that various stakeholders engage in the design and development of games and the affordances and concerns they see with the use of such games in early childhood settings.

Panelists will provide examples from their own work with digital resources for young learners that spur and support rich social interactions and complement effective, established teaching practices for preschool children involving hands-on experiences (NAEYC, 2011). They will discuss the collaborative and, at times, challenging process of creating and evaluating such resources while managing the
competing interests of partners. Participants will also hear the various perspectives of the panelists on how to structure a game for intentional scaffolding and opportunities for children to learn at their own pace, how to track individualized pathways through content, and how to provide essential information for teachers to better understand the skill level of individual children and thereby inform instruction. Finally, they will hear ideas about what makes a usable interface for young children, for example encouraging focused task completion as opposed to overstimulation or potential distraction onscreen and also providing moments for reflection, thought, and learning.

Session Format

Panelists will begin by introducing themselves and their areas of expertise, highlighting their general approach to the design, evaluation, and/or use of educational games geared towards young children. Then targeted questions will be used to generate discussion and debate. Audience participation will be encouraged and there will be ample opportunity for audience members to pose questions to the panelists. Sample questions that will guide the conversation include:

- What makes a digital game educational?
- What do you see as the primary goal of educational games?
- What are features of digital games that are developmentally appropriate? How do these features relate to learning?
- How do you envision digital games being used in early childhood classrooms?
- How do you envision digital games being used in informal early childhood and family settings?
- How do digital games support, complement, and/or supplement traditional learning in early childhood?

The Panelists

Panelists hold expertise in digital game design, educational research and evaluation, child development, and the learning sciences.

Naomi Hupert, MS.Ed. is a Research Scientist at the Education Development Center’s Center for Children and Technology. Her work addresses the supports required to provide all students with engaging and challenging academic instruction. This work has incorporated technology as a valuable tool and includes research, development, and evaluation of programs that make use of technology to support teachers, children, and families. Her current work includes formative and summative evaluations of digital media designed to support early learning in literacy, science, and mathematics, and examines best practices for integrating digital media into formal and informal learning settings.

Jillian Orr, Ed.M., is the Executive Producer at WGBH Educational Foundation in the Children’s Media Group. She has led the development of digital assets on several NSF-funded projects, such as Next Generation Preschool Math (NGPM) and Next Generation Preschool Science (NGPS), and has developed educational games for PBS television shows like Curious George and Arthur. Her expertise lies in producing digital educational resources and games for children, and supporting materials for
teachers and parents, through a participatory design production model. She has also written, tested, and refined algorithms for gameplay progress reporting.

Dr. Camellia Sanford is a Senior Researcher at Rockman et al. She has extensive experience conducting evaluations of educational and program impact within informal settings such as museums, homes, and the web. She then uses these findings to support partners in making design decisions. She leads several media-related projects that include television, online games, and app components and has written several articles on family learning in informal environments, exploring how measures such as time spent, engagement, and content conversations are used in these settings.

Dr. Philip Vahey is the Director of Math Learning Systems at SRI. Dr. Vahey has an established track record in leading design efforts that integrate technology into pre-K–12 mathematics education. He is currently the co-PI of the Next Generation Preschool Math project, a DRK–12 grant to develop and test a digitally enhanced preschool math curricular supplement, and leads the Cornerstone Mathematics and SunBay Mathematics programs, which are integrating Web-based resources into middle-school mathematics classes in England and Florida.

References


Design considerations in game dashboards for teachers

Kevin Miklasz (BrainPOP), Charlotte Duncan (Learning Games Network), & Anne-Marie Hoxie (Classroom, Inc.)

Abstract

Many current data dashboards about educational games have failed to capture teacher needs and gain widespread use in the classroom as an assessment tool. Drawing on results from an in-depth session with teachers and Edtech providers, we will present key points about how dashboards can be used to meet specific teacher needs most effectively. We will also share how those key points relate to BrainPOP, Learning Game Network and Classroom Inc.’s own game dashboards and plans for improving them.

Introduction

Many current data dashboards for educational games have failed to capture teacher needs and gain widespread use in the classroom. At the same time, embedded assessment and data capture from educational games and other complex tools is on the rise. As more data becomes available, we need to get better at making sense of it, and that sense-making activity needs to be informed by teachers. But it’s not exactly clear what issues data dashboards should solve, and subsequently, what data and design will help solve those issues.

Dashboards play an important role in connecting game design to assessment design to teacher needs. Designing effective game assessments is a challenging problem that has received a lot of attention at conferences like GLS in the past few years. But formulating a valid and reliable game-based assessment metric does not guarantee that the metric will have utility in classroom practices. Equally important for changing classroom practices is effectively visualizing assessment data into a clear and actionable graphics for teachers. In many ways, “data” is one of the biggest current buzzwords in education, but many teachers may be unequipped to effectively use data resulting from educational technology products. This may be in part caused by poor or non-existent teacher training in educational data, but also in part caused by poor dashboard design by those that make educational games and game-based assessments (Gates, 2015).

At this year’s SxSW Edu conference, we organized a “Problem Solvers” session dedicated to better understanding the design challenges around making teacher dashboards for educational games. In this session, we used a group brainstorming activity to generate design prompts for game-based dashboards, followed by a “dashboard critique” in which participants critiqued the design of the presenters
dashboards using the results of the brainstorming process as a framework for the critiques. The attendees in the session included a mix of current teachers, former teachers, administrators, and EdTech providers. In fact, the number of EdTech providers outnumbered the teachers in the room, indicating that this issue is an industry-wide concern. The brainstorming process thus captured the collective consensus from both practitioners and designers on the design prompts that should guide the development of teacher dashboards.

We analyzed the results of the SxSW brainstorming and critique process, and published the results in a whitepaper (Duncan et al. 2016). In this GLS panel, we plan to share the results of the SxSW panel, and engage the audience in discussion of those results. In particular, we will focus on summarizing the SxSW participant’s responses to the following questions:

- What questions do you want to answer with a dashboard?
- What actions do you want to take with that information?

Some of the key points that emerged from the responses include the categories of: “Next Steps”, “Content Mastery”, “Interventions”, “Participation/Engagement”, “Content efficacy”, and “Progress in the Game”. In the dashboard critique, each organization’s dashboard had a unique set of critiques that bridged multiple categories listed above, but the one category that consistently appeared in all three organization’s critiques was “Next Steps.”

All three panelists come from organizations that design, develop, and distribute educational games. In addition to discussing the results of the brainstorming process, we discuss how the teachers’ feedback has been applied to our own dashboards and plans for improving them. This will naturally lead into issues about how standardized or unique each game’s dashboard should be, and what aspects of a game should be captured in a dashboard. In this way, our own game dashboards will be provided as a concrete case study for how these principles could be applied to the community at large. Additionally, we hope that the results presented in this panel and whitepaper can act as a useful framework to guide future research into what dashboards designs are most effective at empowering teachers and transforming classroom practices.

Acknowledgments

We’d like to acknowledge Jessica Millstone and Christine Zianchi for their help and contributions during the SxSW presentation and after in writing the writepaper. We’d like to also thank all of the SxSW session attendees who contributed their ideas, and especially thank the attendees who offered comments and feedback to the whitepaper.

References


42.

Personalized Learning in Practice

Gaming Pedagogy in a Personalized Classroom

Rich Halverson (UW Madison), Sarah Hackett (UW Madison), Jim McLure (Institute for Personalized Learning), Eric Anderson (KM Perform School for Arts & Performance), Jill Gurtner (Clark Street Community School UW Madison), Tyler Brunsell (Clark Street Community School), Corey Dean (Clark Street Community School), Alan Barnicle (UW Madison), Tanushree Rawat (UW Madison), Julia Rutlege (UW Madison), Arlene Strikwerda (UW Madison), Emily Schindler (UW Madison), Beau Johnson (UW Madison), & Curtis Mould (UW Madison)

Abstract

This panel included researchers, school leaders, digital media experts, and K-12 students, discussing how personalized learning school design and practice supports gaming and game design. School leaders in these emerging spaces design for learning and fully embrace gaming as a useful tool and form of classroom pedagogy. Halverson, et. al (2015) explain, “In personalized learning, educators develop environments in which students and teachers together build plans for learners to achieve both interest-based and standards-based goals” (p. 1). Our panel discussed key findings from our study on personalized learning, including: students are highly social and collaborative when gaming and using diverse digital learning tools in the classroom, which Halverson, et. al (2015) classify as a socio-technical environment (p. 3). The panel also discussed how gaming happens in these environments in three district ways: game creation by the students, a teacher-designed game-based incentive structure, or implementation of existing games.

Panel Topic and Importance

Personalized learning environments are ripe with opportunity for innovation and implementation of good ideas and new practices. We discussed ways in which these spaces create opportunities for students to play and design games through a flexible, multidisciplinary, and innovation-centered structure. (Squire, et. al, 2003)

McGonigal (2011) seeks to define a game, “All games share four defining traits: a goal, rules, a feedback system, and voluntary participation,” (McGonigal, p. 21). The classrooms we featured share these traits, and we have identified how gaming practices emerge in these classrooms in three ways:

1. Goals – Students use technology to set and meet goals. Game-based levels and achievements are often built into the classroom software, but students also implement their own games and goals into their learning through design and creative goal-setting.

2. Rules – Games fit seamlessly into learning, even when the learning is framed around a set of core standards or learning targets. Students and teachers collaborate to find and create engaging
games that meet the goals and standards of the student’s learning plan.

3. Feedback system – Students and teachers collaborate around technologies in the classroom. We see students working online using various platforms and in person around common devices to produce collaborative work. Teachers will communicate with students virtually and in person around the projects, goals, and learning of the students.

4. Voluntary participation – Students in the schools of our study have agency over their learning through selection of tools, representation of learning, and interest-based topic selection, allowing them to opt into their learning.

We have documented that teachers in personalized learning schools allow students agency over path, time, pace, and place; ask questions such as, What do you want to know? How do you want to learn it? How will you show what you’ve learned; and have changed their assessment practices to collect data around progress, process, as well as performance, broadening the meaning of success.

Our discussion is rooted in Halverson’s (2015) summary of our study’s focus:

(The schools we studied) “develop socio-technical ecologies, that is, environments where technologies are selected by educators to address the interests and needs of all learners. The ecologies have three dimensions:

1. all schools provide information technologies that allow students to coordinate and document learning processes and outcomes;
2. all schools provide computer-adaptive assessment and curriculum programs that individuate skill and content development learning in math and reading;
3. some schools create digital media spaces to foster creativity in activities such as gaming, coding, performance, production and making.” (p. 1)

In these information-sharing, technology-rich, creative spaces, gaming is often welcomed in both practice and philosophy.

Panel Summary

Our panel asked participants to share questions around personalized learning and classroom gaming. Here are themes identified by the large group discussion:

1. Getting Started. Participants were interested in knowing how to start a personalized learning program and how to overcome challenges of the process. What is personalized learning and what is its role in gaming? What are the first steps and timeline to implement personalized learning? What do we mean by personalized learning compared with other definitions?
2. Classroom Design. Participants were interested in learning more about the design of personalized learning classrooms. Participants wondered what the Personalization in Practice team looks for when documenting forms of student-centered pedagogical design.
3. Curriculum Alignment. Participants were concerned with how games and personalized learning aligned with standards. How do you bridge games with traditional instruction?
4. **Student Agency.** Participants discussed ways in which games offer a natural platform for increased student agency, thereby allowing the educator to naturally shift to a greater facilitation role and away from the role of sole designer of learning experiences. How do you tap into kids’ passions? And what are some examples of student choice?

5. **Games 3 Ways.** Participants wondered how personalized learning schools support gaming in schools and how gaming is implemented in these spaces. We discussed the ways in which games are used and created in classrooms, in three ways: implementation of existing games, game creation by the students, and game-based incentive structures developed by the teachers. What do we mean by gaming pedagogy versus game-based learning?

6. **Scalability.** Participants were concerned about scalability of time-intensive community-building and game development. How do you scale games school-wide? How can teachers find the energy to implement personalized learning and gaming?

7. **Cultural Relevancy.** Participants were interested in how student interest facilitated relevant curriculum. How do we think about games and cultural relevance?

**Summary of Time Use During Panel (1 Hour)**

Our panel included: introduction of panelists (10 min); poll of the audience to gauge their background (5 min); collection of questions from the participants regarding personalized learning and gaming (10 min); collaborative panel discussion of personalized learning, game implementation strategies, and key research findings (30 min); closing comments and questions from the panel and audience (5 min).

**References**


Abstract

Each year many papers are presented at GLS discussing the role of assessment in game design and the methods by which different games intend to support and measure educationally valuable knowledge and skills. While many of them claim to use ECD, it is often unclear how they leverage assessment to conceptualize game design around the competency of interest. This symposium aims to discuss and synthesize different processes and methods beyond ECD that are currently being applied by different groups.

Description of the Symposium

For the past several years, educational game researchers and practitioners have increasingly used evidence-centered design (ECD) as a framework to align what we value in students’ learning with what students do in games. While many of them claim to use ECD, it is often unclear how they leverage assessment to conceptualize game design around the competency of interest. Some of the process-related issues that we rarely discuss include: How do you formalize assessment models? How do you translate formalized assessment models to game design elements? When in the game design process does this translation occur most effectively? How do you transform competency models into interesting, engaging game mechanics? How do you ensure psychometric qualities without being too prescriptive? This symposium aims to discuss and synthesize different processes and methods beyond ECD that are currently being applied by different groups. More specifically, we aim to unveil diverse methods and processes related to how design teams, often including learning scientists, subject-matter experts, and game designers, can seamlessly integrate design thinking and the formalization of assessment models. Each presenter will ground their talk around: (a) description of game development project(s) that each group is involved, (b) specific competencies/learning objectives aligned in the game, (c) the process and methods you employed to go from conducting domain analysis to creating engaging game elements and how rigorously or loosely ECD was applied in the process, and (d) encountered challenges and gained insights.
Designing Games for Competency-Based Teacher Education Program

Yoon Jeon “YJ” Kim, MIT Teaching Systems Lab, yjk7@mit.edu

At the MIT Teaching Systems Lab, we are using educational games to develop and assess pre-service teachers’ competencies in partnership with the Woodrow Wilson Academy of Teaching and Learning. The WW Academy will be purely competency-based, therefore, it is crucial to align learning and assessment tools with the learning outcomes. We focus on two games we are designing for this purpose: Unrubric Rubrics and Eliciting Learner Knowledge (ELK).

Both games were inspired by the design team’s understanding of ambitious teachers’ competencies, yet the employed process for each game is somewhat different. Because Unrubric Rubrics has a heavier focus on assessment capacity than ELK, how “rigorously” ECD is applied varies between the two games. For Unrubric Rubrics, we conducted extensive domain analysis to fully understand futuristic and ambitious teaching practices, and developed a progression a new teacher might take to build this expertise. The analysis included literature review, subject-matter experts interview, and teacher interviews. The outcomes of this analysis include a set of formal assessment models that describe (a) operationalized competency model variables and (b) features of actions that we want to observe (therefore, designed interactions in the game) in relation to those competency variables. These formal models, then will be translated into core mechanics of the game, which will be refined via paper prototyping. For ELK, our domain analysis work began with considering the literature on student misconceptions in science, particularly in natural selection. We developed profiles for the “student players” reflecting common misconceptions about natural selection, adaptation, and evolution (Anderson et al, 2002).

A competency, by definition, is a combination of skills, abilities, and knowledge needed to perform a specific task that is objectively measurable (Klein-Collins, 2012). Therefore, capturing the demonstration of a competency in authentic contexts and designing those contexts that elicit evidence for the competencies requires careful design. The biggest challenge that we have been facing is the translation of our understanding of complex competencies (e.g., formal assessment models) to creative and engaging game elements. For both the ELK Game and Unrubric Rubrics, translating our understanding of competencies to game elements will require collaborative thinking among learning scientists and game designers.

Designing Cross-content Assessment Games on a Digital Learning Platform

Kevin Miklasz, BrainPOP, kevinm@brainpop.com

At BrainPOP, we are designing a series of “assessment games” or “playful assessments,” the most recent of which is called TimeZoneX (BrainPOP 2105). TimeZoneX is a game about sequencing historical events, similar to how the card game “Timeline” works. Each of BrainPOP’s assessment games are focused on a skill (in this case, sequencing) that can incorporate many different kinds of content (in this case, historical events from BrainPOP’s 800 animated videos).
For these games, our process generally starts with identifying a mechanic that will cut across content areas and is related to a general learning goal. Next we simultaneously design the game mechanics and content, while having conversations about assessment design. Once the design starts to become settled (but not finalized and immune to change), the role of assessment becomes stronger—we undergo a ECD-like discussion, and the results of that discussion leads to an initial exploratory analysis of the data to test assumptions. We then start to do some assessment-focused user-tests that get at issues of validity of our constructs. Next the design becomes pretty finalized, the game goes live, and we do additional assessment testing on the live game using thousands of anonymous playthroughs.

We use ECD mainly as a communication tool between the game designers and the assessment specialists. In the claims-evidence-tasks framework, the claims are more of the designers territory (what higher level actions the game design is trying to achieve), the tasks are more the assessment data territory (what are the individual events being captured during gameplay), and the evidence is where the two groups meet in the middle and reach understanding. The ECD process (which in practice is a 2-3 hour meeting with all staff on the project) often highlights hidden assumptions that must be tested about the game, and also highlights what data or clickstream events are expected to be most crucial and deserve the most attention in analysis—thus it guides the initial exploratory analysis, and the design of the assessment user testing.

Designing Games to Teach Middle School Science

David Gagnon, University of Wisconsin, david.gagnon@wisc.edu

I was the producer for a project to develop nine 10-20 minute “mini-games” to teach middle school science topics, called “The Yard Games.” The project rose out of a challenge to live in a “game jam” mode for a few months, finding new ways to develop educational games quickly and inexpensively. We were curious if the slow adoption of games in the classroom could be improved if we would: (a) develop small games that could be easily used and completed in one class period, (b) involve teachers as co-designers from the very beginning, (c) ensure that the games were free and open source so that others could remix or modify them at will, (d) tightly align each game with 1 or 2 Next Generation Science Standards.

The design team loosely used ECD as a way to describe and critique our level design, the ways that a player would progress through the game challenges. Levels in these simple games serve two purposes: 1. Incrementally introduce user interface elements and the high-level player role and goal. 2. Provide evidence for player competency of a topic so that the game can increase in complexity. By creating a tight coupling between competency demonstration with game progression, the hope is that we would be able to say that a player who had completed level X had demonstrated competency with concept Y. In theory, this should lead toward very playable games because the conceptual trajectory grows in complexity at a pace that the player can handle. It should also lead to games that would act as an assessment of player competency.

During the rapid playtest/iteration cycles each game undertook, this approach certainly helped us design better games, ones that were more playable as well as formatively demonstrate conceptual growth. At the time of writing this proposal, we are preparing for a much more rigorous study that will measure correlation between traditional assessments of each concept with success rates for completing each
related game level. Because the games are online and we are able to test several versions in parallel, our hope is that we will be able to rapidly iterate on level designs while the games are in production with a goal to increase correlation between game progress and traditional assessment. By doing so we will not only be able to inform a teacher that one of their students are struggling with a part of the game, but with the concept itself. Formative results from this process will be available by the time of the conference.

Formative Assessment of Implicit STEM Learning in Games

Jodi Asbell-Clarke, TERC, jodi_asbell-clarke@terc.edu

EdGE at TERC has studied Scientific Inquiry in an MMO game called Martian Boneyards, Physics learning in Impulse and Quantum Spectre, Biomechanics and relations to the Natural World in Ravenous, and we are currently studying computational thinking in Zoombinis. We design our games with mechanics that are grounded in STEM phenomena such as Newton’s Laws of Motion, Optics, or Algorithmic thinking. We bake the data collection into the game as so that the game mechanics, learning mechanic, and assessment mechanics are inherently aligned.

We observe players in the game, using a combination of screen (and mouse) capture, audio, and video recordings so that we see and hear the strategies that players define for themselves as they play the game. We have multiple researchers code the videos (establishing reliability) for pertinent strategies (moves and behaviors that align with the STEM learning goals) that emerge from players own gameplay and explanations. We then build learning analytics (such as data mining detectors) to detect those same strategies in the game logs. In this way we find evidence of implicit STEM learning in the game. This model does not use a prescribed task model, as often found in ECD, but rather focuses on emergent strategies that come from the learner and demonstrate implicit learning that may not yet be formally expressed by the learner.

Because we are studying implicit game-based learning, we are not relying on formalisms that are easily translatable to school based summative assessments. Our focus is on how players build knowledge in the game, and our studies show that how they play makes a difference in their learning. Our game-based learning model relies on a teacher to bridge the implicit learning to explicit (more easily measured) learning in the classroom. We have gained insights on measuring implicit learning that is not yet expressed by learners in school’s formalized language, yet is foundational for their learning process (Polanyi, 1966). We exploit game-based learning analytics to dig deep into the learning process and reveal insights that are beyond what can be seen by traditional assessments.

References


Gamified Cultural Transformation

In the Classroom and Beyond

Yu-Kai Chou (Octalysis Group), Jerry Fuqua (the Octalysis Group), William LeVoir-Barry (IBM), & Andrew Posselt (Dean Clinic)

Abstract

In the recent rush to adopt game based solutions, some companies have produced function focused games that emphasize game elements rather than lasting outcomes. Serious games that are the most successful are human focused. They are designed from the outset to address users’ needs and motivations and provide the user with more than just an entertaining experience. By blending solid game design with well-established andragogy/pedagogy, truly effective games are can create lasting changes in business, government, and healthcare and beyond. This panel will bring together a variety of experts from professional fields to discuss how the use of analytics, cognitive feedback, and human focused design can shape the future of serious gaming. Panelists will share their experiences, and challenges, implementing games in a variety of settings, and explore the future of games in business and beyond.

Panel Topic

This panel will share and discuss their personal experiences implementing human focused games in a variety of environments ranging from private business to healthcare. The panel will discuss various aspects of successfully implementing games that are designed to change behaviors and address user motivations. They will share lessons learned from working with a wide range of users, and what commonalities they share, and other cases, what makes certain groups unique.

Why this is Important

The members of this panel were purposely chosen from a diverse background and all currently work in the private sector. They each have their own unique experiences related to their user population and how they have helped individuals and organizations meet specific needs through a variety of game based and game inspired solutions.

Panelists

Yu-kai Chou is an Author and International Keynote Speaker on Gamification. He is the Original Creator of the gamification framework: Octalysis, and the author of Actionable Gamification: Beyond
Points, Badges, and Leaderboards. He is the Founder of The Octalysis Group and has been a regular speaker/lecturer on gamification worldwide.

Jerry Fuqua is the currently the Operations Director at the Octalysis Group, which combines research in Game Design, Motivational Psychology, and Behavioral Economics to drive engagement ROIs for our clients. Jerry has worked extensively with technology-based industries and government organizations to help develop and foster successful corporate strategies, including game based solutions.

Bill LeVoir-Barry is currently a Client Technical Leader with IBM, and has extensive experience leveraging advanced game based solutions that have incorporated everything from web analytics, MMO/MMORPG, IBM’s Bluemix, and more. Bill has worked on implementing technological solutions for government, defense, banking, and other private businesses.

Andrew Posselt is a Training Instructor and eLearning Developer at Dean Clinic. Andrew has worked in healthcare and adult training for over 10 years and he trains clinical staff on electronic medical records and clinical workflows. He also develops eLearning solutions for the clinic, which include game based simulations and eLearnings that incorporate elements of augmented reality, user immersion, and other game mechanics.

Panel Structure

The session will be interactive, with the panel giving a multimedia presentation and conversing with the audience.

I. Introduction
II. Cognitive Gaming
III. Human Based Design
IV. Business Outcomes and Patient Care

I. Introduction

Andy Posselt will introduce the group and give an overview of the panel.

II. Cognitive Gaming

Bill LeVoir-Barry will discuss how he and his team have been able to use cognitive gaming, analytics, and data mining to help students and users in variety of settings. Bill will talk about using Bluemix to help pharmaceutical companies develop game based simulations to test chemical interactions and reactions. He will also share his experience using serious games to treat teen depression and teach high school students about infectious disease using a game called Medical Minecraft.

III. Human Based Design

Yu-Kai Chou and Jerry Fuqua will share his experience working alongside of renowned game expert
Yu-Kai Chou at Octalysis, and how they have used human focused design to help businesses reinvent formally unattractive topics into engaging formats. Jerry will cover using Morph Media to address compliance at major financial institutions and using Trade Samurai to teach the complex topic of foreign exchange. He will also discuss Octalysis’s Strategy Dashboard that Octalysis uses for effective game design.

IV. Business Outcomes and Patient Care

Andy Posselt will share his experience using game based technologies to improve business outcomes as well as improving patient care for large healthcare organizations. Andy will explain how he uses elements of augmented reality, user immersion, game based simulation to train clinical workflows and provider optimization. He will also discuss how user motivation, patient care, and business needs can influence game.
45.

Learning about "Self"

Game + Design + Therapy

Heidi McDonald (Centerstone Research), Sabine Harrer (Vienna University), Doris C. Rusch (DePaul University), Susan Imus, (Columbia College), Adam Mayes (Uppsala University), & Martine Pederson (Indspark)

Abstract

This panel brings together game designers and therapists in order to explore the potential of playing as well as designing games for self-inquiry, reflection and therapeutic purposes. Games enable embodied experiences and have thus gained a reputation as powerful learning tools. They can teach us something about ourselves as well as what it’s like to walk in somebody else’s shoes, thus increasing empathy, understanding, and personal growth. Playful engagement with personal conflicts through games and their design can lead to new insights, opening up new perspectives, point towards opportunities for change, increase psychological agency and have transformational power. This panel explores different purposes of and approaches to games and game design from therapeutic perspectives, including an inquiry of game design as a new modality within creative arts therapies.

Games and Positive Psychology

Heidi McDonald, game designer and creative director of iThrive, and Leslie Kirby, psychologist at Vanderbilt University and consultant to iThrive, are going to discuss the Ithrive’s goal of infusing entertainment games with positive psychology values. iThrive brings psychologists, researchers, youth coordinators and game designers together to conceptualize and implement ways of enriching the gaming landscape with products that promote empathy, resilience and emotional well-being. The talk discusses the theoretical frameworks on which iThrive’s design challenges rest, investigations of positive psychology game examples so far, experiences applying the framework to the creation of games and the perspective of youth in all that. The overarching question Heidi and Leslie aim to raise with fellow panelists and the audience is: how can we make games that youth love to play (as much as the readily available and highly appealing AAA games), that rest on sound positive psychology principles and that have a measurable positive impact on their players?

Game Design as Personal Dialogue

Sabine Harrer investigates games about loss and mourning and the power of the design process as a personal, transformative dialogue with the bereaved. Her research pursues both the question of representation – how can games portray experiences of loss and grief? – and the idea that games can be outlets for grief and technologies for commemoration. The talk will share some insights from her
participatory design work with four bereaved mothers recruited via the Regenbogen self help group in Vienna, Austria. It will briefly describe the creative journey towards making the game Jocoi, and touch on the importance of symbolic modeling as mediator between experience experts and design team. Comparing initial ambitions with results and outcomes, the talk aims to work out a response to the question what we can expect from designing for grief, and why it might not only benefit those who go through it but those who creatively engage with it.

**Game Design as Creative Arts Therapy**

This contribution by Doris C. Rusch (game designer) and Susan Imus (creative arts therapist) ties up to Sabine Harrer’s work and argues that game design is a powerful means of self-inquiry and artistic expression that deserves a place in the canon of creative arts therapies. Starting with a brief, introductory overview of the basic concepts, criteria and fundamental mechanisms of creative arts therapies, the panelists share the results of an experimental “game design as therapy” session conducted at Columbia College with a volunteer client and in the presence of five faculty members / creative arts therapists. The design therapy session revolved around the question of “social value”, the desire of having meaningful encounters with people in social spaces and the fear of being perceived as “not worth talking to”. The talk explains how the tools of game design – identifying the goal, conflict, rules and mechanics – were applied systematically, creatively and imaginatively to the personal issue and led to the discovery of multiple win scenarios rather than one, opening up new opportunities for action and social engagement and increased the client’s sense of agency. The discussion of the experiment includes an analysis of the game design process as it corresponds to or deviates from the creative arts therapies’ principles and mechanisms laid out before, and ends with an experience report of the client and what she took away from her “game design as therapy session”.

This contribution aims to open new avenues of exploration towards establishing game design as part of creative arts therapies and initiate thoughts about suitable educational and professional opportunities for game designers interested in applying their skills to personal and social change in the context of therapy.

**Games, Design and Social Work**

Coming at this from the ground is the work of Martine Pedersen, a social worker and therapist and her husband, Adam Mayes, game designer and now lecturer. Over the past ten years they have shared their work process with each other, initially through conversation but now in a more focused manner. These insights have informed, and inspired, each other’s work.

Martine works, primarily, with at-risk youth. She uses the games her clients are already playing as a part of their therapy. Rather than look at their games as a “waste of life,” as many of the adults around them do, Martine was curious to see – and to try to understand – what they gained from playing. Was there a positive narrative that the kids created about themselves in-game, and, if so, what did that mean in their real lives? Through therapeutic sessions Martine creates the space for her clients to explore and discover their agency and in-game narrative, and helps them transfer these positive narratives and competences into their real life.

For Adam, social work was an entirely new window onto his skill set, as well as a new way of thinking. When Martine would talk about three types of therapy, he heard three levels of Critical Thinking,
but applied to a social/personal problem. When they discussed addiction, he came to see problematic behavior as a symptom of a larger problem. They discussed Cognitive Behavioral Therapy as a form of game design with, to paraphrase Jane McGonigal, “A goal, a constraint, feedback and voluntary acceptance of goal, constraint and feedback.” With that as a base, they have started to see if the engagement, personal investment and, to some extent, in-game narratives, that games create could be used to aid therapy.

Together they are testing the waters of game based initiatives within local councils in Denmark, as well researching this in an academic context.

References

Creating Learning Experiences for the Playful Classroom

Kathy Yu Burek (Classroom, Inc), Kara Carpenter (Teachley), Allisyn Levy (BrainPOP), Anne Richards (Cracking Wise Interactive), & Christine Zanchi (Curriculum Associates)

Abstract

This panel brings together practitioners to discuss the unique challenges and opportunities in creating playful learning experiences for the classroom. Participants from BrainPOP, Cracking Wise Interactive, Classroom, Inc., Curriculum Associates, and Teachley will share their approaches to bringing games and other playful experiences into schools, both from a pedagogical and a practical point of view.

Introduction

Despite excitement about the potential of playful learning to truly impact the ways schools teach and students learn, developers who want to make products for schools are often disconnected from the daily realities of teachers, students, and administrators. Even developers that take an active interest in testing and distributing their products in schools may find themselves facing many obstacles to doing so, from inability to access classrooms for product testing to figuring out how to build a distribution network. This panel presents an “on-the-ground” perspective from a group of experienced practitioners who are each working in different ways to create playful learning experiences that impact teacher practice and student experience. Panelists will share their best practices for working with schools, as well as highlight design considerations that may significantly impact adoption and success of playful learning in the classroom. The Panelists The panelists for this presentation represent a cross-section of professionals in the playful learning space, with experience across curriculum design, game development, user experience design, marketing, and distribution. Each panelist has collaborated with at least one other panelist on a project intended for schools. Panelists are:

- Kathy Yu Burek, Educator Experience Lead, Classroom, Inc.
- Kara Carpenter, Co-Founder, Teachley
- Allisyn Levy, VP, GameUp, BrainPOP
- Anne Richards, President and Founder, Cracking Wise Interactive
- Christine Zanchi, Director of Student Innovation, Curriculum Associates
Discussion Topics

The panel will be an opportunity to share both panelists’ and attendees’ experience working with schools, teachers, and students, and to discuss the wide range of factors that need to be considered in developing products for the classroom. Potential areas of discussion include the following.

Design

Creating meaningful experiences for teachers and students; following evidence-centered design practices; personalizing instruction for diverse learners; designing playful non-digital tools and approaches

Working with teachers and students

Playtesting products in development; conducting focus groups; working with diverse groups of teachers with different approaches and priorities

Professional development

Using games and game-like learning to support transformation of teacher practice to create more learner-centered classrooms

Technology

Understanding the amount and quality of devices and wireless access in today’s classrooms and the impact of the digital divide on the ability of products to truly reach students who need them

Adoption and implementation Changing perceptions around play in schools; finding time in packed academic schedules; getting buy in from students, teachers, and administrators; reaching district leaders

Assessment and impact Designing methodologies and reporting structures for formative assessments inside the play experience; measuring results in terms of skills and standards; conducting surveys of teachers and students; tapping into product data for richer and more meaningful reporting and feedback

School design and scale Working with alternative distributors to reach greater scale and impact; designing schools that embrace playful learning as a holistic, integrated experience

Although it will not be possible to cover all of the above topics, each panelist will draw from their work to speak to areas that are particularly relevant to them. In addition to audience Q&A, panelists will be encouraged to ask one another questions and debate best approaches as appropriate. The Session Plan Each participant will share a brief (5-7 minute) presentation on the specific work their organization is doing. This will be followed by a discussion — including audience Q&A as well as questions from the panelists for each other — exploring different approaches to implementation and design, distribution, and professional development and teacher training, among other topics. The goal is a discussion that will not only help attendees get a broader perspective on the design, development, and distribution of playful games and
tools for the classroom, but also identify key best practices and encourage collaboration between both individuals and organizations.

Post-Panel Report

This panel was presented at GLS 12 on August 18, 2016. Rather than making formal presentations, panelists played a game called “GLS FEUD!” built around key issues involving games in the classroom with the attendees. Questions were posed to the group and the panelists and all participants had one minute to write down their preferred answer from a set of four possible answers (or submit them via Kahoot in the case of the attendees). Answers from the panelists, audience, and a group of nineteen teachers who had been surveyed prior to the panel where then revealed, prompting a group discussion about each topic. The Kahoot that was used for this session is publicly available at: https://play.kahoot.it/ – /k/27ea06af-fada-4154-90ae-a0aa22c97841.

Attendees’ responses from this session are available at: https://drive.google.com/file/d/0B3V61Zjk3iiIeGc0c2kzY2dYYTg/view?usp=sharing The results of our teacher survey done in preparation for this session are available at: https://drive.google.com/file/d/0B3V61Zjk3iiIeTVqZGxrZS1NQk0/view?usp=sharing
The Assessment Game

Moving Beyond Traditional Measures

Barbara Chamberlin (New Mexico State University Learning Games Lab), Jodi Asbell-Clarke (EdGE at TERC), Michelle Riconscente (Designs for Learning), & Allisyn Levy (BrainPOP)

Abstract

Educational and serious games can facilitate a wide variety of transformations in learners, such as changes in knowledge and behaviors to changes in beliefs, attitudes and values. Despite a substantial body of innovations around assessment of game-based learning, many game-based evaluations include only knowledge-gain measures. This panel of game assessment experts brought their diverse perspectives to a group discussion, helping game developers think beyond traditional assessments. They played The Assessment Game, proposing a variety of assessment strategies for games predicted by a dice roll.

Introduction

It’s no secret that evaluating the impact of educational and serious games is a complex and challenging undertaking. The community needs new methods for evaluating the effectiveness and impact of these dynamic and sophisticated games, beyond simple pre-post multiple-choice tests of knowledge. During the GLS Panel session, the panelists offered a brief overview of their experiences, then played, The Assessment Game, proposing assessment strategies for randomly generated, fictional games, and engaging the audience in discussion.

The Panel Barbara Chamberlin, PhD, directs development and research at the Learning Games Lab. Most recently, their team has completed a five-year project, Math Snacks, (6 animations, 5 games and extensive teaching materials) and is developing assessment measures for the next round of games. In sharing her approach, Chamberlin offered referenced their pre-post knowledge measure (Wiburg et al., 2016), as well the various additional measures they used in assessing the Math Snacks games (Trujillo et al., 2016). She emphasized the value of using different measures in having data that complements each other, and paints a broader picture. She emphasized that the value of the panel was in allowing attendees to see the thought processes of the panelists regarding assessment and understand how they work through the process of designing evaluations.

Michelle Riconscente, PhD is president of Designs for Learning, a consulting firm specializing in the design and research of interactive learning experiences. Throughout her career, Michelle has translated her passion for technology and learning into innovations to redesign how we teach, assess, and set priorities in educational settings. Most recently she served as managing director of learning and...
assessment for GlassLab. In discussing her approach to the panel, Riconscente said she has become especially interested in the formative assessment process.

**Jodi Asbell-Clarke, PhD** is the director of the Educational Gaming Environments group (EdGE) at TERC. EdGE is a team of game designers, educators, and researchers who builds game-based assessments of implicit STEM learning. EdGE designs games grounded in STEM phenomena. They have used learning analytics on data logs to identify patterns of gameplay that are consistent with implicit understanding about the STEM phenomena addressed by the game. In her opening comments, Asbell-Clark defined implicit learning as knowledge that was unexpressed by the learner.

**Allisyn Levy** is Vice President for GameUp, and leads outreach efforts for BrainPOP’s online learning games portal, a collection of top cross-curricular game titles from leading game creators. Allisyn is a National Board Certified Teacher who spent 11 years as an elementary education teacher. She is passionate about helping educators find creative ways to make assessment meaningful in a playful learning environment. Levy mentioned BrainPOP’s *SnapThought®* assessment tool, which makes it easy to tie assessment and reflective thinking into gameplay (Gardner, 2014).

The *Assessment Game* was designed to reveal the thinking behind assessment design and the process evaluators go through in developing assessment strategies. Dice are rolled three times, with the first roll setting a desired transformation, the second prescribing the audience, and the third establishing the environment or device, from a preset list of options. The challenge of the game is not for the players to brainstorm a game that meets the requirements, but to propose a way to assess this type of learning, with this kind of audience, based on this kind of device or environment.

<table>
<thead>
<tr>
<th>Die Roll</th>
<th>Desired Transformation</th>
<th>Audience</th>
<th>Environment or Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Algebra</td>
<td>6th grade students</td>
<td>Classrooms</td>
</tr>
<tr>
<td>2</td>
<td>Weight loss</td>
<td>Adults over 50</td>
<td>Mobile devices/wearables</td>
</tr>
<tr>
<td>3</td>
<td>Voter participation</td>
<td>English-Language Learners</td>
<td>Public environments</td>
</tr>
<tr>
<td>4</td>
<td>The water cycle</td>
<td>K-3 Students</td>
<td>Augmented or virtual reality</td>
</tr>
<tr>
<td>5</td>
<td>Reasoning</td>
<td>College students</td>
<td>Board or card game</td>
</tr>
<tr>
<td>6</td>
<td>Reading</td>
<td>Employees</td>
<td>Wildcard</td>
</tr>
</tbody>
</table>

*Table 1. Determining the fictional game for assessment.*

The challenge issued to the panelists and the audience was to generate at least two different ways to assess each of the randomly rolled games. The dice were rolled, and each game announced. Panelists were given first option to respond, and then the audience was invited to participate. Chamberlin clarified that, for the purpose of discussion, participants should assume that “assessment” is defined in a broad way, and could include efficacy, knowledge gain, or other types of changes in the game player; assessment designed to help teachers or other helpers guide the game player; data to help the player reflect on their own performance; or assessment that drives future activities within the game, based on the performance of the player. She also reminded the audience of different sources of data, such as the player, observations, or embedded data.

<table>
<thead>
<tr>
<th>Desired Transformation</th>
<th>Audience</th>
<th>Environment or Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 1: Weight loss</td>
<td>English Language Learners</td>
<td>Augmented or virtual reality (AR)</td>
</tr>
<tr>
<td>Game 2: Reasoning</td>
<td>K-3 Learners</td>
<td>At home (audience wildcard)</td>
</tr>
<tr>
<td>Game 3: Water cycle</td>
<td>College students</td>
<td>Mobile or wearable device</td>
</tr>
<tr>
<td>Game 4: Algebra</td>
<td>Employees</td>
<td>Card game</td>
</tr>
</tbody>
</table>

*Table 2. Games presented to panel for assessment*
Discussion on the games was initially led by panelists who presented several different strategies for assessing each game, and also identified themes or key issues as they arose. It is likely that, without feedback from the audience, the panelists could have proposed assessment for 8-10 games; however, the discussion from the audience made the experience richer, and likely contributed to a more valuable experience for the participants. The panel leader ensured discussion focused on assessment of a given game — rather than just the design of a game — and helped moderate discussion from the audience. The game could easily be replicated — and proved to be an effective way to reveal the thinking behind assessment.

References


Acknowledgements

Special thanks to Pamela N. Martinez for taking notes during the session. Math Snacks materials were developed with support from the National Science Foundation (0918794) and (1503507). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
48.

**Diversifying Barbie and Mortal Kombat**

Addressing Gender and Race in Inclusive Gaming Conference Design, Critical Educational Practice, and Intersectional Research

Yasmin Kafai (University of Pennsylvania), Kishonna Gray (MIT/Eastern Kentucky University), Gabriela Richard (Pennsylvania State University), & Sarah Schoemann (Georgia Institute of Technology)

Abstract

One of the pressing issues in gaming over the two last decades has been the continued lack of diversity. Recent events that highlight continued harassment and negative stereotypes against women and non-dominant groups have highlighted that this issue is still alive and kicking. In this panel, we not only discussed these issues but also moved forward with proposals on how to address them in design, research and practice. Panelists presented work on how to set up research labs that invite critical discussions, how to design public conferences that are inclusive in participation, and how to conduct research that examines how gaming communities foster inclusivity.

Overview

The inequalities in game culture along gender lines, with work exploring its intersectional nature across race, gender identity and sexuality have received renewed attention in light of recent events. In particular the continued gender stereotyping and harassment in #GamerGate, the death threats against Anita Sarkeesian, and the continued lack of diversity in gaming and technology in Silicon Valley, have revealed that these issues have not been resolved. In *Diversifying Barbie and Mortal Kombat* (Kafai, Richard & Tynes, 2016) we revisited together with game designer Heidi MacDonald (MacDonald, 2016) the discussion on gender, diversity, and gaming with new perspectives on who plays, how, where, why, what and with whom they play, and most importantly, how we can diversify research, access, participation and designs. In the panel, we focused on key issues and provided concrete illustrations in intersectional research, inclusive conference design and educational practice.

Examining the Critical Gaming Lab to Influence Social Justice in Game Design

The Critical Gaming Lab explores not only creation and content, but also the dissemination of these works within culture paying particular attention to reception, impact, and use. By providing space and infrastructure, this increases engagement with research and progressively influences game design. Exploring texts as persuasive, narratives as exclusive/inclusive, and content as ideological projects, etc, we explore games as having the power to deliver meaning and messages. The immersive nature of the Critical Gaming Lab connects students in game development, education, social justice, cultural studies,
sociology, and other academic disciplines to explore the interdisciplinary and intersecting nature of contemporary gaming—they aren’t just one thing. It is important to highlight the contradiction between ideals of inclusion espoused within the video game industry and society as a whole and the persistence of injustices within the structural and institutional context in which they may have developed (Gray, 2016). This can only occur when collaborative space is created, valued, and sustained. Students are empowered to view the research space as an extension of the classroom where learning still takes place but the participatory nature of the collaborations foster research in generating knowledge. By nurturing these affinity spaces, the Critical Gaming Lab is developing the community of practice where this level of game design and criticism will explore games from this progressive and holistic manner to improve conditions within gaming culture.

Designing an Intersectional Space for Different Games

In just four years, Different Games conference has grown from a small student-run event on diversity in games, into an annual event that draws hundreds to NYU’s downtown Brooklyn campus (Schoemann & Asad, 2016). We discussed how through a mixture of accessible programming, from hands-on workshops and discussion groups to lectures and panels, attendees are part of challenging conversations about the ways players, designers, and critics are moving games forward, to create a more inclusive games culture. Crucial to this annual event remaining open, dynamic and accessible, is the organization behind the conference, a collective of more than a dozen members, collaborating from across different educational, professional and ideological positions. Drawing from experiences as members of grassroots political movements, housing cooperatives, art collectives and pockets of the North American indie games scene as much as from knowledge of academic game studies or critical theory, the conference is designed to reflect a radical approach to the politics of identity and inclusion. The conference has built a reputation for modeling practical ways that both academic and industry spaces can address issues of accessibility and inclusivity, from removing financial barriers of entry to implementing alternative security procedures and de-gendering our restrooms. Through a collaborative approach to articulating shared values through the design of its events, Different Games Collective has been creating a unique and timely celebration of underrepresented voices in games since 2013.

Researching Inclusive Gaming Communities of Practice

Female-supportive gaming communities can serve as models of inclusive learning and for equitable trajectories in STEM (Richard, 2016). One example is the PMS Clan which has diverse membership and participation across gender, demonstrates evidence of higher cross-gender self-efficacy and identification in gaming, as well as trajectories for women in the game industry and computing careers. Self-efficacy and identification are important moderators of persistence in learning and career pursuit, as well as what has come to be termed “non-cognitive factors” that undergird achievement. However, PMS has also been a source, not only for resiliency, but also for resistance strategies to expose and resist the hegemony and vitriol directed at women in game culture. Members were involved in creating fatuglyorslutty.com, a site that documents and exposes abuse in online gaming and can serve as a model for game-based informal learning for marginalized and underrepresented groups. However, it has also demonstrated fragility in supporting intersectional diversity through its singular focus on gender support. Some of the limitations of this community, and future directions for exploring emerging sites and communities for viewing and combating marginalization in gaming (i.e., Twitch.tv) were discussed in the panel.
Acknowledgments

The workshop, edited book and panel was funded with a grant by the National Science Foundation (NSF#1027736) to Yasmin Kafai, Gabriela Richard, and Brendesha Tynes. The views expressed are those of the authors and do not necessarily represent the views of the National Science Foundation, University of Pennsylvania, Pennsylvania State University, and University of Southern California.

References


49.

The Great Dragon Swooping Cough

Stories about Learning Designs in Promoting Participation and Engagement with a Virtual Epidemic

Deborah Fields (Utah State University), Yasmin Kafai (University of Pennsylvania), Jen Sun (Numedeon Inc.), Nina Fefferman, (Rutgers University), Estee Ellis (University of Pennsylvania), Ben DeVane (Iowa University), Michael T. Giang (Mount St. Mary’s University), & Jackie Wong (University of Pennsylvania)

Abstract

In Winter and Spring 2016 the great Dragon Swooping Cough entered the virtual world of Whyville, wreaking chaos with scales, swooping, and great annoyance. In this panel we shared first findings from this engaging and educational epidemic: industry designers, educational researchers, and professional epidemiologists joined together to work to release a virus in a virtual world for kids, promoting experience and engagement with infectious disease. How was the virus designed to create the greatest possible engagement from citizens? What forms of participation and prevention could citizens engage in? What worked educationally? What failed? In the end we invited audience members to reflect on how the virus performed and what could be improved in future iterations. We engaged audience members in a conference-wide epidemic game (the GLS Swooping Spots), simulating experiences of epidemic outbreaks in the virtual world.

Introduction

Plague, influenza, and polio were considered to be epidemics of the past, yet a spate of recent outbreaks of measles in Disneyland, Ebola in Africa and Zika in Latin America suggests that epidemics continue to everyday life. Reading about historical outbreaks or running small-scale simulations in classrooms are good starting points for learning but cannot provide the visceral experience of an epidemic outbreak for ethical reasons. The Corrupted Blood outbreak in World of Warcraft illustrated both from a game design and an epidemiological perspective the potential of virtual epidemics for massive engagement (Lofgren & Fefferman, 2007). A virtual world for millions of tweens, Whyville holds potential to engage youth in learning with infectious disease if the virus, economics, and prevention can be designed well.

Enter the Dragon Swooping Cough, a designed virus unleashed on the virtual world of Whyville in December 2015. This virtual epidemic offers a novel approach to learn about infectious disease by using prominent features of virtual worlds—persistence, real time, personal representation, and massive numbers of players (and data)—to allow youth to experience and investigate an epidemic outbreak (Kafai & Fefferman, 2013). Using an innovative combination of observational methods and field experiments, this research provides insights into how to design large-scale online activities to promote individual and community inquiry. Public health prevention and protection measures were connected to
behavioral changes, conceptual understanding of infection, immunity, and associated social issues. By including an epidemiologist in the design of the virtual epidemics, we assured that the features of the epidemic outbreak and the tools that youth were using related to those of scientists studying epidemics.

In this symposium we bring together different members of the research and design team of the Dragon Swooping Cough to share about the experiential design and research of the virus and community response. How did the team negotiate tensions between design constraints, epidemiological requirements, and pedagogical considerations? In what ways did Whyvillians engage with the virus? What worked and what did not? The audience engaged in reflecting on a pre-approved virtual outbreak of the GLS Swooping Spots, with parallel (but adapted) features to the Dragon Swooping Cough. Drawing on both of these experiences, we invited reflections on the design of future virtual epidemics.

Panel Organization

We organized the panel in three acts: (10 min) First we provided an overview of virtual worlds and virtual epidemics, before illustrating what considerations went into designing different disease vectors both from epidemiological and educational perspectives. (30 min) Second we shared findings on participation and engagement from the virtual epidemic outbreak of Dragon Swooping Cough, including feedback from outside panelist, Ben Devane. (20 min) Finally, Whyville resident epidemiologist “Dr. Nina” Fefferman hosted the audience in a virtual Q&A live on Whyville’s Greek Theater, inviting reflections on experiences with the GLS Swooping Spots) and opening up to questions from the Whyville community at large.

Panelists

Deborah Fields, Whyvillian extraordinaire and learning scientist at Utah State University, examines kids’ learning, creative work, and identity in virtual spaces. Yasmin Kafai, a learning scientist at the University of Pennsylvania, studies children’s participation and learning of science and computation in massive virtual communities. Jen Sun is president and co-founder of Numedeon, which develops and runs Whyville, one of the first virtual worlds. Nina Fefferman studies epidemiology and biosecurity at Rutgers University and consults for the CDC. Estee Ellis, an undergraduate research assistant from the University of Pennsylvania, engages in on-the-ground ethnographic observations in Whyville. Ben Devane studies sociocultural design, identity, and learning in games at the University of Iowa.

Overview and Design of Virtual Epidemic for Learning

The design of Dragon Swooping Cough draws on 15+ years of experience with virtual epidemics, beginning in 2001 when Whyville first introduced a virtual epidemic: WhyPox (Kafai & Fields, 2013). Building on insights gained from WhyPox outbreaks, we designed the Dragon Swooping Cough virus to reflect real-life features of particularly dangerous infectious viruses in the real world, like Ebola. We carefully considered incubation period (time between infection and symptoms) and infectious period (time between infection and being infectious) as well as the rate and mode of infection. We targeted key aspects of engagement on Whyville to trigger emotional responses and interest: avatar appearance (dragon scales), chat (roaring), movement (swooping around the screen), and finances (stopping salary deposits during infection). Building on the economics of earlier viruses, we created various preventative
measures that worked to varying degrees, introduced tests for infection with false positives and false negatives, and provided graphs of current infection rates in the population.

Findings and Discussion of Dragon Swooping Cough Outbreak

The massive outbreak of Dragon Swooping Cough impacted the breadth of users in Whyville, demonstrated by the high purchase and use of preventative measures (e.g., biohazard umbrellas, scale block lotion, hand-washing). While some users were enchanted with the disease, seeking to catch it and spread it, others maintained vigorous protocols to prevent infection, including misapplied preventative measures previously designed for the flu (i.e., covering coughs) that were not helpful with this skin-based virus. A large number of experienced users refused to log in during the first week of symptoms—leaving the scene! How can future iterations build on citizen reactions for disease prevention?

Public Debriefing with Dr. Nina [In Whyville’s Greek Theater]

In the final part of the panel, we will open up for a broad discussion with the audience by connecting to an online public forum with “Dr. Nina” in the Greek Theater in Whyville. Here audience members can compare Whyville viruses and the GLS Sneeze to real-life counterparts alongside Whyvillians.

References


III

Workshops
Using Games to Teach Computer Science Concepts

Elisabeth Gee (Arizona State University), Kelly Tran (Arizona State University), Earl Aguilera (Arizona State University), Casper Harteveld (Arizona State University), Gillian Smith (Northeastern University), Jacqueline Barnes (Northeastern University), Yetunde Folajimi (Northeastern University), Carolee Stewart-Gardiner (Kean University), Stephanie Eordanidis (Kean University), & Gail Carmichael, (Shopify)

Abstract

Games that help players develop an understanding of computer science concepts are a promising alternative to the current emphasis on programming. This workshop introduced participants to digital and analog games that demonstrate how CS concepts can be integrated with game play and engaging story contexts. Relevant issues such as the value of analog games for use in classrooms and informal learning environments, the role of narrative in educational games, and the challenges of identifying appropriate concepts for game-based learning were addressed.

Overview of the Topic

In this workshop, we introduced participants to digital and analog games designed to help players develop an understanding of several core computer science concepts. The games are intended to be appealing to middle school age girls, and have been tested in a variety of informal educational settings, including libraries, after school programs, and summer enrichment workshops. Our plan for the workshop was to (a) briefly introduce the rationale for the games and provide an overview of the game design process, (b) give participants a chance to play a few levels of the games (described below), (c) debrief and discuss participants’ reactions to game play, and (d) engage in a broader discussion of issues of interest to attendees.

The games used in the workshop were developed in two related NSF-funded projects\(^1\) (Horn et al., 2016; Stewart-Gardiner et al., 2015) aimed at exploring different aspects of games to teach CS concepts. A myriad of educational efforts are aimed at increasing young people’s interest in and ability to succeed in computer science (CS) by using game design as a means of introducing them to basic programming skills (Gee & Tran, 2015). Often such approaches intend to attract girls and boys from currently underrepresented groups to computer science (ibid). These approaches, while valuable, take a rather

---

\(^1\) This material is based upon work supported by the National Science Foundation under Grant Numbers DRL- 1422750 and 1421806. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.
narrow view of the potential of games to facilitate computer-science related learning, tending to treat game design as an appealing means of learning programming rather than, for example, leveraging the affordances of games for supporting CS understanding and skills. Even games designed to introduce computer science through play tend to focus on teaching programming (Harteveld et al, 2014).

Our games take a different approach, by marrying game mechanics and goals to fundamental concepts in computer science. Our approach is aligned with the guiding assumptions of the Computer Science Principles curriculum from the College Board and NSF (The College Board, 2014) that computer science education must go beyond a primary focus on programming, and introduce students to fundamental concepts and the wide range of their potential impact. In selecting concepts as the focus for our games, we relied on the following criteria: (a) Can aspects of the concept be taught in an age-appropriate way? (b) Is the concept general enough to be understood by a student with no prior computer science training? and (c) Does the concept have the potential to be explicated through a puzzle-type game format? Each project had a different research focus: the team based at Northeastern University is exploring how the use of procedurally generated puzzles affects the educational effectiveness of a digital game focused on one CS concept, while the joint Kean University-Arizona State University team is investigating the role of story in promoting girls’ engagement with and learning from analog games addressing three different CS concepts (see our project website for more information: http://www.northeastern.edu/gramshouse/).

The games played in the workshop were developed and tested over the last 18 months in a variety of settings with middle school age youth. In addition to involving workshop participants in playing the games, we shared game play data and learning outcomes from the games, including the methodologies and tools we used to collect this information.

Presenters

The presenters and workshop facilitators were members of the two research and design teams for each project. They represent a wide range of backgrounds, including researchers, educators, game and educational media designers, and computer scientists. This diversity enabled presenters to provide varied perspectives on the design process and value of using games to teach CS concepts.

Workshop Format & Activities Participants were seated at tables in small groups as they join the session. The workshop began with a brief 10-minute introduction to the rationale for the games, our guiding assumptions about the use of games for learning, and key steps in our game design process. We moved relatively quickly to an introduction to the games themselves. Each group played a portion (one or more levels or rounds) of one of the following games:

- **GrACE**, a digital puzzle game focused on the common CS problem of finding a graph’s minimum spanning tree (MST). Players coordinate the actions of animals who are trying to collect vegetables while expending the least amount of effort.

- **Algorithm Relay Race** is an analog game that helps players understand algorithms as series of clear and concise directions to solve a simple problem. This game is designed as a collaborative relay race in which partners and teams collaborate on writing and following directions to complete tasks and progress in the game.

- **Hidden Image Game** is an analog game that demonstrates how data can be represented in many different ways and still have the same meaning. Players compete to encode and decode images,
while learning about related concepts such as binary code and run length encoding. Participants also had the opportunity to try a digital version of the game created by project team members.

- **Organize & Search** is an analog card game that helps players understand the importance of well organized data for data retrieval. Players take turns using “action cards” representing different sorting strategies to arrange a card deck with the goal of isolating their target cards.

Game play and small group discussion much of the session. Presenters worked with each group to introduce the games, facilitate game play, and discuss reactions to the games. We planned to conclude with a large group discussion, but changed plans due to participants’ interest in trying more than one game. We allowed participants to circulate to a second table and game. One common theme across our small group discussions was the appeal of analog games for classroom situations in which access to computers or game consoles might be limited. The final versions of the games and facilitator guides will be available on the project website (noted above) by June 2017.

References


Designing Design Research for Game Development

Carly A. Kocurek (Illinois Institute of Technology), Michael DeAnda (Illinois Institute of Technology), & Jennifer L. Miller (Illinois Institute of Technology)

Abstract

Design research can fuel innovation, shape approaches, and ensure efficacy. In game development, design research is a means of getting away from common sense assumptions and moving an accurate understanding of player interests, motivations, and concerns. This workshop provided a brief overview of design research approaches. Participants worked in groups to develop design research strategies for their own planned or prospective projects. While we are interested in the benefits and advantages of design research for game development, the focus here is on practical aspects of integrating design research into game development, including the selection and execution of appropriate research methods, how design research can affect game production schedules, and associated costs.

Introduction to Design Research

Design research, put simply, is research conducted as part of the design process. This type of research can be used in a variety of design projects, including the production of things from consumer products to public spaces. Design research is distinct from marketing research; while the research methods employed can be similar, they are used to different ends. Ideally, design research has as its goal not the effective moving of products in a marketplace, but rather the optimization of human experiences. Design research enables design that addresses real human needs and desires. As a practice, design research is fundamentally pragmatic (Hevner, 2007).
Table 1. Brenda Laurel's approach to design research

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Secondary Research</td>
<td>Literature review of existing studies followed by expert interviews</td>
</tr>
<tr>
<td>2. Analysis of Secondary Research</td>
<td>Analyze findings from secondary research to identify patterns and research opportunities and formulate research questions.</td>
</tr>
<tr>
<td>3. Qualitative Research</td>
<td>Conduct qualitative research using methods appropriate to the research questions.</td>
</tr>
<tr>
<td>4. Analysis of Qualitative Research</td>
<td>Conduct analysis in three stages: identify patterns; express patterns as findings; convert findings into design principles and heuristics.</td>
</tr>
<tr>
<td>5. Validate Qualitative Findings With Quantitative Methods</td>
<td>Use quantitative studies to test if findings are accurate for a larger population. Potential methods include presenting a prototype to a larger sample to conduct quantitative evaluation.</td>
</tr>
</tbody>
</table>

Design Research for Games

The game design process rarely incorporates design research. However, design research can be useful for driving innovation and connecting meaningfully with audiences. The relative homogeneity of commercial games can be attributed in part to a lack of diversity in the industry’s workforce, but both issues can be related to the “I” methodology of game design. In this methodology, designers make games they want to play, presenting scenarios and characters they can relate to, producing games that, in turn, appeal to players who are demographically similar to producers (Potanin, 2010). These players, then, see themselves reflected in the industry and are more likely to enter the field at which point the cycle repeats. Design research is an antidote to the “I” methodology. The games produced by Purple Moon during the 1990s are an excellent example of the use of design research in game development (Laurel, 2001). As VP of Design, Brenda Laurel drew on years of research into gender and technology she had previously conducted at Interval Research. The key findings from this research were translated into heuristics which Laurel and her team then translated into a series of successful games for girls aged 9-12, a demographic that the industry had historically neglected.

General Approaches

Carefully conceptualized design research is relatively affordable. Brenda Laurel proposes a multi-step approach that begins with secondary research and culminates in the validation of initial qualitative findings through quantitative methods (see Table 1). This method is adaptable and can be integrated into the development cycle while still allowing the design team to better understand their target audience and its needs. By beginning with research on a smaller scale, this style minimizes research costs without sacrificing efficacy. Fundamentally, design research moves the emphasis of the design process from the designer and her designers to the audience and their desires and needs.

Workshop Overview

This workshop introduced participants to the practice and benefits of design research as applied to the
design and development of games. The topics in this workshop, Research Design, Implementation, and Funding, were addressed through hands-on exercises and collaboration drawing on our experience with research and design projects, including our current work developing a research-driven game for early language acquisition.

Research Design

Research methods appropriate to a project to develop a game intended to teach young children fractions will likely not be appropriate for a project to create a social network game for adult women. Because of this the workshop covers ways of identifying and implementing appropriate design research strategies. Fundamentally, we suggest that research design should consider various stakeholders—for example, in the case of learning games for children, this includes educators, parents, and of course, the children themselves—and use appropriate research questions and data collection methods specific to each.

Implementation

The integration of design research into development processes can seem disruptive or overly costly. While design research may increase production time in the early stages of the project, it can also save time in the long run and help ensure that design is optimized early in the process rather than requiring substantial correction later.

Funding

Design research can add costs to projects, and individual teams ultimately have to weigh costs and benefits. We argue that the innovation and optimization possible through design research add significant value to projects. That said, the workshop covered how to complete design research efficiently and affordably and how to identify alternative funding through grants, foundations, student professionalization programs, and other types of partnerships.

Acknowledgments

This workshop draws on research completed with funding from the Nayar Prize at the Illinois Institute of Technology.

References


Abstract

The hands-on demo of the PlayableMedia Story Builder, a free and open source game engine, allowed participants to quickly build and publish responsive narrative games. Workshop participants learned PlayableMedia’s approach to rapidly developing narrative games with the Story Builder through modding an existing game in the engine, and iterating on the game’s design to affect the experience and message of the game.

The PlayableMedia Story Builder

The PlayableMedia Story Builder is a narrative game engine designed for journalism and other serious game makers. The tool empowers digital storytellers to leverage existing multimedia skillsets, alongside newsroom and media resources, to create games for new readership and engagement opportunities. The first game engine designed explicitly to meet the needs of journalists in the newsroom, it seeks to simply demonstrate what games and journalism can do when brought together, and introduce a basic framework for narrative game design.

Learn more and sign up to use the engine at http://playablemedia.org. Story Builder repository on GitHub: https://github.com/User10/playable-stories

Workshop Description

The workshop began with an introduction to the PlayableMedia team, the team’s approach to newsgame design and an overview of the Story Builder narrative game engine. Participants learned how to use the engine to build an engaging game and discussed possibilities for adding mobile game design to an informational and educational offerings. The session engaged participants in hands-on mobile game design, based on the PlayableMedia Story Builder, a free and open source game engine built with support from the Knight Foundation Prototype Fund.
Format Recap

Participants learned how PlayableMedia guides journalists in choosing game mechanics that achieve storytelling goals and leverage the Story Builder to make engaging and meaningful games. The group of 20 participants walked-through modifying a mobile game in the engine. Then, participants broke into teams of 2-4 to experience first-hand the engine features and to change a game’s design and mechanics to affect the experience of a simple narrative game. Beyond this, we discussed why journalists and serious game designers should explore newsgames, and how newsgames offer possibilities for valuable data fountains and support valuable and deep dialogues with today’s readers. The session ended with a debrief of the participants experience learning and using the engine.

Takeaways

The goal of our session was to walk our audience through the Story Builder tool, establish a common base understanding of games for journalism, and broaden the community of participants and collaborators leveraging mobile narrative games as a technology and practice for engaging audiences in complex issues.

Participants walked away with:

- Introductory knowledge of game design for journalism.
- An account in the PlayableMedia Story Builder game engine, including the modded demo game from the workshop exercise.
- The ability to design and release hosted mobile games using the PlayableMedia Story Builder.
- Workshop presentations slides including a core mechanic game design model and design tips.
- PlayableMedia contact information.
- Participants shared the following feedback during the debrief session:
  - The engine was simple to use and friendly for new game designers.
  - It would be helpful to include a model of the engine’s story structure (non-linear with multiple choice outcomes).
  - It would be helpful to add the ability to export playable pdf versions of games created.
  - A participant shared the choice outcomes probability feature would be useful when teaching students this concept in the classroom.
  - A participant shared ideas around creating engaging content to help college-aged students think about what it takes to jump into new experiences like taking courses online or studying abroad.

Conference Diversity

PlayableMedia is a majority minority, majority women-led team. We bring together innovative thinking and experience from journalism, game design, learning science, and entrepreneurship. In addition to our diversity personally, we deliberately seek to tell stories from alternative perspectives, using alternative formats games and virtual reality for journalism. We work to empower women and minority voices in
technology and game design to build and launch their own playable stories – benefiting the future of interactive, immersive, and mobile journalism.

Acknowledgments

The PlayableMedia Story Builder was created with support from the Knight Foundation Knight Prototype Fund.

References


Designing for DIY

Talking through Tensions, Lessons, and Questions to Guide Innovative Learning Environments

Deborah A. Fields (Utah State University), Sara M. Grimes (University of Toronto), Jayne C. Lammers (University of Rochester), & Alecia Magnifico (University of New Hampshire)

Abstract

How do we apply lessons learned from research on do-it-yourself (DIY) media in conscious design of practical learning environments, from classrooms to after-school clubs to websites? From fanfiction writing to video game design, DIY media has provided rich opportunities for learning. Yet while individual sites or particular youth may stand out as success stories, applying principles learned from such research into our own designed educational settings remains a challenge. In this workshop we invited participants to join in productive conversation about “tensions” faced in connecting theory to practice in thinking through design principles for creating educational affinity spaces.

Introduction

Over the past decade many have documented the rich opportunities in online environments where children and youth can create and share what they make. These do-it-yourself (DIY) media sites can support deep learning, agency, community, and leadership. Think of the positive stories told about kids programming video games and sharing them online (Kafai & Burke, in press) or learning English through writing fanfiction in a constructive community (Black, 2008). Yet while individual websites or particular youth may stand out as success stories, applying the principles learned from such research into our own designed educational settings (local and/or online) that can reach a broad range of youth (not just a few select students) remains a challenge. In this workshop we invite participants to synthesize lessons from three current studies working to analyze and apply findings about kids’ DIY media online (from writing to programming and beyond) to learning environments for young people and their teachers.

Let us be clear. We do not have all of the answers. This is not a set of presentations where we expected people to listen and come to particular “correct” answers we had thought through in advance. Rather, we presented thoughtful, in depth research on three delightfully related topics that have implications for learning, design, and practice connecting multiple types of educational spaces: online, informal, formal, and personal. We structured this workshop to elicit thoughtful conversation and problem solving around applying lessons learned from our research of online spaces to actual educational settings. Below we describe highlights from each study and outline the workshop format.
Kids DIY Media Comparative Study (Deborah A. Fields & Sara M. Grimes).

To understand best practices of DIY media websites (Grimes & Fields, 2015), we conducted a comparative study of 120 websites where children can share media that they create. This includes an analysis of the forms of moderation, funding models, scaffolding and supports, networking residues, hierarchies of access, and line-by-line analysis of legal documents on the sites (e.g., privacy polices and terms of service that pertain to data collection, copyright, and rights of users). The results are both positive and concerning, raising questions around issues of privacy and authorship, agency and supervision, and using and consuming. We are working to create “best practices” documents to distribute to educators, designers, and policy makers; feedback from this workshop will formatively shape these best practice documents.

Key Questions: What key questions do designers and educators need to consider in creating and using kids DIY media sites? How do they navigate the tricky territory of design needs, educational opportunities, and policy constraints?

Fanfiction Goes to School Study (Jayne C. Lammers).

To bring lessons learned from studying youth writers in online fanfiction sites (e.g., Lammers & Marsh, 2015) into the practice of teaching writing in school, I studied the design and facilitation of a 3-week affinity space exploration unit in a high school class. Young writers engaged in teacher-supported analysis of audience expectations in online writing spaces, such as Fanfiction.net and Wattpad, using what they learned to shape their creative writing contributions and the feedback they offered as readers. Analyzing the successes and tensions from this experience yields insights into the challenges of honoring the authentic practices of online affinity spaces while also responding to the expectations of classroom-based instruction. Feedback from this workshop will influence how I share these insights with educators and parents.

Key Question: How can teachers support youth in creative activities, helping students develop critical thinking and creative skills without over or under scaffolding or intruding on their affinity spaces?


Many have called for teachers to adopt multimedia composition opportunities in their classrooms (e.g. Alvermann, 2008; Curwood, Magnifico, & Lammers, 2013), but few accounts of transitions to such experiences exist. Here, I document how a pre-service teaching class explored digital composition by experimenting with digital tools and social media, participating in #WalkMyWorld, an “accidental MOOC” where participants create weekly challenges and connect on Twitter. Together, we learned about benefits and risks of sharing work with a wide audience and reflected on “best practices” for multimedia writing and literacy instruction. Feedback from the workshop will help me continue innovating with pre-service teachers in the next semester of this curriculum.

Key Question: What kinds of making/sharing experiences do teachers need to experience in preservice classes or professional development to enable them to include such activities in their own classrooms?
Workshop Outline

To support rich participation, the workshop was arranged in four sections.

- *Introductions & Research Briefs (15 min)*: Each of the lead researchers introduced themselves and shared short briefs of key research findings from their projects, providing a background on the current work being done, highlighting challenges and issues that have arisen in applying DIY media online into the design of other learning environments.

- *Specialized Focus (15 min)*: Participants divided into three groups, each one meeting with one researcher to delve into the content and problems that she specialized in (e.g., online websites; applying affinity space design to writing education; connective work across teachers and students).

- *Jigsaw Synthesis (15 min)*: After focusing in on one research area, participants then regrouped so that each new group had at least one representative from each specialization. Participants outlined shared tensions that occur in designing across these different learning environments, and developed a set of design-questions that could be asked in creating new educational settings.

- *Whole Group Debrief (15 min)*: At the end, the entire group reconvened to discuss the tensions, questions, and other issues that came up in our “group think”. Each group shared a few key ideas that they outlined and together we synthesized these thoughts. We worked to begin generating some “best practices” that could be applied in existing educational settings as well as ideas and questions that could be explored in future studies.

Acknowledgments

The Kids DIY Media comparative study is supported by a grant from the Social Science & Humanities Research Council of Canada.

References


Visualizing Game Data

Collaborative Dashboard Design for Researchers and Teachers by Researchers and Teachers

Mark Stenerson (University of Wisconsin) & Aybuke Gul Turker (University of Wisconsin)

Abstract

Digital games have become one of the more popular learning mediums, both in and out of the classroom (Prensky, 2003). While they provide engaging and diverse learning experiences, it is still unclear how to properly assess student learning in these massively complex environments. Furthermore, the integration of these programs into existing teacher curricula requires a large amount of resources and development centered on how to provide concise professional development materials and meaningful data visualizations for the increasingly busy K-12 teachers (Work, M.D.). The ADAGE system aims to collect real-time telemetry data from games and present it to teachers and researchers in a way that can provide quick assessment of student learning (Stenerson et al, 2014). In this workshop, attendees will interact with three different educational games and asked to collaboratively design a mockup of an interface that they would use to assess learning in their professional lives.

Introduction

With research supporting the benefits of games in education (Squire, 2005), more and more educational game are being designed both by well-known academic institutions and commercial game companies (e.g. Games+Learning+Society Center, UW Madison, Schell Games, GlassLab, Kidaptive). Games have the potential to report hundreds of thousands of data points, these educational games are not only great opportunities for learning but also for innovations in learning assessment. However, while it is great to have all of this information, it is hard enough to make sense of all of these data points from a research perspective, let alone from the point of view of a teacher who might not have any direct knowledge of how the game was developed nor the time to look into it.

To solve this problem, novel ways of not only analyzing game data but also representing it to researchers and teachers need to be created. There are two main challenges: representing data in a quick and meaningful way on a single interface, and being able to apply that interface to a wide variety of game types and platforms.

The Assessment Data Aggregator for Game Environments (ADAGE) system being developed at the Games + Learning + Society Center is an open-source system for data analysis and visualization for educational games. This workshop aims to involve the audience, many of whom are end-users, early in the development process by leveraging their collected experiences in teaching and games research.
to create early interface designs of ADAGE data outputs. By collecting this information directly from the primary users and future users of ADAGE, the organizers of this workshop hope that a singular user experience can be created that could leverage data from an ADAGE-enabled game to create quick references and visualizations regarding the state of student/player learning.

Introduce the Topic

The workshop organizers will explain how students, both during their formal and informal learning, use games as learning medium and how researchers and teachers fail to understand students’ learning processes in these rich environments because of a lack of well-designed and scalable analytics tools. The organizers will show some example work from similar studies and projects in order to introduce the audience to the goal of the workshop: to create designs for an interface that will meet the needs of teachers and researchers using games as learning implements. There will also be a quick overview of how to think about software development use cases so that participants can start to think and talk like developers.

Hands-On Activity

The organizers will split the participants into three groups and will give each group a game to play for approximately 10 minutes. After they play their assigned game, each group will collectively design the user interface for a dashboard where they could visualize the data points they would personally expect or want to see and also design how they would want to interact with those points in an manner that is consistent with their role in the learning games community. Then, staying in their groups, they will be assigned a different game to repeat the play/design process from a different game genre and perspective. While they are encouraged to think about their initial designs during this time, they will be expected to create a completely separate artifact in an effort to qualify changes in their thinking between games during post-conference analyses.

Discussion

The workshop will conclude with a short overview of the different designs that each group created. Audience feedback on each design will be welcomed so that the organizers can take notes on the features that the audience found helpful and, conversely, the features that the audience felt didn’t apply to their domain or the features that would be too confusing or time consuming. Also, in an effort to extend the iterative testing and design processes touched on in this workshop, the organizers will allow interested participants to sign up for future user-testing regarding the design and implementation of the ADAGE system.

Conclusion

Although there are tools for data analysis and visualization, many can be overly technical for teachers and researchers. Therefore, data cleaning and analyzing can take a long time before the even more challenging task of starting to interpret the data can begin. ADAGE aims to remove as much of the busy-work from educational data analysis as possible so that users of the system can focus on the interpretation and action needed in response to said data. In essence, we foresee that systems and tools
like ADAGE will help to eliminate many of the biggest technical hurdles for teachers and researchers studying games with big data thus enabling them to focus on what is most important: delivering positive learning experiences for student players.

Acknowledgments

The authors would like to thank the National Science Foundation for their continued support in funding ADAGE (DRL-1119383), though the views expressed herein are those of the authors and do not necessarily represent the funding agency. The authors also thank all of the developers, artists, and researchers that have continued to help make ADAGE a reality.

References


Work, M. D. Teachers Know Best.
Twine Game Jam

Kelly Tran (Arizona State University), Earl Aguilera (Arizona State University), & Mark Chen (Free Agent)

Abstract

This workshop will teach participants how to use Twine (twinery.org), a platform for making text-based games. Twine is an accessible game design platform that mostly relies upon plain written text, with a few programming constructs for more advanced features. In this workshop, participants will be given a brief introduction to the tool and how to use it, then will be free to work in teams or alone to create a short game and publish it to the web. At the end of the session, participants will play each others’ games, then as a group we will discuss thoughts about the tool and implications for learning with it.

Twine

There are many tools out there today for making games (Gee & Tran, 2015; Burke & Kafai, 2014, Chen, 2015). Making games represents a different approach to learning than the more traditional learning from games (Kafai & Burke, 2014). Through design, learners understand the inner workings of various systems found in games and experience first-hand a process of discovering what is and what isn’t possible given particular constraints, such as limited class time, limits of their development platform, theoretical limits to the gaming medium, etc. However, there are often many barriers to creating games: many game design platforms are complicated to use and can be expensive, making it difficult to use with students in formal and informal settings.

Twine has been garnering attention recently for being an accessible, easy-to-use game design tool (Anthropy, 2012; Chen, in review). It has been taken up by people who are often outsiders to the game design community (Kopas, 2015) and represents a different way of making games than using other game design tools that require technical knowledge.

Using Twine

Twine are, on a basic level, like choose-your-own adventure books. In these literary “precursors” to digital adventure games, readers are presented with choices at varying points of the book, with each decision instructing them to turn to a different part of the book to continue the story (to open the castle door, go to page 38; to sneak in the side entrance, go to page 102). In Twine, users take on the role of
designers that can easily offer their players choices about how the game should proceed. Using some simple, built-in programming logic, a Twine designer can add additional layers of complexity into a game (for example, using an if-then statement to see whether or not a user has found a key to open a particular door).

In the screenshot below (see Figure 1), the squares of text are called passages. The arrows represent other passages to which the player can proceed.

![Figure 1: The Interface of Twine.](image)

### The Workshop

One of the great affordances of Twine as an accessible tool is that no previous game-making or programming experience is necessary. As Twine can be run in a browser, any program attendee with a laptop can join the workshop without downloading any special software. This workshop is framed as a game jam, in which people work and learn collaboratively to make a game. Some scholars have noted the rich learning potentials of game jams (Fowler et al., 2013; Shin et al., 2012), and this session will extend that idea to a condensed format, similar to previous GLS-run game jams (Nicholson, 2014; Turkay et al., 2015) but featuring digital games rather than tabletop games.

Participants will be given a very brief tutorial of the basics of Twine, less than 10 minutes, which will introduce how to use the tool. Then, working in either small groups or individually, participants will have 30 minutes to make a game. We will set up a web page accessible to participants which explains some very basic features and how to use them, which they will be able to use as reference as they make their games.

True to the spirit of game jams, the idea will not be to make a finished or perfect product but rather to be creative and see what the tool can do. Participants will then have 10 minutes to rotate and play each
others’ games. At the end of the session, we will have a group discussion about Twine, participants’ impressions of the tools, and implications for using such a game design tool in both formal and informal educational settings.

We will encourage participants to keep working on and showing off their games throughout the rest of the conference. The site Philom.la offers free web hosting for Twine games, and we will encourage all participants to upload their games with the hashtag #glsTwineJam as well as the the general GLS hashtag so that participants can share their games.

References


56.

Early Careers Workshop

Building a Network for Early Career Scholars of Games and Learning

Owen Gottlieb (Rochester Institute of Technology/ConverJent) & Crystle Martin (University of California, Irvine)

Abstract

The Early Career Workshop brought together scholars from around the North America, to meet, share research, consider potential collaboration and sow the seeds of the network they will grow together. It is the initial workshop that will be the launching point for the creation of a network of early career scholars in Games and Learning, which will foster new collaborations in research and grant writing.

Workshop Description

The Games and Learning Early Career Workshop offered select early career scholars the opportunity for valuable career advice and critical feedback on their scholarship. The workshop was a half day meeting and was the initial phase to create a larger network to support the development of early career scholars across the interdisciplinary field of Games and Learning. The intention of the network is to connect scholars from different disciplines who all research in areas related to games and learning. The initial participants came from departments of education, information science, and business, with research that covered design, intervention, and ethnography.

The purpose of the workshop is to nurture early career scholars in Games and Learning. We endeavor to both widen the field and deepen research in the field as a new generation of scholars embarks on their careers. The workshop provides mentorship, the opportunity to build networks, and through collegial support work to advance and propel the study of Games and Learning.

The inaugural workshop consisted of several events. The first event was a panel on mentorship and career development from senior scholars and practitioners in the field. The panel offered the participants a chance to ask candid questions about career development in a safe and judgement free environment. The panelist shared their experiences and expertise, and each shared their unique career path. The participants then presented their research to their fellow participants. The presentations were used a way for the participants to get to know each other, understand what each other’s immediate and long term goals are, and to be able to determine overlaps and intersecting areas of research with the workshop participants. After the presentations the participants met in birds-of-a-feather groups with one another along research interest lines to discuss possible collaborations and opportunities for grant writing. The workshop ended with a brainstorming session where participants shared ideas with us, the facilitators, on what the group needed for professional development and what would work best for keeping the network connected while the members were distributed.
The subject matter for the presentations reflected the interdisciplinarity of the participants. Research included a study on the career trajectory of women in games, analysis of the design process of serious games, study of relationships in online games, training teachers to use board games in early elementary classrooms, student learning outcomes in early elementary classrooms, the impact of audio on games, and the development of a unified theory of digital games. This diversity of participants’ research reflects the diversity and variation in the field of games and learning itself.

The early career network has initiated an online forum through which to stay in touch, as well as share ideas, jobs, calls for participation, and news; and create connections and collaborations. The online forum will also be used to set up in person meetings at shared conferences attended by early career network members. The network will be developed through the inclusion of other early career scholars to the group.

The workshop has an advisor group of senior scholars in place to help guide the development of the network. The advisory panel will work with us over the next two years to guide the development of the network as it expands.

This workshop is the initial phase of the development of the workshop. From here we will build the network by inviting more scholars to join, using a snowball method to get the initial network started. We will also create meetups at conferences like the American Education Research Association, Digital Media and Learn and Games for Change frequented by early career network members, before we hold a second workshop next year. The long-term goal is that this network will become self-sustaining and will foster new collaborations.

Acknowledgments

This workshop is funded by a National Science Foundation Cyberlearning CAP grant titled “Workshop for Building a Network for Early Career Scholars of Games and Learning,” PI Owen Gottlieb and Co-PI Crystle Martin.

This material is based upon work supported by the National Science Foundation under Award No. 1621101. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
Well Played
Clash Royale, A Casual Deck-Building Battle Arena for Parents and Kids to Battle and Build

Eric Klopfer (Massachusetts Institute of Technology), Oren Klopfer (McCall Middle School), & Maya Klopfer (The Lynch School)

Abstract

Clash Royale is a casual mobile deck-building battle arena game. The mashup of these genres has created a game with appeal to different kinds of players, and also promotes productive interactions between different kinds of players, making for interesting family game play for “hard core” players and those less so. The distinguishing characteristics of this game that make it appropriate for family play include a broadly appealing aesthetic, a combination of synchronous and asynchronous game components, consistent challenge and significant social components. These components become the basis for productive mentoring, collaboration, communication and challenging decision-making. These components will be demonstrated in real time.

Clash Royale On Ramp

Clash Royale is a casual mobile deck-building battle arena game, launched by Supercell (creators of the top App Store game, Clash of Clans). The number of genres included in the description may make Clash Royale sound like a disastrous mashup, but Supercell has combined these genres in an interesting, and more importantly accessible way. While it isn’t the kind of game typically associated with family play (e.g. Chiong, 2009), it does bear some resemblance to Overwatch, a collaborative real time battle arena which was designed in part to appeal to families (Starkey, 2016).

The game soft launched (as many mobile games do) in Australia, Canada and a few other English speaking small markets. It was during this time that we discovered it, read the early reports online, and wanted to participate in the soft launch. “We” in this case is a father (Eric) and 12-year-old son (Oren). We made accounts in these other countries and quickly came to enjoy the the game due to the clever mixing of deck building and real-time battle.

The combo of deck building and battle arena works in part because deck building games often include some element of battle, it just isn’t real time. In Pokemon or the digital Hearthstone, the player collects cards with different traits, assembles complimentary cards into a deck and then players battle in turn
against another player or AI. In Clash Royale you also build decks of characters (Figure 1a). You slowly collect gold and get characters (cards) randomly from chests that you receive from winning battles. In any one battle you can only take eight different characters into battle. So you must curate the characters to make sure that they have the necessary skill balance. Each character has a set of traits like ground/air damage, and hit points that are familiar to players of this genre (Figure 1b).

![Figure 1](image)

Figure 1. (a) The eight characters in the battle deck along with the other characters that can be selected from along the bottom (b) the stats for an individual character and a (c) real time battle showing the characters eligible to be placed (bottom) and the playing field (top).

However, the battle unfolds in real time as you place characters on the playing field (Figure 1c), they move and battle each other. The exact timing and placement is key in defending your towers from your enemy and knocking out your opponent’s towers. You are limited in your pace of placement by “elixir” which accumulates at a set rate (bottom of Figure 1c). Winning battles provides chests which contain rewards like new characters, and advancement also leads to additional tower hit points and new types of characters which are unlocked at higher levels.

There are two forms of advancing in the game. Trophies are awarded for battles that are won. But they are also subtracted for battles that are lost. Having more trophies places you in a higher tier that is associated with better rewards. Therefore, losing trophies similarly leads to worse rewards. There are also experience points which can only go up and provide more hit points for the towers which are being defended.

While there are elements to Clash Royale that are shared across a variety of games that make for worthwhile family interactions between parents and their tween/teen children, such as in game dialog, bonding over game specific jargon, and discussion of strategy, there are several characteristics that stand out for Clash Royale that make it fill this niche particularly well.
• Broadly appealing aesthetic – The game provides a cartoon aesthetic that still doesn’t feel too young.

• Combination of synchronous and asynchronous game components – This in turn provides opportunities for playing together in real time, but also for staying connected even when that opportunity is scarce.

• Consistent challenge – Advancing in the game does not change the dynamics, it just gets more challenging. This makes communication across players at different levels fairly easy.

• Significant social components – Social components include chat, leadership, viewing battles, friendly battles and card donations.

How these play out in the game are elaborated in the next section.

Two is a Crowd and Three is Company

Father and son started to play the game quite a lot in soft launch, which meant talking about it at meals. This caused 9-year-old sister/daughter (Maya) to invoke a dinner rule that Clash Royale was not to be talked about during dinner. She stated that it was annoying that we were always talking about it so much. This rule lasted about a month until the game launched in the United States, at which point Maya said, “Fine I’ll play, but you need to teach me how.”

Maya quickly was drawn into the group, originally at the periphery and quickly moving to the middle (Lave & Wenger 1991). The game is well-balanced (and following the continual rebalancing is another source of discussion), which means that progress is steady for all, and everyone feels appropriately challenged. For Maya playing and participating was clearly as important as winning, if not more important. A string of defeats that would depress and frustrate father and son, is hardly noticed by Maya, who seeks consultation during many of the real-time battles. “Which one should I put out next?”, she asks as Oren looks over her shoulder or to the game projected onto the family TV. Maya seeks advice on deck curation, playing the role of apprentice (Stevens, Satwicz & McCarthy 2008). But she will just as often realign her decks herself.

Unlike her father and brother who are extremely analytical in their approach, Maya (who is analytical in other parts of her life) curates her deck as much based on whimsy or as a mirror of her opponents. These attitudes are further reflected in how seriously each player takes defeat. Dealing with defeat in a game that is designed to punish players who slip (rewards are lower for lower tiers) is very challenging if one takes the game seriously, and leads to interesting conversations about both defeat and addiction. It is very easy to say “just one more battle to get back to where I was” following a defeat. And much harder to put the game down. While the notion of addiction in video game play is quite controversial (e.g. Kuss, 2013), the game does have components that make it easy to to get hooked on play. There is a constant (albeit diminished) reward for continued play.

Maya also plays the role of self-appointed unofficial Clan Cop. In Clash Royale you can create groups of up to 50 players who are in the same “clan”. Members of the clan (yes, this should clearly be called something else) can interact in several ways, including chat. In our clan clean language is one of the stated rules, which means that Maya is the one to patrol and report any foul language (which is rather scarce, as most of the players in our clan seem to be young kids). Though conversation can slip into
other languages (the clan has quite a number of French players at the moment), which makes it harder to patrol but presents a language learning opportunity.

The game has other aspects that promote interaction throughout the day for the Oren, who keeps his phone with him in school. But the success of this game lies in its ability to appeal to each of the family members, with differential expertise and participation, and allows for interesting interactions between the different dyads amongst us. There are several activities that the game enables to make these dyads work effectively:

- **Socializing** – Chatting in the clan chat allows for groupwide discussion and for sharing of great victories and defeats.

- **Assisting** – Players can request cards from each other, and donate extras that they have. Donating is incentivized through gold and experience point rewards.

- **Collaborating** – (or Compete) Clan members can request friendly battles from each other and test out new decks and strategies with each other. While any clan members can battle with each other, friendly battles can often be coordinated.

- **Advising** – This is the most important for promoting family interactions. Advice comes around both deck building and real-time strategy. For deck building, advice can be asynchronous and deliberative, bolstered by data. Past experience, competitor’s decks and Internet research can all be brought into discussion. For real-time battles, advice usually comes over the shoulder and in a rush of suggestions. There is far less time for discussion, but much more immediate feedback on results.

The opportunities for advice are what initially promoted the copious dinner conversation, which annoyed Maya. But it now provides a way for all of us to interact around the game. What Maya misses in opportunities to dole out advice, she gets back with opportunities to interact by getting advice. Her leadership then comes from her role as Clan Cop in the social dimension. For Oren, he primarily dispenses the advice, being the highest level in the family. He enjoys giving both deck-building and real-time advice (though often about two seconds too late). He also has the most friends in the Clan. Managing those relationships becomes another challenge at times. His authority comes through promotions (ranks within the group), and the opportunity to judge and jury complementing Maya’s policing.
Clash Royale has one glaring challenge for use in a family. It follows the “free to play” paradigm of many mobile games. The app itself is free, but there is a lot of waiting around, and that can be accelerated by in app purchases. We have had a no in app purchases policy. But the pressure from this particular game – from seeing similar level players with better cards – is very high in this game. The challenge is turning this pressure into a learning experience – how to budget free resources, and how to write a persuasive essay (Figure 2a) about why you should break the no in app purchases rule (Figure 2b).

In the conference presentation we will show the game dynamics, and family dynamics that emerge from the modes of real time and asynchronous interaction that the game facilitates to demonstrate design principles for differential participation.

Acknowledgements

We would like to acknowledge Rachel Klopfer for her efforts in managing the frustration of players in this game.

References


Perceptual, Decision-Making, and Learning Processes During Video Gameplay

An Analysis of Infamous – Second Son with the Gamer Response and Decision (GRAD) Framework

Sam von Gillern (Iowa State University)

Abstract

During video gameplay, gamers constantly perceive and interpret multimodal symbols presented by the game, which influences their decision-making and learning processes that help them achieve goals and progress during gameplay. Furthermore, the gamers’ decisions (e.g., which paths, weapons, and power-ups they choose) influence how the game unfolds and responds through presenting new multimodal feedback. So, as video gameplay is an iterative process of interpreting multimodal symbols, making decisions, and learning, it is important to recognize how multimodal communication impacts the gamer’s decisions and learning. This paper uses the Gamer Response and Decision (GRAD) Framework (von Gillern, in press), which highlights important video gameplay features and processes, to analyze multimodal symbols presented during gameplay in Infamous – Second Son, an action-adventure game for the PlayStation 4. Additionally, this paper examines how these symbols carry meaning to gamers that influence their decisions, learning, and progression during gameplay.

Introduction

Views on literacy in the contemporary world have been expanding (Gee, 2007, 2015; Kress, 2003; Lankshear & Knobel, 2011; New London Group, 1996). The New London Group (1996) called for an expanded view of literacy, multiliteracies, a perspective that included emerging technology and a variety of forms of media. This perspective of multiple (multi)literacies has significant implications for understanding literacy and learning in the modern world. The work of Lankshear & Knobel (2011) complements the concept of multiliteracies and recognizes that emerging technologies provide new ways of interacting with the world and thus provide new literacies. Gee (2007, 2015) has developed a variety of ideas and concepts that connect video games, learning, and literacy. He illustrates how video games are a unique media that promote learning and engagement, and schools and educators can learn from this media that promotes deep and enjoyable learning.

Building on the ideas of the New London Group (1996), Kalantzis, Cope, & Cloonan (2010) have illustrated how various meaning-making modes, such as written and oral language, as well as visual, audio, and tactile forms of representation can convey meaning through multiple literacies. Multiple literacies are often required for interpreting modern media and multimodal texts. Video games are one
such form of new media and require that the player constantly interprets multiple meaning-making modes (e.g., written language, visual images and symbols, sound effects, tactile experiences, etc.) while interacting and making decisions within the game. This paper first analyzes these multiple modes of communication presented during *Infamous—Second Son* gameplay, and then illustrates how these modes influence players’ decisions, goal setting, and problem solving.

**Gamer Response and Decision (GRAD) Framework**

As video gameplay requires gamers to interpret a wide variety of multimodal symbols, use metacognitive strategies, make decisions, and learn about the game (Gee, 2015), a framework that draws on existing literature and aids in the interpretation of these processes would be valuable. The Gamer Response and Decision Framework (von Gillern, in press) was created for this purpose and serves as a tool for interpreting video gameplay experiences. The Gamer Response and Decision (GRAD) Framework draws from Reader Response Theory (Rosenblatt, 1995), new literacies (Kalantzis, Cope, & Clonan, 2010; Lankshear & Knobel, 2011) and Affordance Theory (Gibson, 1977). Ultimately, it’s purpose in this study is to be used as a tool to develop an understanding of how gamers interpret symbols, interact, make decisions, and learn while playing video games.

The GRAD Framework posits that each gamer’s unique background (e.g., knowledge, experiences, agency, self-efficacy, skills, and goals) influences his or her experiences with games and that games also possess unique qualities and features (e.g., multimodal sensory display and feedback; game rules, mechanics, and systems; story and dramatic elements; opportunities for personalization; and opportunities for social engagement). Video gameplay is a constant transaction between the gamer and the game, mediated by the gamer’s decisions, all of which occurs in a larger environmental context (see Figure 1).
It is not within the scope of this paper to cover the GRAD Framework in depth in this paper, and while the GRAD Framework covers a variety of concepts and processes, this paper will focus on its features of multimodality, decision making, and problem solving. More specifically, it will explore how, during gameplay, multimodal elements help gamers interpret affordances (Gibson, 1977) that can be matched with their effective abilities to help them accomplish goals and solve problems (Gee, 2015). The following section will provide a brief story and gameplay overview of Infamous – Second Son. Subsequently, multimodal elements will be examined, and finally, an analysis of how the various multimodal features influence player decisions, goal setting, and problem solving.

Infamous – Second Son – An Analysis

Story and Gameplay Overview

Infamous: Second Son is an open-world action-adventure game set in Seattle about Delsin Rowe, a man who gains superhuman abilities after an accidental encounter with another superhuman “conduit.” The government has developed an organization, the Department of Unified Protection (D.U.P) designed to capture these conduits to prevent them from wreaking havoc with their supernatural abilities. Delsin, after encountering the D.U.P. in the beginning of the game and witnessing their leader’s wrath on innocents, decides to fight back against the D.U.P in an attempt to restore justice to a broken system. In Delsin’s efforts to dismantle the D.U.P, he needs to utilize his superhuman powers, such as emitting fireballs from his hands, hovering, and super-jumping from building to building. While Delsin has superhuman powers, they are not unlimited; he needs to replenish his powers by extracting resources,
such as smoke, from his environment. Without these valuable and scattered resources, Delsin is considerably weaker and more vulnerable to enemy attacks.

*Infamous: Second Son* is an open-world game in which the player can largely guide Delsin around the city, look for valuable objects and activities, and start the next main mission or a variety of side missions whenever he or she wants. Even within missions, the gamer can largely choose how to navigate between areas, although there are some locations that must be visited during the mission. Ultimately, *Infamous: Second Son* provides a large and beautiful open world ripe for exploring that allows players to personalize their use of Delsin’s superhuman powers according to their own goals.

Infamous as a Multimodal Learning Experience

**Written Language**

*Infamous* uses written language in a variety of ways. The opening scene of the game is a written introduction to the story and world the gamer is about to enter. It informs the gamer that recently people have emerged with superhuman powers that allow them to harness the power of various forms of matter and the government has taken measures to prevent these “conduits” from abusing their newfound powers by detaining them. Written language is used in other ways as well. Occasionally the game will use written language to inform the player of actions he or she needs to take to advance, such “Search the crash for survivors” or “Smoke Dash (O) and then Hover (hold X) to cross wide gaps”. Such messages inform the gamer what they are supposed to do (in both instances) and how they can accomplish it (in the latter instance by indicating buttons that need to be pressed to accomplish the task). Players decode these messages and then translate their meaning into action.

**Oral Language**

The primary way oral language is used in *Infamous* is verbal dialogue between characters. Dialogue exists during active gameplay as well as cut scenes (brief movie-like sequences during which the player has no control over his or her character). During active gameplay, the main character has conversations with other non-playable characters in the environment. For example, Delsin regularly communicates with his brother via walkie-talkie, and his brother will provide him valuable information about what is happening in the city and places he should visit. Additionally, numerous cut-scenes exist in the game in which the player has no control over his or her avatar, during which the player’s total attention is focused on the audio and video of the movie-like scene to learn more about the story.

**Visual Representation**

There are a variety of ways the *Infamous* uses visuals to convey information to the player for interpretation. A primary form of visual representation consists of the three-dimensional open world that the player explores through Delsin (see Figure 3). Within this vast world there are buildings, streets, pedestrians, landscapes, valuable items, and more. The gamer sees and controls Delsin within this environment while envisioning immediate possibilities and opportunities that influence the player’s
actions and decisions. Players explore this world in different ways, seeing and interacting with different settings and activities at different points in time. Additionally, during gameplay, the heads-up display (HUD), a set of icons that are superimposed over the digital world, also conveys various visual information to gamers, such as gauges and maps that inform the gamer of available resources and locations of valuable objects and activities in the environment. For example, a player may notice that Delsin is taking damage (in the world) and running low on his superpower resource (via a HUD resource gauge; see Figure 2), and thus will seek cover and try to find a location to replenish this valuable resource, so Delsin (and the player) are ready to reengage in battle.

Audio Representation

Sound effects are abound in Infamous. Sirens, explosions, and gunshots are part of the experience and contribute to the immersive atmosphere of the game. These sound effects and countless others carry meaning about what is happening in the digital world. Even when enemies are not visibly on screen, the sound effects can alert the player to nearby adversaries. Additionally, as is the case with film, music contributes significantly to the mood of the experience, ranging from emotional background music played in a makeshift hospital to intense scores that magnify battle scenes.

Tactile Representation

The dominant form of tactile representation in Infamous is the player’s interaction with the wireless controller. The player explores the world through controlling Delsin’s actions via the Playstation 4 controller. Different buttons are pushed in different combinations and sequences to help gamers achieve their goals. This is a deeply tactile experience as one’s fingers, hands, and arms are constantly engaged with the controller in an effort to guide Delsin’s actions and progress in the game.

Goal-Setting and Problem-Solving during Gameplay: Paths for Progression

Gamers look for affordances to match with their effective abilities during video gameplay (Gee, 2015) similarly to how people in general look for affordances in the real-world to match with their effective abilities (Gibson, 1977), processes that are mediated by the goals of the individual. Throughout video gameplay, searching for and identifying affordances is a process rich in symbolic interpretation. Gamers constantly interpret an array of multimodal symbols and use this information to locate and follow paths for progression in the game by identifying and pursuing goals, problems, and opportunities through matching perceived affordances with effective abilities. Such perceptions influence the gamer’s decisions, leading to new experiences from which gamers then learn from consequences of their actions. This process represents an intersecting set of goals, problems, and actions. Given this perspective, this remainder of this section will illustrate the various ways gamers experience Infamous as a problem-solving environment.

Gamers identify goals based on the symbols Infamous provides as well as their past experiences with video games, such as general ideas about video gameplay structure, mechanics, and progression. The variety of multimodal information presented in video games, and Infamous more specifically, can be interpreted as a problem or set of problems related to the goal(s) of the gamer. One broad goal
that gamers often have is the goal to progress through the game. This progression, however, unfolds differently for each gamer based on other progression-related goals. Goal-setting processes are often nested, as larger goals (game progression and beating missions) have smaller embedded goals (defeat a group of enemies), which have even smaller contingent goals (replenish resources when necessary). Furthermore, every goal represents a problem:

Goal: Beat Mission  Problem: How Can I Accomplish the Mission?

Goal: Defeat Group of Enemies  Problem: How Should I Beat the Enemies?

Goal: Replenish Resources  Problem: How Often and from Where?

This process constantly requires gamers to interpret the situation, formulate goals, make informed decisions, and learn from their actions. This goal-setting/problem-solving process, even when subconscious, represents an important aspect of gameplay experiences in which gamers identify and follow paths for progression that help them accomplish goals and solve problems.

To illustrate this process, examining Figures 2 and 3 and the context they are drawn from is helpful. Two overarching goals during this gameplay session were to defeat all enemies and stay alive. Figure 2 illustrates Delsin battling D.U.P. enemies. In the lower-left corner is the smoke gauge, which shows his smoke powers are nearly depleted from battling enemies. Delsin, speaking to himself (and the player) verbally says “Time out for a break,” which signals to the player, in addition to the smoke gauge, that his smoke energy is low. After the player interprets this situation, he or she could continue to battle, but heeding the advice of Delsin and recognizing smoke power is low, the player decides to retreat and extract more smoke energy (Figure 3), and even though the player momentarily retreated to replenish resources, the player learns this action can help Delsin to live and fight on in the future.

In this situation, the player’s interpretation and decision occurred extremely quickly and led to a learning experience (i.e., momentary retreat can aid in the goal of survival and eventually help solve the problem of defeating enemies and beating the mission). Similarly, the player may have failed to interpret Delsin’s low smoke energy or decided to not retreat, in which case the player may have failed to stay alive and had to start over from a previous checkpoint, a different learning experience.
Another example from *Infamous* of goals, decisions, and learning occurs through the game’s karma system. If one’s goal is to earn good karma, he or she must avoid hurting innocent bystanders as well as police officers (not to be confused with the D.U.P.), who may even attack the player. This often makes completing a section of the game more difficult than for players who are seeking evil karma, as they can freely attack, and actually get rewarded, for harming innocents and the police, who are often located closely to enemy forces. So, a player seeking good karma (as a goal) must take extra caution to not hurt innocents and police when they intermingle with D.U.P forces, which creates problem that is not applicable to players seeking evil karma. As players strive for goals and solve problems through their decisions, they learn from their actions, which influences future goal setting and decision making.
Figure 3. Delsin absorbing smoke power over the city.

Conclusion

This paper recognizes video gameplay as a new literacy practice and examined one game to illustrate how multimodal symbols influence gamer perceptions, decisions, goals, and learning. Given the prominence of video games in modern society and the value of multimodal communication and learning, it is important to continue analyzing video games from a multimodal-focused new literacy perspective, so we can continue to learn about the complex meaning-making and learning processes video gamers experience.

References


Well-Played Narrative Adaptivity

Consequentiality and Story Pathways in Dreamfall Chapters
V. Elizabeth Owen (Age of Learning)

Abstract

Dreamfall Chapters, a new episodic RPG from Red Thread Games, innovates on its legacy action-adventure genre by developing choice-customized narrative. In addition to the role-playing immersion offered by user-adaptive narrative, the game enriches story through multi-dimensional characters, strong dialogue and voice acting, and story-aligned mechanics. Although imperfect, the single-player Chapters breaks ground in the frontier of branching, user-adaptive story progression—while holding a steady, deep tone in character development and dialogue that remains true to its classic RPG roots.

Introduction

A deep violet haze slowly fades in on the screen. The hypnotic beep, keeping time with a heartbeat, serves as a soundtrack to the swelling scene: a misty, twilight valley bordered by cold, icy peaks. Jagged pale rocks dot the landscape and form a twisted, floating frame of where you stand against the frigid wind, staring resolutely at the horizon. You are Zoe, a woman trapped between consciousness and dreams, struggling to find continued life while your body lies in a coma. Behind you, as if through a window into the physical world, you can see your own still figure unconscious in a hospital bed, kept alive through the steady percussion of life support. Your psyche continues to thrive, however, in this between-realm of Storytime—a place between physical worlds—as you struggle to find meaning in past events and a way forward.

This mystic scene opens the choice-driven, compelling and lushly-depicted journey of Dreamfall: Chapters, a new episodic RPG released by Red Thread Games. Kickstarted by over 21,000 backers, this project literally manifested the sheer will of the series’ hardcore fans. The first game, The Longest Journey (1999) which introduced the settings of Stark (a modern world of science) and Arcadia (a timeless world of magic) as parallel worlds. Events in one have ripple effects into the other, requiring an equilibrium of chaos and logic to preserve the larger Balance. The follow-up game Dreamfall (2006 Game of the Year) blew open the genre as an action-adventure RPG, introducing more open-world, first-person movement and combat mechanics as part of play strategy. This sequel introduced Zoe Castillo as a heroine, with an edgy, modern, corporate-

4. Gamespot.com
themed conspiracy spurring the Stark-based plot forward. Enter Dreamfall: Chapters, which picks up the thread in the shoes of Zoe in the eerie calm of Storytime.

![Figure 1. Zoe in storytime.](image)

**An Overview: Branching Paths, Deep Characters, and Story-Aligned Mechanics**

From Zoe’s opening scene, *Chapters* launches the player into an immersive, choice-based world—whose main storyline morphs in adaptation to the player’s individual choices, and where moment-to-moment decisions in the game have fundamental, long-term narrative consequentiality (c.f. Gee, 2003). In Storytime, Zoe is immediately faced with situations in which her choices will have long-term narrative impact—on both a small and large scale. One instance is her approach of a young girl who is stuck in a frightening nightmare. In interacting with her, the player has the power to treat the girl with kindness or cruelty, which has narrative impact later in the game. On a broader scale, at the end of the Storytime scene, Zoe must make a pivotal decision in order to help herself survive the coma. This is a major life event that splits the main storyline into two diverging paths. In this sense, Dreamfall immediately institutes narrative adaptivity in a way that it’s original, strictly linear predecessor did not. Not only can this be seen as an expansion of the series, but it newly leverages the single-player RPG genre to optimize narrative adaptivity.

Strengthening these player-adaptive narrative paths, the debut Storytime chapter highlights other strengths of *Chapters* that contributes to its story-driven immersion: multi-dimensional characters, and story-aligned mechanics.

**Thoughtful, Complex Characters**

First, Zoe herself exemplifies the deeply conceived, multi-dimensional nature of many characters in Dreamfall. For the most part, dialogue is witty and well-crafted, and the voice acting is superb across the board. Zoe is a humble, complex human, which we can see from her inner monologue. For example, in commentary during Storytime, she notes wistfully that her father (whose relationship with Zoe is complicated) comes and visits her hospital bedside a lot, and that she doesn’t know how to feel about it. “He keeps apologizing—I wish he wouldn’t,” she admits. Honest fluctuations between fear and curiosity are tempered with heartening touches of well-delivered humor, particularly in her search to move beyond the (relative) comfort zone of Storytime. Later, in order to find a way out, she actually confronts herself (a younger, more judgmental alter ego). “Did you think it was going to be that easy?” younger Zoe quips, dripping with sarcasm. “Sayonara to Storytime, hello second chances?” Indeed, her own former
self proves formidable, and reveals a deep, plausible complexity around themes of past, deep guilt, and the power of self-forgiveness.

Characters as vehicles for confronting bias in the immediate worlds of Stark and Arcadia is also a recurring theme in the game. Around gender, for example, the lead character Zoe is not built in an exploitative, superficial way. In addition to having a real, complex personality, her physique does not mimic a Croft-like stereotypical female avatar. Other women characters in the story are also realistically proportioned, avoiding the busty, emaciated stereotype: these include Enu, a young fighter that Zoe encounters; Shepard, the leader of fighters; and Saga, a woman that helps Zoe complete her journey. In addition, these characters carry importance in the story in their own right—not relative to a male character (as a sexual object, arm candy, love interest or otherwise).

Characters in the game also challenge bias around sexual orientation and race. A lead character in the story reveals himself as gay, with no shame or closeting, despite overt assumptions to the contrary by other well-meaning NPCs. (In the real world, this revelation in the game’s third episode was in delightful challenge to thousands of heterosexual female fans who previously expressed, er, very enthusiastic admiration for the character’s well-built physique and a desire to foster in-game heterosexual romance.) In addition, two key female characters cultivate a healthy, grounded romantic partnership without hyper-sexualized fanfare or exploitation. These pivotal, strong, relatable characters with a variety of sexual orientations embody an egalitarian perspective on sexuality and gender. Through elements of story and character, the game also tackles injustice of institutionalized racism as a major theme. Broadly, the story unfolds around the mistreatment of an entire race by the martial rulers of a province, and hinges on the efforts of main characters Zoe and Kian to uncover inhumane, genocidal behavior and stop it from happening. Several supporting characters are members of the victimized race, and the player intimately gets to know the stories of each—and the complex cycle of atrocities committed by both sides.

Story-Aligned Mechanics

Interactions with these rich characters are fueled by intuitive mechanics. For example, pivotal moments like the self-confrontation scene introduce intuitive interaction mechanics that are naturally aligned to story direction. Solid integration of story and mechanics, are considered essential for sustaining a narrative-driven magic circle (c.f. Salen & Zimmerman, 2004) in a good RPG (Costikyan, 2001). In the case of Chapters, a game which has no combat and hinges around narrative progression and character development, mechanics provide the means to immersively interact with the story environment. In Chapters, these include context-specific abilities, like the ability to slow time and connect to a person’s subconscious (specific to Storytime), as well as a tracking mechanism that marks pivotal decisions. In the self-confrontation scene, Zoe uses the subconscious-connection ability to communicate with her comatose being. (Intuitively, this ability is no longer available when Zoe is back in her native “real world” of Stark.) In interaction with most NPCs, there is an extensive dialogue system which gives agency in selected topic and response choice. Similar to TLJ, there’s also an inventory system in which stored objects are used to interact with the surrounding world. This manages to feel intuitive and not overused, with often just one or two items collected at a time, and sans far-fetched inventory-based puzzles.

In addition to player affordances that make sense situationally, the game visualizes pivotal moments of choice transparently. When a player is presented with a decision that will have some future impact, the interface will light up with an exclamation point in the upper right of the screen. If a more major
decision is being made, an additional metric called the “Balance” will show up: an elaborate twisted circle in the bottom center of the screen. When the player’s choice is selected, the Balance will light up and show a shifting animation. “The balance has shifted,” the screen will show, and at this point, it’s clear the player has made a choice that impacts a major story direction. This balance shift is introduced early in the game, and recurs throughout the game, as the player carves their own path through Stark and Arcadia in this game’s visit, with the entertaining opportunity to play as both Zoe and Kian (an anti-genocide resistance fighter). Ultimately, the small choices (with the exclamation icon) have satisfying, long-term consequences that can affect the state of the gameworld, and relationships with NPCs, but do not typically alter the main story arc. Decisions that “shift the balance” are more major, and usually result in impact on the main storyline—if not an outright split in the underlying narrative.

Deep into Branching Paths: Narrative Adaptivity

Delving deeper into decisions that impact story, it’s possible to visualize forking story paths that characterize Chapters’ core narrative adaptivity. Instead of the classic point-and-click adventure game formula (e.g. Syberia\(^5\), TLJ) of a purely linear story, Chapters allows choice to open different experiences and even alter the main storyline based on the individual player’s decisions. Figure 2 is a simplified visualization of this idea, in which the blue circles represent main storyline points, green and purple represent minor choices (which have lasting impact on the state of the gameworld, but don’t affect the main storyline), and yellow and red circles to represent major choices that can dramatically alter the main story path. For example, in the Storytime opening, Zoe has choices about whether she can treat others with kindness or cruelty (see left-most green and purple dots, Figure 2). This has impact on later relationships with NPCs, but does not majorly alter the storyline. For example, choosing to treat the girl having a nightmare (a green/purple choice) with cruelty—or kindness—has impact in the way she interacts with Zoe later on in the story. This minor choice being reflected in a later point in the story is shown below as the dotted line. Although fundamental plot isn’t altered, these early choices can greatly impact the player’s experience with the game’s setting and characters in future story points.

In Zoe’s next step on the map, she makes a major life decision at the end of the Storytime scene, which presents a major branching choice (red/yellow below). The player’s verdict here actually changes the main storyline drastically, creating a whole different set of events to experience (and enhancing replayability). Each of the these narrative chunks may have their own branches (last column of green/purple), and ultimately can culminate in very different endings of the episode (and extend across all).

---

This model is in contrast to other game models like a completely linear traditional adventure game, and many MMO RPGs. These games, broadly, tend to have one fixed main narrative with optional side quests (in varying quantities) that don’t impact main story events. Figure 3 gives a simplified visualization of progression in games in which side quests occur with little to no bearing on the single, linear main quest line.

Classic adventure RPGs like *TLJ*, *Syberia*, and *Myst*[^6] are great examples of narrative-based games with a linear story line. Side quests can be offered in these games, but they are generally few and far between. Gameplay hinges on a single linear story: the player is taken through a series of immersive environments.

---

[^6]: http://cyan.com/games/myst
and must solve puzzles (often constrained with a single correct solution) as a “checkpoint” to pass to the next major static plot point. These games are natural predecessors to a game like *Chapters*, which places an emphasis on immersive interaction with the world and NPC characters—with some inventory-based progression and no combat. However, *Chapters* feels more like an action RPG, because players move around third person in a dynamic, “3D” world\(^7\), and “point and click” is transformed into interaction which requires dynamic movement, exploration, and navigation skill. Timing and sneak come into play as well, which adds an action dynamic to the game. Perhaps the most fundamental difference, however, is the branching, choice-responsive narrative (Figure 2), contrasted with the linear plot in Figure 3.

MMO RPGs also tend to have a single fixed main story peppered with optional side quests (Figure 3). These side quests (in tan, Figure 3) generally happen in complete isolation and have no bearing on the main story line. This may be, in part, a constraint of the genre, which necessitates a shared player environment which cannot easily record or accurately reflect the choices of any given individual. The PvE (player versus environment) tracks of MMOs like *WoW*, *WildStar*, and *TERA* follow this formula. Other newer MMOs have the same main-plus-compartmentalized-side-quest structure, but attempt to engage the player in interesting choices around side quest outcomes. These include games like *Star Wars: The Old Republic* (SWTOR) and *Elder Scrolls Online* (ESO). For example, in a regional side quest, a player can decide whether a repentant criminal deserves a second chance or should be sent to the gallows. The choice doesn’t impact the main story; however, there is 1) some agency in choosing the outcome and 2) an attempt to give the decision some persistent consequence. Based on player decisions, SWTOR awards dark side or light side points across all quests (affecting avatar appearance, and gear availability). In ESO, NPCs may reference the choice in random dialogue, and an outcome can unlock special player properties (new avatar movements, or achievements and new armor dyes). These games overlap with *Chapters* as RPGs with adventure elements, but clearly feature more combat and have different constraints (especially in accommodation of multitudes of live players acting on a single world state). In contrast to *Chapters*, the main story is not always at the center of play in these MMOs. However, if the MMO main storyline is not always required for immediate leveling up, it is often the only way to open a new area of the map (needed for future leveling) or unlock critical gear.

Discussion and Conclusion

Overall, *Dreamfall: Chapters* builds on its classic adventure predecessors in an ambitious attempt to customize player narrative and immersion in a 3D-modeled, interactive world. It’s carefully crafted characters and themes of social egalitarianism strengthen this effort, while aligning interface and most game mechanics to feel intuitive to each situation.

Like any game, however, *Chapters* has its limitations. It blatantly bills itself as an immersive story game; nonetheless, RPG fans who are combat-oriented will likely find play tedious. Some mechanics are a bit clunky—like awkward timing of stealth missions, and (in early episodes) the mind-numbing necessity of roaming around an entire city for hours to find a single object or character. Facial animations could be

---

7. not in the VR sense, but more that objects are modeled in 3D, and the player moves around the city from a third person camera perspective (rather than just watching the character walk around on a fixed 2D drawing on the screen, like older adventure games).
8. [http://us.battle.net/wow/en](http://us.battle.net/wow/en)
9. [http://www.wildstar-online.com](http://www.wildstar-online.com)
10. [http://tera.enmasse.com](http://tera.enmasse.com)
11. [http://www.swtor.com](http://www.swtor.com)
12. [http://www.elderscrollsonline.com](http://www.elderscrollsonline.com)
a bit more convincing (especially in main character Kian), and earlier episodes (before the recent Unity revamp) were graphically uneven, with some characters rendered in lovely detail and others drawn more coarsely. At times the storyline feels over-ambitious, occasionally going down an inception-like rabbit hole that can be difficult to track. Lastly, the main story line splits early and ultimately converges back into a single line for the ending of the game; while minor decisions still are reflected in the ending, final outcomes may not vary greatly enough for some fans.

Ultimately, however, Chapters is a lovingly crafted RPG with consequentiality and customized narrative, story-aligned mechanics, multi-dimensional characters, and strong dialogue and voice acting. Red Thread’s incredibly time-consuming dedication to creating parallel main story paths for the sake of player adaptivity is admirable, and the deep metaphors of balance, self-realization, tolerance and forgiveness hold true from predecessors The Longest Journey and Dreamfall. Overall, Chapters breaks ground in the frontier of branching, user-adaptive narrative—while holding a steady, deep tone in character development and dialogue that remains true to its classic RPG roots.

References


Sotería
Teaching Strategies to Overcome Anxiety
Doris C. Rusch (DePaul University)

Abstract

*Sotería – Dreams as Currency (SDC)* is a metaphorical, single-player, 3D adventure game intended to promote players’ readiness to use psycho-therapeutically proven yet counter-intuitive strategies to overcome general anxiety disorder. It is based on the research of Anxiety Treatment Center founder Prof. Reid Wilson and serves to communicate principles of anxiety treatment in a way that enables embodied learning and experiential understanding. The design leverages a “recursive learning” approach (Mitgutsch & Weise 2011) that subverts player expectations and promotes the insight that to overcome fear, one must “move towards it”. This paper is an in-depth analysis of how we harnessed rules, mechanics, narrative, metaphor and voice over to model anxiety behavior, dismantle it as unproductive and then introduce new, productive strategies to respond to fear in order to claim one’s dreams and live a full life. The game can be accessed here: http://playforchange.cdm.depaul.edu/projects/soteria/

Introduction

According to the Anxiety and Depression Association of America, anxiety disorders are the most common mental illness in the US, affecting 40 million adults in the US age 18 or older, or 18% of the population.¹ Cognitive-behavioral therapy is the treatment of choice, yet as anxiety expert Prof. Reid Wilson states:

“[…] to engage the client in treatment, even skilled clinicians face the daunting task of changing anxious people’s rigid belief system regarding how to cope with distress. (…) Typical clients have long established a mix of avoidance and resistance that is the most powerful potion they can conjure up to keep uncertainty and distress from boiling over. They seek help not because their current strategy fails to reduce distress, but because the decision to resist and avoid is generating a new set of problems.” (Wilson, 2009)

To overcome anxiety, Wilson continues, patients need to let go of their desire for safety and certainty and move towards the fear, learn to not only accept, but even want it. This requires a difficult, because counter-intuitive, perspective shift. The impetus behind developing *Sotería – Dreams as Currency (SDC)* was to facilitate this shift through providing an *embodied experience* informed by a *recursive learning* model. According to Jim Gee (2003), *embodied experience* means learning by doing, by acting upon the (game)world and experiencing the consequences to one’s actions first hand, just like in real life.

The embodied nature of games makes them potentially supremely persuasive and vivid, more so than other, non-interactive forms of media (Bogost, 2007).

The recursive learning approach aims to address the rigid belief system anxiety patients have in order to cope with distress. Before one is open to trying something new, one needs to let go of the old. According to Mitgutsch & Weise (2011), recursive learning is based on the disappointment of old beliefs through failure followed by a restructuring and reframing of expectations, perceptions and meaning making. Recursive learning is transformational. It goes beyond knowledge acquisition to changing our modes of thinking. It is this kind of learning that gets us to “change our ways” and it can promote anxiety patients’ readiness to adopt new strategies. The safe space of a game presents the ideal “trial ground” to set the learning process in motion, to disappoint old beliefs in a tangible, experiential way by leading players down a path of failure and impasse, letting them experience first hand the negative side-effects of their established coping mechanisms. This disappointment reduces resistance towards trying a different approach and prepares the ground for the new strategy to be adopted: embracing fear.

It cannot be stressed enough that the purpose of the game is not to cure anxiety. It can best be compared to a self-help textbook, only with the advantages a procedural, experiential medium has to offer: to experience first hand and thus comprehend in a deep, embodied way the effectiveness or ineffectiveness of different approaches to fear. The game can only promote understanding of what needs to be done. It cannot hold players accountable for doing it. For some, playing the game might be enough to change their approach to fear in real life. Other still might need therapy. In any case, the game’s purpose is to help anxiety patients “get with the program”. To do so effectively, we had to address the following challenges with our design:

1. We needed to model anxiety in a general sense rather than focus on one, particular surface manifestation of it, such as Obsessive Compulsive Disorder, panic attacks, phobias or social anxiety.
2. We needed to create something people would actually want to play / finish, and that helped counter their potential resistance to the theme.
3. We needed to make sure “fighting fears” wasn’t perceived as trivial in the context of the game
4. We needed to promote reflection and insight to help make sense of the gameplay experience and connect it to real life.

The following provides an in-depth analysis of how SDC addresses these challenges, how we used mechanics, metaphor, game structure, narrative and voice over to convey the message, and foster experiential, recursive learning. Reid Wilson acted as subject matter expert throughout the design process, providing feedback and ensuring accuracy of the portrayed strategies. Playtesting with people who self-identified as anxious and those who didn’t also played a crucial role throughout the whole design process. Anecdotes from testing are interspersed below. A formal study on SDC and its use in middle and high schools is in planning.

Metaphorical Approach – A Harbor Town, Shadows, a Key, and a Cat

To model the essence of anxiety disorder, rather than depicting specific surface manifestations of it, we decided to take a metaphorical approach to the design. According to Wilson, treating anxiety disorders
has little to do with the content of a particular fear (e.g. germs, flying, social judgment.) It is about targeting the motivations behind anxiety patients’ actions.

Most decisions by anxious clients are motivated by two intentions: 1) to only take actions that have a highly predictable, positive outcome, and 2) to stay comfortable. If you lead with technique or skill practice without accounting for these implicit goals, you will encounter resistance. (Wilson, 2009).

These motivations are the invisible force underlying all anxiety disorders. They are also abstract. We can only see their symptoms, e.g. carefully avoiding the cracks between two cobblesones, not flying. Metaphors are excellent tools to make the abstract concrete. They allow us to get an “inside view”. According to Lakoff & Johnson (1980), “The essence of metaphor is understanding and experiencing one kind of thing in terms of another”. With a metaphorical game, we can depict fear itself and use rules and mechanics to model the relationship between the fear, the person with anxiety and the issues that arise from that.

A metaphorical approach further addresses our second challenge: how to entice players to play a game on anxiety disorder? We were wary that a literal depiction would be overly preachy, boring and unappealing. A metaphor, however, creates a magic door into a difficult theme. This is a common approach in traditional media (few parents would go see a movie about death with their child, but Bambi addresses both in a manageable way through metaphor) and is becoming more and more popular in games as well (See Papo Y Yo (2012) and Spirits of Spring (2014) by Minority Media). Lastly, metaphor implies mystery. Beneath the visible surface is a deeper meaning. Uncovering this meaning motivates continued play and an active decoding process conducive to learning.

SDC’s core metaphor is the inner landscape of a young woman, Ana, who is tormented by fears. It is represented as a night-time harbor town infested with Shadow Creatures and dedicated to the worship of the Goddess of Safety: Soteria. Your goal is to liberate your dreams from the clutches of Oicy (= the anxiety disorder) and his Shadow minions. The town is empty except for a few non-player characters – Soteria’s servants – that stand for aspects of Ana’s anxious self. They bestow protective items upon you: Soteria’s token, which can be used to teleport out of danger into the safe town center; a compass to reduce uncertainty of navigation; a flash-bang lamp infused with Soteria’s light that temporarily stuns the Shadows; a Phobos suit that is the ultimate protection against the Shadows (but has the side-effect of preventing you from claiming your dreams).

The only other character in Soteria is the alley cat O’Malley, whose sarcasm is only surpassed by his mangy appearance. O’Malley is the counter-voice to Soteria’s servants. To reinforce the recursive learning process, he is designed to raise suspicion and resistance. He pushes you out of your comfort zone, but you are not ready. It makes sense to doubt his trustworthiness at this point.

The town center is the only safe place in the game and prominently features Soteria’s statue – the cupped hand that protects and confines. The three districts that branch off to the east, west and north from the center are metaphorical representations of salient and pervasive aspects of anxiety. They all feature a special “challenge” location that further reinforces the district’s theme, reusing its central motifs. The music district revolves around “loss of self-expression” due to anxiety. Its special location is the music store, which contains piles of silenced instruments. The theatre district’s central idea is “fear of judgment”. The district is lined by rotating eyes. Getting caught in their gaze draws the Shadows. At the end of the district is the puppet theatre that features a puppet version of Ana hanging over a pit on the stage. This plays with the concept of “being fear’s puppet”. The stage lights continue the eye motif and
their anxiety-inducing gaze. The third district forms around the observatory. Its core theme is “fear of uncertainty” represented by an illuminated, safe pathway that leads through the district and is guarded by Shadow Creatures. Step off the path and the Shadows attack. The observatory itself continues this motif by guiding you on a grid on the floor via a star chart that is projected on its far wall. Following the star chart’s instructions keeps you safe.

SDC’s mechanics are also metaphorical. They model Ana’s relation to her fear and its evolution in the course of the game. The game is structured in three parts, each with its own mechanics. In the first part, the Shadows are insurmountable. This models the perceived reality of anxiety patients that their fear is too big to be faced. The only way to deal with it is to avoid it. The first part of the game thus has stealth mechanics: observing movement patterns, sneaking, hiding and teleporting out of danger. The only non-stealth mechanic is “stun” with the flash-bang light. This mechanic, however, is extremely limited, can be used only once per level and needs to be recharged in the town center. (Some playtesters interpreted the lamp as anti-anxiety medication, which wasn’t intended but makes sense). The stealth gameplay is designed to evoke an experience of helplessness, making the player wish for more safety. In the second part of the game, this wish comes true when you obtain the Phobos suit. The Shadows can’t get to you while you’re wearing the suit, yet can’t do anything other than walk around. The suit prevents you from doing anything outside of your comfort zone. This is a mechanics-based commentary on the fact that safety measures severely limit your agency and keep you stuck. The third part of the game – the liberation – introduces two new mechanics to replace stealth: lingering through the fear and provoking it. “Lingering” is represented by repeatedly pressing space bar. This player input is meant to physically reinforce the will power needed to stand your ground in the face of fear. We deliberately stayed away from a “fighting” mechanic, since fighting is just another form of resisting fear. The point is to allow fear and endure it. You learn to provoke fear by choosing the right phrases from a dialogue menu.

From Fearful to Fierce – Promoting Reflection and Insight through Game Structure

Another big challenge was to make fighting fears non-trivial in the context of the game. We decided to depict the whole process of anxiety treatment – anxiety, impasse, overcoming – rather than fast-forwarding to the solution.

Part I: Modeling Anxiety

At the beginning of Soteria, you are subjected to the perceived reality of someone with an acute anxiety disorder. Fighting your fears – the Shadow Creatures – is not a choice. The game’s rules don’t allow it, because to someone with anxiety, facing the fear doesn’t feel like a choice. To set the journey in motion, we had to introduce a strong goal: un-lived dreams. Like someone who would love to go on a camping trip with a bunch of friends but has a deep fear of spiders, or someone who wants to spend the summer with grandparents overseas, but is afraid of flying, Ana feels stuck, tired of feeling scared, but afraid to move forward. While she wants to pry her dreams from Oicys’ clutches, the only strategy she knows is to avoid and reject fear. Hence, when you as Ana try to confront Oicy’s right away, the gate to his domain is locked. O’Malley the cat tells you that you are not ready, yet. You need to find the key first. This key is broken into three pieces, each one hidden in one of the aforementioned special challenge locations and guarded by a particularly fearsome Shadow Creature. Since you only know how to sneak, hide and teleport out of danger, you are helpless in the face of these foes and are forced to back away.
Our intent was to make this part of the game feel profoundly disempowering and frustrating and to cater to all the false beliefs held by anxiety patients: that more protection – rather than less – will do the trick. We would then dismantle this instinct as misleading to leverage the power of recursive learning, which relies on the disappointment of current beliefs as the basis for new insight.

Part II: Impasse

After you have been forced out of the special locations with no key pieces to show for, you turn to the tailor for help. He says exactly what someone with anxiety might want to hear: that there is a way to be perfectly safe: the Phobos suit! He sends you back into the districts to collect cards that will infuse the Phobos suit with its protective qualities. Each district holds three cards: two represent dreams, one represents an avoidance strategy: card of chameleon to blend in; card of eggshells to walk as quietly as a little mouse; card of star chart to always stay on known pathways. These avoidance cards make the Phobos suit effective. It is a cocoon of fear and when you revisit the challenge locations with it, it keeps you safe by preventing you from doing anything. You’re stuck.

Part III: Move Towards the Roar!

After your faith in safety strategies / Soteria has been utterly disappointed (and you got rid of the suit), the third part of SDC is dedicated to learning new strategies to overcome anxiety: O’Malley, whom you are now ready to listen to, teaches you how to linger through the fear. The ability to linger makes stealth superfluous, yet we observed that players often continued to sneak and hide for a while. Lingering is not difficult to perform on a mechanical level, but due to the conditioning players underwent in the first part of the game, it now presented an emotional challenge. Confronting the fear – even in the safe space of a game – had become non-trivial. You revisit the challenge locations and this time instead of being turned away by the Shadows, you linger through the discomfort as the noise in the music store, the scrutiny of the eyeball laps or the uncertainty of leaving the known path threaten to overwhelm you. Your reward is the “key to recover”, which you cannot fit into your limited inventory without letting go of all safety devices. We observed that some players were reluctant to toss their protective items but understood that it was necessary.

The final step to recovery is to provoke fear. You learn this strategy by “rattling Oicys’ cage” before the final confrontation. From several dialogue options, you pick the most provocative to announce your presence to the foe. O’Malley applauds a bold choice and is unimpressed by a timid one. Each provocation of fear is an act of blasphemy towards Soteria and erodes her statue in the town center until only one piece is left. This piece blocks the sewer gate to Oicys’ realm. Before you can use your key to open the gate and confront Oicys, you have to choose the right dialogue line to explicitly abandon Soteria, destroying the least piece of the statue. The final showdown with Oicys uses “linger” and “provoke” in tandem. You pick the right provoke from the dialogue options and then endure Oicys’ resulting tantrum. The confrontation has three stages to make sure players have to understand what they need to do and can’t just win by accident. Choose the wrong provoke resets the encounter and you have to start from the beginning. Only when you got all provokes right and lingered through the fear, Oicys’ exhausts himself and releases your dreams.
Speaking the Mind – Promoting Reflection and Insight through Voice Over

Apart from the metaphors and game structure, Soteria’s voice over served a crucial role in helping to convey the game’s message and promote insight and self-reflection. It was mentioned before that Soteria’s servants represent aspects of Ana’s anxious self. The exchanges with them express Ana’s concerns (e.g. going after her dreams is dangerous) and false hopes (e.g. if she just follows her “gut” and stays safe, all will be well). Ana’s voice over reveals how conflicted she is about wanting to live her dreams and going after them. Her script was rewritten several times, taking feedback by subject matter expert Reid Wilson into account. According to Wilson, the first pass made her appear too confident. In order to accurately capture the mindset of a person struggling with anxiety disorder, she had to be much more hesitant and reluctant to move forward, yet compelled to do so by a strong motivation (=dreams). He also pointed out the importance of articulating her worries – the whispers you hear in the challenge locations – in a way that didn’t speak towards one, particular manifestation of anxiety, but captured a broader range of the disorder.

Ana’s voice over is meant to be a vehicle for empathy as well as identification. Players’ feedback to Ana as a character was mixed, though. While some players who self-identified with anxiety disorder said they had to take a break from playing because the whispers were “too close to home” and triggered intense discomfort, others experienced Ana as “too whiny” in the first half of the game. We generally observed players responding positively to Ana’s increasing empowerment in the second half of the game. It is noteworthy that particularly players who self-identified as anxious rejected Ana’s initial hesitancy, while players who had anxious friends or family members found Ana very relatable and thought she was an accurate representation of someone with anxiety disorder. We found that people who most rejected Ana didn’t do so because anxiety was a foreign concept to them, but because they were overly familiar with it. As one of our playtesters said, who self-identified as having anxiety: “What she says rings true, but it made me disengage. No one wants to be that pathetic!” How a player relates to Ana can promote self-reflection and critical discussion, which promises to be particularly productive when the game is played in the context of therapy, counseling or with a parent.

O’Malley also has substantial voice over presence. The dialogues between him and Ana are some of the main drivers of reflection, aimed at helping players interpret and make sense of the game’s metaphors and encounters. O’Malley’s job is to point Ana in the right direction, yet he is deliberately designed to be ambiguous to make his advice as “un-preachy” as possible. One of our playtesters, a 15 year-old young man, exclaimed delightedly after a dialogue with O’Malley: “Oh that cat, he’s such a dick! I love him!” Raising doubts about O’Malley’s intentions and reliability was further conducive to our recursive learning approach. If O’Malley had been clearly portrayed as trustworthy from the start, it would have conflicted with our goal of luring players down the wrong path first. However, the relationship with O’Malley changes after Ana’s strategies have been disappointed. As in many mentor-disciple narratives, the disciple first rejects the mentor’s ideas as absurd or pointless (think of the great car washing scene in Karate kid!) and tries to go his / her own way, until he / she hits bottom and ruefully returns to the mentor, willing to trust his / her tutelage. Once O’Malley taught Ana the linger mechanic, he becomes a source of encouragement, providing her with the affirmations that help her stand her ground in the face of fear. These affirmations are eventually internalized by Ana and her voice over replaces that of O’Malley’s when she beats the Shadows in the challenge locations.
Conclusion

SDC allows players to experience the ineffectiveness of common, counter-productive anxiety strategies – rejecting and avoiding fear – in order to prepare the ground for new, more effective strategies to deal with anxiety: moving towards, enduring, even wanting the fear. It does so by leading players through the whole dramaturgy of anxiety treatment with its game structure: from modeling the initial problem (i.e. fear is perceived as insurmountable), to reaching and impasse, to providing a solution. The game leverages metaphors to reduce resistance to the theme, tap into players’ curiosity and, most importantly, to portray the essence of anxiety, rather than depicting particular surface manifestations of it. It “works” in the sense that players cannot complete the game without understanding its core messages: they cannot win, if they don’t stop worshipping Soteria, the goddess of safety, if they don’t abandon their stealth gameplay in favor of confronting and lingering through the fear, and if they don’t learn how to provoke fear. Does that mean players who identify with having an anxiety disorder are cured after playing? Unfortunately, no. Reading a self-help book doesn’t absolve you from applying the newly learnt strategies to real life, “doing the work”, and neither does playing SDC. It is our goal, though, that the game effectively challenges players’ belief system about how to deal with anxiety disorder; that it provokes reflection and insight through embodied experience, and that it sets a process of rethinking / relearning anxiety strategies in motion that – maybe with the help of a supportive context within which the game is played – transfers into real life and transforms how people approach the disorder.

References


GLS Showcase
Wrainbo’s Magitech is a mobile fantasy game that helps players learn business management and data-driven decision making skills. By casting “business spells” and analyzing “crystal ball data”, players will compete with opponents to maximize profits through various business activities, from operations, marketing, to financial management. Featuring immersive gameplay, bite-sized play sessions for both single- and multi-player, and rigorous learning both through simulation and embedded library, Magitech makes adult learning much more engaging and effective.

Game Design Wrainbo’s Magitech is motivated by the huge skill gap in business analytics – 1.5 million shortage in US alone by 2018 (Lund, Manyika, Nyquist, Mendonca, & Ramaswamy, 2013). Because business decisions are based both on intuitions and scientific analysis, we want to create a world where players could weave both magic and technology power to compete with others in marketplace. Magitech aims to combine the fun of Candy Crush and Angry Birds with the rigor of Duke University and McKinsey business analytics. There are three main features to highlight:

- Fantasy fun: Magitech is the first fantasy business game where players could produce, trade, and cast spells to compete with computer AI and other players (Figure 1). Players could immerse in this world to learn and hone analytics skills.

- Dynamic chart: Magitech’s chart UI displays relevant analytics based on the decision context players are in (Figure 2), and the chart change dynamically based on internal and external factors. Players will have ample opportunities to solve problems using data analytics.

- Bite-sized levels: Each level or multiplayer session is designed to last around 5-10 minutes (Figure 3). This is different from traditional business simulation games where each meaningful session typically lasts over 30 minutes. The bite-sized levels will suit modern lifestyle well.
Figure 1. Magitech main UI screenshot

Figure 2. Magitech analytics UI screenshot

Figure 3. Magitech bite-sized level map
Learning Design In Magitech, players will learn the business fundamentals in 20-30 single-player levels and have continuous opportunities to practice via multiplayer gameplay and future level expansions. The learning includes three business foundation fields – Economics, Statistics, Accounting – as well as three applied functions – Marketing, Operations, and Finance. There are three unique features of Magitech learning to highlight:

• Interleaved subjects: Players will learn about various business concepts in an interleaved way, which is proven to be more effective than clustering by topic (Rohrer & Taylor, 2007). For example, in the game, when learning how to conduct promotion to boost sales, players will also be introduced to linear regression technique.

• Spaced learning: Magitech is designed to revisit certain concepts in a spaced manner. For example, while price elasticity may be introduced in the first 10 levels, it will re-appear as a key concept to solve the problem in later levels. Studies have shown that massed practice (doing the same thing repeatedly) is inferior to spaced practice for learning retention (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006).

• Personalized feedback: Players will have multiple opportunities to receive feedback in Magitech—one is through the trading results and report. The other is through a personal library that will highlight player’s strength and suggested improvement areas. Studies have shown that providing feedback to both correct and incorrect choices will lead to better retention (Butler, Karpicke, & Roediger, 2008).

Important Review Notes

• Video footage: https://www.youtube.com/watch?v=8rONN5ztS8E
• Android demo: https://play.google.com/apps/testing/com.wrainbo.magitech
• iOS demo: available upon request via Apple TestFlight app
• Web demo (PC and Mac; not compatible with mobile browsers): www.wrainbo.com/demo/index.html

Acknowledgments

• Chief Designer: Duke Wong
• Level Designer: Naresh Panda
• UX Designer: Hui Liu
• Artist: Cystem Chen
• Programmer: Paul Hsin

References


Community in Crisis

Kathy Burek (Classroom, Inc.)

Abstract

*Community in Crisis* is a literacy learning game that immerses students in an authentic workplace experience while learning literacy skills, engaging with meaningful texts, and developing 21st century life skills. Players take on the role as Director of Common Ground Community Center, a local organization responding to the effects of a major hurricane. As the Director, players must focus on providing services to the community with the help of their support staff by deciding how best to respond to daily challenges by making critical decisions based on information gathered through various sources in the game. As players navigate through the life of a working professional, they learn how to be critical thinkers, tackle real life problems, become strong decision makers and hone valuable literacy skills.

Game Overview

*Community in Crisis (CIC)* (Figure 1) makes an authentic connection between school, college and career and offers students opportunities to practice select Common Core State Standards (CCSS) in Reading for Informational Text. The game focuses on the aftermath of a major hurricane that has hit the town of Port Douglas and players, who take on the role as Director of Common Ground Community Center, the town’s local community service organization, must read their way through their day at work solving problems and making evidence-based decisions.
CIC consists of 12 episodes, each representing a full day at work. Each episode centers around a particular theme. At the beginning of each episode, players are presented with the central issue of the day and must decide how best to respond by gathering information from informational texts, conversations with colleagues and town citizens, and performing workplace tasks. They also have their smartphone handy throughout the game with tools such as a ToDo list, text messages, glossary and note-taking applications to help keep things organized.

The game addresses 21st Century Skills as defined by the P21 Framework and assesses students in three CCSS for Reading for Informational Text. These standards were specifically chosen to help players develop a strong foundation for success in reading comprehension and college and career readiness.

Assessment

Each episode also contains one major workplace activity (Figure 2) that is a seamlessly embedded assessment focused on one CCSS and where players must read and interact with a real-world document that is related to the day’s central issue. Tasks for completing each assessment include determining the best images or text to use in a document or citing evidence that supports a particular point.
Behind the scenes, CIC differentiates instruction and moves students through different types of tasks based on their performance in a workplace activity. All students work with the same text and what distinguishes the assessment levels are the tasks that students perform. The first time students complete an activity of a particular standard, they will complete a moderate activity that is an average level of difficulty. Based on their initial performance, players are then routed seamlessly, the next time they complete an activity assessing the same standard, in different ways:

- If performance is above the threshold, students will move to an advanced activity, which is the most difficult task and contains more items.
- If performance is within threshold, students will complete another moderate activity.
- If performance is below the threshold, students will complete a support activity, which is an easier task and contains less items.

As players navigate through the game making decisions and completing tasks and activities, the game will respond to the player to provide each with a unique experience.

Teacher Dashboard

Community in Crisis also provides a comprehensive teacher dashboard that provides real-time data to inform instruction. Teachers can create and manage accounts, control which episodes students can access and when they can play them, view student progress and performance reports by class and by student, and play the full game and various levels of each workplace activity. Data from reports allow teachers to determine instructional decisions and next steps with their students.
Educator Guide

*Community in Crisis* also contains wrap-around materials included in an Educator Guide to deepen the in-game experience. The Guide includes:

- Pre-game lessons that build knowledge background knowledge, 21st century skills lessons, literacy lessons that focus on the main concepts in each episode and post-episode discussion questions.
- “Text Talk” lessons provide students with the ability to develop their own reading fluency, and the opportunity to engage in collaborative text-based discussions.
- “What’s Next” lessons provide a lesson and guide for teachers to reinforce the core literacy skills assessed in the game.
- “Serving My Community” is a student-driven collaborative learning project with a focus on creating a community service organization.

Acknowledgments

Classroom, Inc. Product Development Team: Anne Richards (Executive Producer), Patty Grossman (Director of Instructional Content), Christopher Spivey (Director of Production), Kathy Burek (Educator Experience Lead), Madison Kinnard (Product Development Associate), Raiet Intraub (Production Assistant). Fablevision Studios Production Team: Gary Goldberger, (Executive Creative), Margarita Dekoli (Lead Game Developer), Leigh Hallisey (Creative Director), Brian Grossman (Technical Director), Bob Flynn (Director of Art & Animation), Michael Fogarasi (Associate Producer)
Highlighting MazeStar

A Platform for Studying Avatar Use in Computer Science Learning Environments
Dominic Kao (Massachusetts Institute of Technology), Fox Harrell (Massachusetts Institute of Technology), Chong-U Lim (Massachusetts Institute of Technology), Sneha Veeragoudar Harrell (Massachusetts Institute of Technology), Maya Wagoner (Massachusetts Institute of Technology), & Helen Ho (Massachusetts Institute of Technology)

Abstract

MazeStar is a platform developed as part of a National Science Foundation-funded project researching effective uses of virtual identities in STEM learning environments. Contained in MazeStar is both a game (Mazzy) and an editor. In Mazzy, players solve maze-like levels by creating short computer programs. As levels become increasingly complex, players learn fundamental computing concepts such as code blocks, procedural thinking, looping, conditional statements, etc.\(^1\) In the level editor, players create custom maps with a high degree of customizability in terms of map size, map layout, and artwork.\(^2\) Mazzy has been used as a testbed for studying virtual identity in a STEM learning environment (Kao & Harrell, 2015a-e; 2016a-c), while the addition of the level editor will allow us to take new directions as we begin studying intersections of virtual identity, social identity, and education in the context of game play as game creation.

MazeStar

The MazeStar platform is a key component of an NSF-funded project to better understand the role digital identities play in STEM learning. Avatars are a selective projection of a player onto a virtual representation (Harrell, 2013). A central aim is to assess how avatars can support broadening participation in STEM fields by attending to learners’ social and STEM identities. Towards identifying best practices in avatar use, early studies compared avatars such as photos of player faces, shapes, player likenesses, etc. in online studies now cumulatively involving 8,357 participants. These studies have led to publications in the areas of human-computer interaction, games, artificial intelligence, and education (Kao & Harrell, 2015a-e; 2016a-c). Also integrated with MazeStar is AIRvatar, an interface for studying avatar customization (Lim & Harrell, 2015a-b). Understanding how avatars may affect individual learners is crucial, since virtual identities are now ubiquitous in video games, Massive Open Online Courses (MOOCs) and forums, intelligent tutors, and more.

The Game

The STEM learning game is called Mazzy (Kao & Harrell, 2015). Mazzy’s design is grounded in a constructionist pedagogical approach (Papert & Harel, 1991) and was influenced by Gee’s design principles (Gee, 2003). The goal in Mazzy is to author a program that results in the character reaching the end of each maze. Players in Mazzy use code blocks, procedural thinking, looping, conditional statements, etc. See Figures 1 and 2. There are twelve levels in the version of Mazzy here.

![Figure 1. Level 1 in Mazzy introduces the basic game mechanics.](image1)

![Figure 2. Level introduces looping.](image2)

The Editor

The editor takes a constructivist approach to learning, i.e., learning is most effective through the activation of one’s own experiences (Piaget, 1976). Therefore through level creation, students use generative themes (e.g., personal interests) (Freire, 1970). Most recently, we have run a small study of 12 middle and high school students over a single day. Students were given only basic instructions on how to use the interface (e.g., creating a new map, moving around the map, etc.), but were able to quickly begin creating and customizing their own maps. Figures 3, 4, and 5 are three of the many student maps created that day. Many of the students spoke excitedly about how their level incorporated, e.g., the famous Boston Zakim bridge, or all the different Boston sports arenas, etc.

![Figure 3. “PATVBRO” (or Patriots versus Broncos).](image3)

![Figure 4. “Boston Sports Map”.](image4)

![Figure 5. “Underwater Coral Fish Party”.](image5)

We aim for young STEM learners to become, and see themselves as, learners and doers of Computer
Science. Ultimately, we believe that MazeStar can be a step towards this goal, through both use of virtual identities and level construction, with both acting as technological supports valuing students’ broader sociocultural identities and interests.

Acknowledgments

We thank the anonymous reviewers for their valuable feedback. This work is supported by NSF STEM+C Grant #1542970 and a Natural Sciences and Engineering Research Council of Canada (NSERC) fellowship.

References


The Da Vinci Coders

Teaching Programming with a Board Game
Nora Husani (Miami University), Alyse Capaccio (Miami University), Danny Capaccio (Miami University), Lauren McKenzie (Miami University), & Bob De Schutter (Miami University)

Abstract

In today’s society programming has become a necessary skill—some may argue as important as reading or math. Yet, children are not typically introduced to the topic of computer science until high school or even college. Further, schools that do aim to introduce programming to children at younger ages cannot always do so because of a lack of technological resources and funding. To address this issue we designed a board game that aims to teach middle school children how to read and write Java code without the use of a computer. The game goes beyond teaching basic programming and problem solving techniques and actually introduces real syntax and code to the players. After several play tests with the target audience we have found that children not only enjoy playing the game but also can actually write syntactically correct Java code when tested after play.

Game Overview

Unlike other attempts to teach programming to young children that focus solely on teaching programming concepts and principles, The Da Vinci Coders teaches actual Java Syntax. The Da Vinci Coders requires players to read real Java code in order to successfully move their tokens around the board.

Gameplay and Mechanics

Game Objectives

The day has finally come! The De Schutter Historical Institute in San Francisco, California has finally opened. You visit on opening day, amidst thousands of other excited guests and patrons. As you walk through the beautiful halls of the new museum, unnoticed at first by the security guards, you take a wrong turn and come upon a giant door with a complex lock system and a sign that reads, “Top Secret! This area off-limits to museum guests!” As you look closely at the lock, a museum employee swiftly walks up with a smile and escorts you down the hallway away from the mystery. Curious as to what lies beyond the door you assemble a team of spies who will adventure through the museum with you, closely inspecting and decoding the museum’s exhibits. Your team of spies creates disguises modeled after one
of the four prized exhibits; to show your dedication to the museum and blend in with the other excited patrons. Your task is to start in your exhibit and travel throughout the rest of the museum until all of your spies have made it through the secret vault by solving a final challenge. Only then can you explore the secret exhibit and discover the secret history of games.

Game Progression

Players begin with their three tokens in their own start circle. Players have a deck of “guide cards” that correspond to their exhibit. Guide cards (see Game Components below) are written in Java code and tell a player how many spaces they can move a token forward on a given turn. Each guide card has a different result for every turn and so players must decipher the Java code in order to move their tokens around the board. When a player gets his token all the way around the board he must solve a final challenge card by translating English into Java to “unlock the secret vault” and win the game.

Education

Learning Objectives and Programming Concepts

- Strategic Thinking (achieved by allowing players to choose their own guide cards to use to maximize the spaces they move forward)
- Loops (achieved by the use of for and while loops in the guide and challenge cards)
- Ifs/Conditionals (achieved by the use of if and else statements in the guide and challenge cards)
- Booleans (achieved by the use of true/false values in the guide, guard, and challenge cards)
- ints and doubles (achieved by the use of integers and decimals in the guide, guard, and challenge cards)
- Functions/Methods (achieved by the use of guide cards as individual Java methods)

Learning Approach/Philosophy

Endogenous Fantasy: Our game is an example of endogenous fantasy (Malone & Lepper) and integrated game design (Habgood). The museum theme and spy narrative add to the learning objectives because players are literally decoding Java in order to “break into the secret vault”. Further, the theme and narrative attempt to increase the entertainment value by engaging the players in competition and a story that they see themselves in so that they are learning for the sake of learning, perhaps without even realizing it. This makes the game an example of intrinsic motivation as well. The intrinsic motivation is also enforced through having optional path cards added to the board. These cards allow the players to voluntarily make the game more difficult in such a way that enhances their learning. Since the players are challenging themselves by choice, they are learning for the sake of learning.
Audience

The Da Vinci Coders is designed for middle school aged children (12 years of age and up) who have little or no coding experience. The game is created with a gender-neutral theme to encourage both boys and girls to pursue computer science.

Demo

Below is a link to a demonstration video of The Da Vinci Coders Version 1.0. Version 2.0 will be professionally printed prior to the GLS conference with upgraded game mechanics and aesthetics (not shown in video):

https://youtu.be/W6uw4Uu7QxM

Game Components

![Example guide card](https://example.com/dv_coders_card.png)

Figure 1. Example guide card.

Full game components documentation: https://goo.gl/AsrfvU

Rulebook

https://goo.gl/xv9jCb
Acknowledgements

https://goo.gl/zGZJc0

This game was created entirely by Miami University students.

References


JUMPGYM

A Jumping Exergame For Waiting Areas

Mmachi G. Obiorah (Northwestern University), Emily Harburg (Northwestern University), John Franklin (Northwestern University), Brianna Downs (Northwestern University), Sean Ye (Northwestern University), Maarten Bos (Northwestern University), & Michael Horn (Northwestern University)

Abstract

Waiting in line can be a nuisance and a waste of time, but this doesn’t have to be the case. We present JumGym, a multi-player exergame that explores the opportunity and time afforded by queues to occupy people with exercise and interactive play as they wait. We conducted testing with 75 participants to understand the effects of playing the game on a participant’s mood, perceived waiting time, exercise self-efficacy, and exercise awareness.

Motivation

Americans spend roughly 37 billion hours each year waiting in line (Blake, 2010). Research suggests that waiting impacts our mood and outlook on our days (Comm & Palacheck, 1984; Chebat, 1993). At the same time, obesity is becoming a larger and more ever-present issue in society as fewer people engage in physical activity. Studies have found that 97 percent of American adults get less than 30 minutes of exercise per day (Roberts et al, 2013). Lack of time, opportunity, motivation, and knowhow have been identified as top causes of our inadequate exercise culture.

Game Description

Inspired by existing exergames such as Wii Fit and Xbox Fitness, we designed JumGym to help people exercise and improve their waiting experience through play. JumGym is an exergame designed for
waiting areas. Players use whole-body interaction (physical jumping) to control game characters on a computer screen. The game presents obstacles to the characters that players have to jump over. The game keeps track of the number of times the player jumps and displays health facts at the end of the game. JumpGym can be played single or multiplayer.

Game Objectives

JumpGym aims at reducing perceived wait time and increasing user mood by providing an opportunity for (a) player interaction and engagement with others through gameplay, (b) educational learning, and (c) exercise for people while they wait.

1. **Multi-player Interaction:** Playing games with other people can be a social activity (Lenhart, 2008). JumpGym’s two-player option provides an opportunity for people to interact while they wait. This is a means for people who may not know each other to socially connect during their wait and potentially improve their waiting experience.

2. **Health Education:** At the end of game play, JumpGym displays health facts to the player. The health facts inform the user about the advantages of jumping. This allows the users to immediately know how their game actions are beneficial to their health.

3. **Playful Exercise:** Adding the exercise component to the fun component of gaming is a strategy that is gaining popularity in addressing obesity (Sinclair, 2007). JumpGym also uses this strategy. JumpGym requires physical exertion by the player through jumping in order to control the game character. The player has to jump to avoid obstacles and continue game play.

Study Overview

We have conducted a study of JumpGym involving 75 participants in three conditions. In the first condition, players used JumpGym in pairs for a fixed period of 7 minutes. In the second condition, pairs played a non-physical version of JumpGym using a more traditional game controller, also for 7 minutes. In the final condition people waited without using JumpGym. After participating, we administered a questionnaire gauging participants’ mood, perceived waiting time, exercise self-efficacy, and exercise awareness. We are in the process of analyzing these data.

Implications

This research has implications on the way we design interactive, multiplayer game systems for people as they wait. Through utilizing time that people typically stand idle and don’t enjoy, we can both improve the waiting experience and encourage exercise through play.

Demo Links

- Demo Video: https://drive.google.com/open?id=0Bwp4SktRqpYBYTFHY0x2ak9XY0k
- Game Link: http://obiorahm.github.io/JumpGymJS
References


Abstract

You’re a fast food worker, preparing burritos and making minimum wage. Without a living wage and no paid sick days, you’re forced into a situation where you have to work even though you’ve got a cold.

Introduction

Policies engineered by lobbyists can be shortsighted. The National Restaurant Association aggressively opposes mandated sick day legislation because they assume it will increase operating costs (“Cities and States Debate Paid Sick Leave”, 2013). While a well-paid employee can easily take days off to recover from a cold, for a minimum wage employee, the decision to stay home could mean financial suicide. And in the restaurant industry, employees going to work while sick could result in a public health crisis (“Backed into the Corner”, 2012).

Unsavory is a mobile game designed to put the player in the precarious position of choosing between their personal health, public health and their financial wellbeing. Like other activist games, the intention is to create awareness and empathy around an issue that is best understood as part of a larger system. Additionally, the game seeks to be a catalyst for change by embedding a social media campaign into gameplay that encourages players to share meaningful facts and statistics regarding restaurant workers, access to health care, and paid sick day legislation.

Game Play Description

The objective of the game is to pay all of your bills at the end of the month by working at a minimum wage job. Your job is to prepare tacos, quesadillas and burritos by tapping on the ingredients in front of you that match each order slips. Each round equals one day, and the game difficulty increases by introducing a new type of order slip. Every 5 days, the time allowed between orders is reduced to increase player difficulty. A player is allowed to screw up an order twice in one day without being penalized. However, if the player makes a third mistake and receives a third strike, they can either quit for the day or use a “re-shift” to play the round over again. If a player is out of re-shifts and goes home early more than two days out of the month, they’re fired.
At the end of each week, the player is paid for time worked. Typically, this is a full 40-hour week but if the player went home early the time they were unable to work is deducted from their paycheck. After work, the player is transported to their apartment where they are able to pay their bills, take medicine, and call in sick. To ground the game further in reality, the bills to be paid by the player are a simplified version of a financial plan created for McDonalds employees by Visa (Weissmann, 2013).

**Getting Sick**

The key lesson that Unsavory attempts to teach players is that a person making minimum wage without paid sick days is systemically forced to work while sick. In the second week of the game, the player catches a cold, which introduces an additional mechanic of wiping your nose to stop yourself from sneezing so as not to alert your boss of your sickness. When the player sneezes, the boss sends them home for the day. The player can opt to buy and take medicine or take a day off from work to increase their health, but they are not paid for that time. This makes paying all of the bills impossible if the player takes more than one day off from work.

![Figure 1. When the player doesn’t swipe their nose in time, they sneeze on the food trays.](image)

**Social Media Campaign**

When the player first becomes sick, they receive a letter from an advocacy group that informs them about paid sick day policy in the United States. The player continues to receive messages with additional
information about paid sick day legislation each time they come home from work sick. The letter invites them to participate in a social media campaign within the game. From this campaign screen, they can select various tweets that highlight the issue through different lenses (with regards to business, public health, human rights concerns) and target specific hashtags and accounts related to the campaign. Thus, the game promotes a call to action that allows players to go beyond the gameplay and get serious about trying to fix a real-world problem.

Downloads

The game can be downloaded at the following places:


Additional Resources

- Game Play Video: https://vimeo.com/126556061
- Game Play Trailer: https://vimeo.com/125715103
- Game Website: http://playunsavory.com

Acknowledgments

Thanks to the development team: Pablo Obando (Lead Artist), Alejandra Jimenez (Composer), Andrew Curtis Gaines (Writer) and Brandon Wilson (Background Artist). A special thanks to Maria Myotte and Yesenia Garcia at ROC United for their support and feedback.

References


67.

Cerebrex Ultimate

Hugo Enriquez (Galileo University) & Ali Lemus (Galileo University)

Short Game Description

Cerebrex Ultimate is a serious educational videogame with the objective of improving the cognoscitive processes of players, specifically in the numeric, visuospatial, memory and rational areas. Players are faced with a variety of minigames which need to be completed in order to obtain materials, collectibles and virtual money. Materials can be used to obtain new equipment for the player’s avatar. The game uses high-end 2D graphics, music and thematic game elements to immerse the player in the Mayan culture.

Game Overview

Cerebrex Ultimate is a browser based game (also available on Android) that includes 12 minigames in total, each minigame is of one minute duration and are categorized by area. The four areas of Cerebrex Ultimate were chosen among the main cognoscitive areas because they can be easily implemented as game mechanics. From a learning perspective, each minigame was designed to contribute to the respective area’s cognoscitive processes. All minigames can be replayed indefinite times in order to improve the game score, a daily test mode challenges the player with a group of four randomly selected minigames from each area. Players need to complete the daily test mode in order to register their best scores in the player ranking list, this list include the best scores from players of the same school and can be filtered either by grade or year.

Statistics are stored on the game data base and include a dedicated interface to present the data to the players. All players can access this interface and can check their performance on each minigame, the recent scores and the dates of the scores. The statistics interface features multiples views, a graphic with all four areas shows the best score forming a blue diamond that illustrates the overall balance, graphics for each area can be viewed as well.

A very important aspect of the game is the theme, a Mayan theme was used to emphasize on the cultural aspect. The Maya was chose since the game was developed in Guatemala, it was mean to be used as a way of identifying oneself with the historical culture of the country. Although the theme is supposed to appeal to local players, the game is multilanguage and players around the world can learn more about the Mayan culture while playing.
The Game Elements and Core Mechanics Game Feedback and Progress

A game progress system was designed as one of the main game elements to keep players immersed in the game. The system implements experience points (XP) which are needed to level up, an exponential equation was used to calculate the XP needed for the next level, making each level more difficult to reach. A progress bar indicates the total XP needed for the next level as well as the current XP earned, the maximum player level is 40.

![In-game screenshot of the XP progress bar in the rewards interface.](image)

Relics and Virtual Money

The relics are collectible objects that players can obtain by completing the minigames, players can view their relic collection on the player profile interface as well as sell them to earn virtual money. A total of 28 relics exist on the game and there is no limit in the number of relics that a player can own. Each relic has its own level of rarity, it determines the probability of the player to actually get it as reward at the end of a minigame. Performance in minigames determine the number of relics earned and the rarity dictates which relics are given as reward.

The virtual money is called “Mites” and introduces an economy system into the game. Mites can be earned by either completing minigames or selling relics, the higher the rarity level of a relic the higher its selling price is. The mechanic includes selling and buying items, this requires the player to manage the game money responsibly, deciding which items are the most necessary and which items can be sold are all part of systems thinking.
The Player Avatar and Equipment

The avatar is the player’s representation within the game and a way of self-identification. The pieces of equipment are objects that introduce customization into the game and can be equipped to the avatar in order to change his appearance.

Equipment is the most important game mechanic since it allows the player to change the game rules, thus having a direct impact on game dynamics given that it could totally change the drop ratios for relics and money earned. *Cerebrex Ultimate* has game rules like the duration of each minigame, the score given per hit, score lost per miss and the relic drop ratio based on the rarity level. All the mentioned game rules can be altered by using different pieces of equipment, each piece of equipment has a different ability and can be purchased at the game shop in exchange of Mites and relics, more powerful equipment requires relics of higher rarity level and more Mites. All these game mechanics introduces a whole new level of systems thinking into an educational game.

The Game Balance

All the game mechanics fit together with the final objective to keep the player engaged while playing an educational game. The money management, planning and strategy required to obtain the best equipment is part of the design to create a game world in which the player can achieve a sense of progression, responsibility and autonomy. Balancing the game mechanics such as the drop ratios, amount of money given, the power of each piece of equipment and item prices was the most difficult task in the design process, even at the end it might not be perfect.
Acknowledgments

*Cerebrex Ultimate* is a collaboration project between Elemental Geeks and Galileo University, proper credit is given to each team member in the game’s credits. *Cerebrex* reached semifinals with a paper presented at the 8th European Conference on Games Based Learning 2014 Berlin, Germany. A trailer of *Cerebrex Ultimate* can be found at http://bit.ly/1TVj4xb.
FANschool

turning students into fans of learning
Eric Nelson (FANschool)

Abstract

FANschool turns students into fans of learning with fantasy sports-like games for school content + current events. Our “geopolitics” vertical started in Eric’s classroom to get students interacting with current events and is now played by more than 1,500 paying classrooms throughout the U.S. and the world. Students draft teams of countries, become more aware, and get points every time their countries are mentioned in the news or make moves on a conflict-collaboration tone scale. A U.S. states version of the game and a March Madness round-like challenge for the Electoral College will also be available in August.

Introduction

More current events content is produced than ever before, yet students are increasingly disengaged with it. FANSCHOOL.org turns students into fans of learning with fantasy sports-like games for school content + current events. Picture students drafting countries or states, rather than football players, and March Madness prediction-like contests for big events like Elections, Olympics, and the World Cup.

We’re on a mission to connect classrooms to content in a more fun, authentic, networked, and strategic way and intrinsically motivate students to create daily current events reading habits inside and outside the classroom.

Eric created the FANgeopolitics vertical in his high school social studies classroom to “gamify” world news and engage students in curriculum. Students drafted teams of countries, followed them in the news, and adjusted their lineups and traded countries as they became more aware about what’s happening in the world, automatically scoring points every time their countries were mentioned in the news or made moves on a conflict-cooperation tone scale.

It dramatically improved engagement, news interaction, and test scores. The game received national attention from publications like Mashable, Techstars, and the New York Times, as well as support and awards from national education organizations like 4.0 Schools, Edsurge, and the Software and Information Industry Association (search “fantasy geopolitics” for more).

More than 1,500 teachers and schools paid to use it the past two school years. Students say they’re most engaged in class when playing and that it increases awareness about the broader world. Teachers say
students love seeing the changes in trends and scores and that students actually want to read the news and dive into learning about it more.

100% of surveyed teachers either agreed or strongly agreed that it had a “tangible positive benefit on student performance and engagement” in their classroom. Additionally, thirty-two percent of teachers said it improved student grades.

We’re winning in the marketplace because we put people and purpose first. Our team is growing, our teacher-customers are our biggest evangelists, and we have some of the best mentors in education technology and fantasy sports!

Links:

www.fanschool.org

YouTube playlist with how-tos + demos:

https://www.youtube.com/playlist?list=PLQX6Xj7dft90hvDsrZIHHrtK9fXFiQzB-k

What teachers and students are saying:

“Students are learning in independent ways I’ve never seen before in 18 years of teaching…” – Mrs. Kristin Davis, teacher, Madison WI

“FANgeopolitics is beneficial because it keeps us all involved in what’s happening in the world… and makes you want to learn something new.” – Sammi B., 10th grade

“Having it be a competition pushed me to do my best. It was the only reason I came to class” – Ty N., 12th grade

Publicity:

- http://www.techstars.com/content/uncategorized/make-way-edupreneurs
- http://mashable.com/2014/02/02/high-school-fantasy-geopolitics
- https://www.youtube.com/watch?v=Q6RsTtx3IabM

Value Proposition:

The FANschool platform gamifies school content and news, delivers global information sources to students, and provides standards-based resources to teachers.
Development Stage:

- Validated problem with other teachers as part of 4.0 Schools Launch program.
- Crowdfunded $12,700 through Kickstarter Campaign, got first paying users.
- Awarded SIIA’s Education Technology Industry Network’s “Most Innovative”.
- 1500+ paying teachers. 150,000+ students impacted. Early data similar to fantasy sports.
Invasion of the Energy Monsters

A Spooky Game About Saving Energy

Michael S. Horn (Learning Sciences and Computer Science, Northwestern University) & Amartya Banerjee (Computer Science, Northwestern University)

Abstract

We present a cooperative tabletop game called Invasion of the Energy Monsters designed to help families reflect on how they use energy at home and to think about implications for global environmental sustainability. The premise of the game is that your home is being invaded by a menagerie of menacing energy monsters, each representing a different form of waste. The monsters start out weak but quickly grow stronger as they feast on your excess electricity usage. The energy heroes must band together and expel the monsters before it’s too late.

Design and Game Play

Invasion of the Energy Monsters is a cooperative tabletop game for 2-4 players ages 6 and up. In the game, energy monsters (Figure 1), each representing a different form of waste, attack your home. Bonehead is a mindless energy zombie who’s always forgetting to turn off lights and appliances. Wattwolf loves poor insulation and old, inefficient appliances. Ampire has a knack for doing things inefficiently, like running a half-empty dishwasher on heated-dry mode. You and your family play the role of energy heroes.

To win the game, the energy heroes must band together and expel the energy monsters from their home before it’s too late. On each turn, the monsters find a devious new way to waste energy. As the energy level rises, your electricity bill gets more expensive and the monsters become stronger. If the monsters ever get the power level above 3,000 watts or the heroes run out of money, the game is lost. The heroes work together to turn off appliances and electronics while avoiding the monsters. At the beginning of
the game, players create a house from a collection of 21 room tiles. Each tile has an OFF side and an ON side that indicates the power used by an appliance or device in that room (see Figure 3b and 3c). For example, the Basement has a spare refrigerator that uses 200 watts when plugged in. Each tile also indicates the type of switch needed to turn the appliance off (sockets, remote controls, light switches, power buttons, and thermostats). On each turn a player moves his or her hero token, plays hero cards, and trade cards with other players in the same room. At the end of their turn, players must flip over one purple monster card indicating a new form of energy waste. For example, flipping over the basement card means that Wattwolf plugs in the old spare fridge in the basement. To turn a device or appliance off, players must move to that room and play two corresponding switch cards.

![Image](image1.png)

**Figure 1.** Energy Monster miniatures (Bonehead, Wattwolf, and Ampire).

![Image](image2.png)

**Figure 2.** a) Close-up of the power spinner. The orange area is variable & conveys current energy usage based on game state (b) Power spinner on an iPad app (on the whole-home extension of Energy Monsters) that also takes input from household infrastructure to affect game state. (c) Energy consumption data shown on the app.

Heroes can also attack monsters by playing an attack card against monsters in the same room and then spinning a power spinner (Figure 2a) with a probability that changes with the energy consumption level (visible in Figure 3a from an actual gameplay session). If the spinner lands in the black region, the heroes win the attack and the monster is temporarily removed from the game. Heroes win the game by expelling all four monsters before they run out of money.

**Smart Home Extension**

We have an expansion of this game currently under development that makes use of a tablet computer
app connected to a whole-home electricity meter. Since whole-home electricity meters are not yet commonplace, we are playtesting the concept by deploying Apple Homekit enabled sockets in homes.

These wireless electricity meters transmit energy consumption data to the companion iPad app (Figure 2c) and affect game state. In this version, players will start the game with an Energy Blitz in which they run around their house turning on as many lights and appliances as they can. This will immediately be reflected on a digital power meter. As the game progresses, heroes will be able to play special cards allowing them to turn off real appliances and devices in their house, thus weakening the monsters.

Figure 3. a) A family playing the game. b) Example room tile showing an appliance and c) the rate of energy consumption of the appliance and the switch card needed to turn it off.

Credits

Monster & Title Artwork: Eric Uchalik (euchalik.com).

Room Artwork: Maisa Morin (maisamorin.com).

Funding: This game was made possible through support from the National Science Foundation (grant IIS-1123574). Any opinions or recommendations are those of the authors and do not necessarily reflect the views of the NSF.

Research, Design Advice, and Playtesting: David Horn, Hannah Horn, Madeleine Reed-Horn, Gabby Anton, Sarah D’Angelo, Pei-Yi Kuo, Cameron MacArthur, Zhao Zong.
Trade to the top

Teaching economics and complex systems through the Lead Caravan multi-player game

Vishesh Kumar (University of Wisconsin-Madison), Mike Tissenbaum, (University of Wisconsin-Madison), & Matthew Berland(University of Wisconsin-Madison)

Abstract

Lead Caravan is an interactive, multiplayer mobile game that leverages the physical co-presence of participants. In Lead Caravan, you are an interstellar miner collecting resources at the far reaches of the galaxy. With nothing but a keen sense of business, you must outwit the other “space miners” to fulfill your order requests from back home. Use your keen negotiation skills to barter with other miners, and trade resources to gain advantage. But be careful… or another miner might out negotiate you and leave in their space dust!

Introduction

There is an increasing recognition among learning scientists and economists that youth financial literacy is extremely low (Lusardi et al., 2010) the youth has little knowledge on how to make wise consumption decisions (Johnson & Sherraden, 2007), and are less likely to accumulate wealth and manage wealth effectively (Stango & Zinman, 2007). Many games, from Lemonade Stand to SimCity, have attempted to engage players in economic thinking and practices, but few (if any) engage players in real-time with their peers. Negotiation is also an important mechanic within the broad scope of economics-focused games. However, most of these games focus on “game theory” elements (outwitting your opponent, or focusing on zero-sum outcomes in one-off events) rather than situating the players within a complex economic ecosystem (Bachrach, Kohli, & Graepel, 2011; Hinton, Hamner & Pohlen, 1974). In response, we are introducing Lead Caravan – an interactive, multiplayer mobile economic complex systems game that engages multiple players in face-to-face and real-time resource trading. Herein, they need to physically move throughout the environment, and negotiate deals to trade resources with their peers, while planning to maximize their economy.

Game Working

In Lead Caravan, players are distributed in teams (the team members are initially clustered together) and are given a “home market” in one spot in the room. Their home market has a resource stock which is initially populated with different amounts of various resources (e.g., wood, steel, metal) that is shared across all members of each team. While some of the resources are shared across all the markets in the
game, each team has their own unique resources that other teams need to barter and trade for in order to obtain.

![Figure 1. An example of the initial resources in a market.](image1)

Players are tasked with recognizing which goods are in demand in their market, and must move around the room finding other teams (or players) that have and are willing to trade that resource. Using their mobile devices, players make trade requests to other players, which they can either accept or reject. Throughout this process players are encouraged to engage in negotiation and bargaining tactics.

![Figure 2. An example of two groups trading.](image2)
Throughout the game, changing of resource amounts and “pivotal events” (technological developments changing the value of resources, or demands of different items), can cause the prices of resources in the market to change; requiring players to make decisions on the fly and adapt to changing market conditions. Additionally, some items in the game can only be made by combining multiple resources together – requiring further cooperation and negotiation among players and teams.

When the game ends (generally by time), all teams sell all their remaining resources to their home market, at the current price of each item. The team that ends with the most money, wins.

An important aspect of Lead Caravan is that it uses players’ mobile devices and requires them to actually move throughout a physical space to engage in negotiation and trades (versus only through computers screens). Using a Bluetooth tracking system, we can track players’ movements through the space as they interact with one another and make trades. Coupled with a rich array of telemetry data (e.g., the trades proposed, trades accepted, fluctuating market prices, and total profits earned by players), we hope to gain insight into the flow of capital, ideas, and participation throughout the room. In this way, we hope to understand how players built the relevant skills and identify patterns in: how different players play; what behaviors lead to success; and highlighting different play and negotiation styles.

By playing Lead Caravan, we anticipate that learners will begin to understand the fundamental concepts around complex systems, equilibria, economics, negotiation, resource management, and market dynamics, operations, and processes. They learn this both through gameplay, embodiment, and social interaction in a real space.

A link of the game’s early prototype, intended to run on all players’ devices simultaneously, is available at http://caravan.complexplay.org.

References


River of Justice

Conflict Resolution in a Complex World

Earl Aguilera (Center for Games and Impact, Arizona State University) & Sasha Barab (Center for Games and Impact, Arizona State University)

Short Game Description

River of Justice is a 3D immersive game exploring the complexities of global conflict, ethical decision-making, and tensions between justice and forgiveness. Players take on the virtual role of an international agency representative in a fictionalized version of Uganda during the violent reign of the Lord’s Resistance Army. Suddenly finding themselves swept into the conflict, players are faced with ethical dilemmas that have both local and far-reaching consequences.

Introduction

While games have emerged as potentially powerful spaces of deep engagement and transformational play, a key challenge faced by the “serious games” community is how to leverage these experiences to cultivate positive change in the player beyond the game experience itself. Although we recognize games as ideological worlds that potentially offer powerful experiences (Squire, 2006), our current theory of change seeks to go beyond “bounded” game experiences and the fictional narratives they represent, offering more service-based engagement systems that invite and empower players to realize new possibilities both within the game and in their lives. Thus, part of our design process involves developing a supportive infrastructure around the bounded game context that would enable players, educators, and community advocates interested in engaging with complex issues of justice and forgiveness within their own lives and local contexts (Gee & Hayes, 2011). In other words, rather than simply having a transformative experience within the game world (Barab et al, 2010), our current focus is to take the core in-game tension around how one responds to injustice and support players in transforming their relationship to their personal history with our broad ideological commitment being to reduce resentment and increase the amount of forgiveness in our world.

River of Justice, a 3D immersive game set during the violent reign of the Lord’s Resistance Army (LRA) in Uganda, represents one of our recent efforts to shift this emphasis of focus. The original intent of this experience was to engage players in the complexities of global conflict, ethical decision-making, and tensions between justice and forgiveness, within the context of a particular conflict (Barab et al, 2011). However, given the shift in our focus away from “bounded product” and toward service-based impact, three core design aspirations became the emphasis of our current approach:

• How to blur the “magic circle” (Huizinga, 1955), such that more direct connections could be
drawn between the in-game and real-world experience of the players;

• How to leverage conversations around the game in the service of deeper engagement; and

• How to build external resources that help extend the implicit understandings embodied in the game experience.

Given the limitations of scope of this submission, the focus of this discussion is on the designed features of the game experience, with the understanding that showcase conversations would jointly emphasize “within-game” and “beyond-game” design aspirations.

Background

*River of Justice* is set in the nation of Bunalá, a fictional analogue of a historical Uganda during an era of violence and atrocity perpetrated by the Lord’s Resistance Army, an anti-governmental military force. Over a 20-year period, the violence committed by the LRA resulted in the death and displacement of millions, while leaving countless others mutilated, raped, or enslaved as child soldiers (Eichstaedt, 2009). Players take on the virtual role of a field representative for an international agency tasked with exploring villages and engaging the perspectives of local Bunalans, before making a final recommendation about the most appropriate way to address the LRM (a fictionalized LRA) conflict. Soon after arriving, however, players find themselves swept into the conflict themselves, and are faced with ethical dilemmas that have both immediate and far-reaching consequences. While the notion of setting a game within the context of a recent period of conflict rife with atrocity and human tragedy presents its own challenges, we reasoned that such a design would allow players to more directly face the atrocities and inhumane conditions that we, as people, have inflicted on one another in our darkest times (Barab et al., 2011). By illuminating the complexities of the nature of peace and justice, we invite players, educators, and other stakeholders to engage with the moral complexity of our modern world.

Central Aims

At one level, an aim of the experience is to deepen player understandings of the ethical and moral complexities of conflict resolution in both global and locally-relevant contexts, while positioning such dilemmas in a personally-relevant way. At a deeper level, the experience addresses the issue of how players deal with moments in their own lives in which they feel they have been treated unjustly. At a level beyond the in-game-experience or even player reflection, we seek to inspire, support, and sustain conversations between players, educators, and community advocates interested in engaging with, or even transforming notions of justice, peace, and forgiveness in their everyday contexts.

Approach to Learning

Within the bounded game context, *River of Justice* employs a 3D immersive narrative structure, which players navigate the virtual world of Bunalá using an in-game avatar, make choices through in-game dialogues with non-player characters (NPCs), and collect, assemble, or distribute in-game objects that further progress the story. Game play also includes a set of meters (one of which is locked until a certain point in the game) which grow based on how the player’s in-game choices reflect advocacy toward
justice, amnesty, or other outcomes to the LRM conflict. The player’s actions toward these ends impact other events and interactions in the story, including story outcomes. The objective of the player is to recommend a decision to the fictional ICC, with the in-game boss judging the alignment between the recommendation and particular game play interactions and choices. Beyond offering a simulation of the conditions and struggles, which might draw upon factual data to inform the outcomes of a user’s actions, we situate the player as decision-maker immersed in the conflict itself, tangled in a mesh of unforeseen possibilities, difficult choices, and unintended consequences.

Consistent with our beyond-game impact aspirations, we sought to design in-game dialogue and interactions that aimed to blur the “magic circle” between in-game experience and the player’s real-world identity (Salen & Zimmerman, 2004). While conversations with NPCs generally focused on in-game occurrences, several encounters asked players for their views on real-world issues such as capital punishment, which would then impact events in the game world. Additionally, research implementations centered on the game also focused on leveraging conversations between pairs of players around the game through questions designed not only as “data gathering” tools, but also prompts for eliciting further player reflection on core issues. Finally, we have established a network of impact-focused services, including discussion guides, curricular integrations, and digital learning platforms that invite stakeholders to engage in partnerships to adapt our designs for their purposes and realize the real-world outcomes they envision for the communities they serve. The River of Justice project is meant to illustrate just some of the potential of these game-enabled opportunities for real-world change.

References


Acknowledgments

Full Game Credits: www.gamesandimpact.org/team
Revealing Stealth Health

Examining Agency in Physical Activity Games
Cynthia Carter Ching (University of California, Davis), Sara Schaefer (University of California, Davis), & Roxanne Rashedi (University of California, Davis)

Abstract

This poster presents a framework for analyzing games that are designed to impact players’ physical health in some way. Our analysis is grounded primarily in the notion of player agency (or, in many cases, lack thereof) relative to players’ own bodies, behavior, and health. We borrow the concept of “stealth health” from nutrition research to articulate this problem with agency, and analyze several examples of commercial games or research-designed games that represent distinctions among various kinds of player agency and motivation.

Introduction

Many health researchers and game designers attempt to harness the motivational power of games to help improve players’ physical health. But evaluations of such games tend to lump them into a single category of “exergames” and examine their overall effectiveness at impacting narrow health indicators such as BMI, resting heart rate, etc. Instead, we argue, a more nuanced approach is necessary to evaluate the means and goals of physical activity games, and to forward a different way of thinking about the agentive role of players in relation to these games and to their own health and behavior. We present key concepts useful in analyzing healthy games and include some examples from the research field and commercial marketplace for each.

Literature Review and Framework

There are numerous technological tools being used to promote health and wellness among youth, but increasing in popularity is gaming technology and other tools that use gamification principles (Baranowski & Budday, 2008). Lu and colleagues (2013) conducted a systematic review that examined the effects of healthy videogames and found approximately 40% of the 28 studies reviewed actually saw improvement of young players’ selected health indicators, but this study did not articulate the design and motivation strategies used by game designers to realize these outcomes, nor did it deal with the agentive relationship of players relative to their own health and bodies.

“Stealth Health” is a term borrowed from health and nutrition research, and it describes an intervention or product that attempts to sneak healthy practices into daily routines, masking the medical goal of...
these activities or products and making them fun (Lieberman, 2009), such as “fruit punch” containing vegetables and “gummy” vitamins. In the most “stealthy” interventions or products, the explicit goal is actually a lack of agency, since such interventions attempt to actively mask choices individuals would normally select against, such as eating vegetables they usually find unpalatable or remembering to take a daily vitamin or medicine. Some studies suggest that while games that essentially “trick” players into exercising may temporarily improve health metrics, these interventions merely motivate children to change their dietary or physical activity patterns as a result of the game’s goal, not for the intention of enhancing individual health practices, and consequently the beneficial health outcomes could be described as side effects rather than realized goals (Robinson, 2010).

Motivation in particular has long been a challenge to get right for educational games in general, let alone new developments in healthy games. Intrinsic motivation is a desire to do something for enjoyment or for its own sake, whereas extrinsic motivation is a desire to do something because of some outside factor such as material reward, social approval, avoidance of punishment. Many learning games have been criticized for relying on extrinsic motivation; for example, solving mathematics problems in order to blow up asteroids, rather than to progress through an interesting and inherently mathematical situation (Ito, 2008). The same criticism can certainly be leveled at many healthy games, particularly those relying on stealth-health tactics. Changing negative attitudes toward physical activity seems unlikely when the activity is treated like something that has to be concealed in order to be enjoyed.

Analysis and Examples

Many commercially available games are based on a micro-level behavioral reinforcement model, wherein individual movements and intensity are rewarded within the game immediately after they are performed (Adams, et al, 2009). These games are also all exergames, in that they are designed to encourage and reward physical activity taking place during the immediate experience of game play, at the game console or with app-in-hand. Figure 1, which shows a martial arts training game for the Nintendo Wii, is an example of this type of game, wherein players receive points as they punch.

![Figure 1. (left) Nintendo Wii martial arts game screen. Figure 2. (right) Motionmaze app screen with movement directions.](image)

Other commercial games are designed to accompany players as they go about their daily routines, encouraging them to incorporate more physical activity into otherwise sedentary moments. Such games often send alerts to players at various times during the day and tell them to move, then reward that movement with in-game rewards. Motionmaze is a game designed for children in which the
player moves their body to guide a character through a series of mazes. A related category of games accompanies players’ existing exercise routines, such as running or walking, in the surrounding world. Commercial examples include Zombies Run! and Wokamon. While these portable games are more integrated into players’ fitness-related activities than console-based games, neither type bolsters or encourages intrinsic motivation, and both Motionmaze and Wii are marketed as incorporating physical activity into a game type that would otherwise be sedentary and are thus essentially stealth-health. The poster will describe other examples and a deeper examination of agency via player decision making as well as game type.

Acknowledgments

This analysis was conducted as part of a larger research project on wearable activity monitors and health gaming among youth, sponsored by grants from the National Science Foundation to the first author (IIS 1217317 and IIS 1451446).

References


73.

Grand Test Auto

Designing Simulator Assessments of Game-based Mental Models of Automotive Safety Technology

Ben J. Miller (University of Iowa), Ethan Valentine (University of Iowa), Yile Zhou (University of Iowa), Joyce Moore (University of Iowa) & Benjamin DeVane (University of Iowa)

Abstract

Drivers often have poor conceptual understanding of new driver safety systems, such as adaptive cruise control (ACC). Older drivers tend to be more willing to learn about these systems by reading manuals, but also struggle with learning the uses and limitations these safety systems. This study investigates the effect of different materials and modes of learning – tinkering with games, solving problem scenarios and reading direct instruction – on mental models of ACC and driving performance in a driving simulator. We designed written assessments to supplement the driving measures produced in the simulator in order to understand how different forms of instruction impact the ways older and younger drivers learn about ACC systems.

Introduction: Comparing learning with games, scenarios, direct instruction

Drivers often have dangerously poor conceptual understandings of new driver safety systems such as adaptive cruise control (ACC) (Jenness et al., 2008), a form of cruise control that maintains distance between vehicles. In fact, a majority of ACC owners are not aware of any system limitations, and many are confused about when and how their ACC is operating (Jenness et al., 2008). Many drivers of ACC-enabled vehicles do not read their owner’s manuals and consequently overtrust system performance (Kazi et al., 2007). Older drivers, in particular, often struggle to understand the uses and limitations of a safety system (Jenness et al., 2008).

We present a framework for assessing three different modes of mental model development about adaptive cruise control. Our assessment model compares tinkering with game-like interactives, problem-solving with case scenarios, and text-based direct instruction, and then examines mental model development using a high-performance driving simulator and a test of conceptual knowledge about the ACC system’s limitations.

Theoretical Framework: Games, scenarios, mental models

Research suggests that game- and simulation-based interactive media can be powerful tools that help learners build domain-specific knowledge and skills, because they a) guide players as experience,
experiment and tinker with a model of complex phenomena; and b) ask players to use concepts to solve increasingly-difficult problems (Gee, 2008). Modeling these experiences through games and scenarios is a method of building and transforming knowledge that enables individuals to focus on specific properties of a concept. Based on these models, people can make and test predictions to see if they hold true in real life. Once interrogated, these specific experiences facilitate problem solving that moves from concreteness to abstraction (Gee, 2008).

**Learning across instructional formats for older drivers**

Counter to the perception that older learners may be uncomfortable with technology-based materials, research suggests older individuals learn more from multimedia than from static visual material (Lin & Hsieh, 2006). Other suggestions for older learners include using interactive materials or hands-on involvement (Mayhorn et al, 2004).

**Methodology**

During the study, participants: (1) take a ACC mental model pretest; (2) are randomly assigned to one of three instructional formats; (3) take a second ACC mental model test; (4) complete a 30-minute simulator drive; and (5) take a post-drive assessment. We use 2x3x3 repeated measures design, with Age (younger/older) and Instruction (text, scenario, interactive) as between-subjects variables, and Assessment (pretest, post-instruction test, post-driving test) as a within-subjects variable. We will also compare driving performance measures to a post-driving assessment about ACC limitations and system function.

**Characterizing Modes of Learning: Games, scenarios, and direct instruction**

The game condition involves tinkering with an interactive game-like toy (see Figure 1) in which the user can manipulate parameters such as driving speed, traffic speed and road curves, and observe how ACC responds. The scenario condition involves sequenced, text-and-graphic problem-based scenarios of driving situations using ACC. The direct instruction condition is similar to reading a car manual, with text and graphics.
Driving Simulator

In the driving simulator task, subjects are asked to complete one drive that features a 5-minute warm-up drive and a 30-minute ACC challenge drive. Throughout the 30-minute challenge drive there are events that test the driver’s ability to utilize and understand ACC (see Figure 2). A participant’s performance in the driving simulator is logged and then processed into standard driving performance measures (e.g., initial response time, time to collision) and event-specific measures (e.g., steering response, vehicle position).

Assessment of Mental Models

We constructed a written assessment to evaluate drivers’ mental models of ACC (based on Beggiato & Krems, 2013). This measure is comprised of 40 5-point Likert-scale items. 30 of these items require the participant to indicate their degree of agreement with statements about ACC functioning, and 10 items require the participant to indicate how well the ACC system would help them to avoid a collision in various situations.

Significance and future research

This framework investigates the relationship between generational ways of learning with different forms of media, mental model development, and driving performance in an effort to better understand the relationship between a person’s conceptual knowledge and their capacity to use that knowledge in timely action.

References


EarthGames

Making Games Centered Around Climate Change

Kurt Blancoflor (University of Washington), Dargan Frierson (University of Washington), Josh Lawler (University of Washington), Daniel Zhu (University of Washington), Sally Wei (University of Washington), Rabea Baroudi (University of Washington), & Zane Brant (University of Washington)

Abstract

EarthGames develops games and other interactive experiences with the aim of increasing public awareness of environmental issues such as climate change. Interactive digital experiences are an important part of the future of education, and environmental science is particularly lacking in this area. We believe that the playful nature of games can also counter the typical “gloom-and-doom” tone of the environmental movement, giving students a sense of agency while they learn. We hope to use the power of games as an educational tool to inspire action and more sustainable habits.

The State of Climate Change Education

The problem climate change has existed for decades, but the American public still struggles with understanding the basic facts (Leiserowitz et al, 2013). And although there have been some successes, there has been much unsuccessful communication about climate change (Boykoff, 2011, O’Neill & Nicholson-Cole, 2009).

It is not necessarily the information that is presented that is the problem, rather, it is—at least in part—the way it is presented and who is presenting it. Climate scientists, activists, and the environmental community need new messages and new messengers (Kahan, 2012). Video games provide a medium that can effectively deliver these messages in classrooms and other environments, providing opportunities for active learning in a playful context.

Developing Games for Change

EarthGames is working on projects for game mediums ranging from table-top games to mobile platforms. Some projects have been in the making for over a year while some were recently conceptualized, but each one is currently a work in progress, being designed with hopes of being implemented into museums, classroom lesson plans, and other environmental education related activities.

In addition to our overall development goals, we participate in and use our status as a subsidy of
the University of Washington to host Game Jams and other events that bring together gaming and environmental study enthusiasts alike.

**Climate Quest**

In Climate Quest, climate disasters are occurring across the United States, but your 4 heroes have the skills to save countless lives and protect fragile ecosystems! Forecasts of climate disruptions appear all across the map, each based on real impacts selected from the US National Climate Assessment. The player must choose which scientist-hero is best suited to prepare against the disaster: the urban planner, the ecologist, the agricultural scientist, or the climate scientist. Only the swiftest player will be able to prepare for all the events and earn the top score!

![Figure 1. A screenshot of Climate Quest gameplay.](image)

Climate Quest is for ages 8 and up, and is designed to be played in a museum or classroom setting, or at home. It takes approximately 10 minutes to play through the game. It is available to download for free on Mac and PC, and we are currently working on ports for both android and iOS devices.

**AdaptNation**

AdaptNation is a cooperative tabletop game for 3-6 players. Each player leads a fictional city and together they form a nation. Players must work together through trade, preparation, and investment to balance resources and keep their cities running in the face of progressively severe climate change over the next 30 years.
Smogtown: A Pretty Gritty City

Smogtown is a city-building simulation game that allows players to manage and improve upon a city that is, at its start, not optimized for sustainability. Using real life carbon footprint and economic data, players are encouraged to upgrade their buildings to not only reduce their carbon emissions, but also to save money. Players can then use the money saved for further in-game upgrades. Since the game uses real-world data, we hope that their explorations of the most efficient and cost-effective strategies will allow them to apply this knowledge in their own homes as well.

Life of Pika

Life of Pika is a runner that teaches players about the lives of the pika (an inhabitant of the Pacific Northwest that is threatened by global warming). Pikas cannot survive above a specific temperature, and this is used as the main survival mechanic for the game, in which players run to collect food, but must stay in the shade to keep their temperature low.

In addition to these games we are also developing a trivia game and a sustainable building simulator. Both will pool in real data to provide information on global warming and environmental change.
References


Abstract

Games are now prevalent enough in the mainstream entertainment culture to be an inevitable inclusion in classrooms seeking to motivate and engage students. This study proposes to investigate how educational games can be developed to be more effective instructional tools by examining the effects of individual game design components on learning outcomes. To that end, the proposed experiment will test an agency supporting game condition against a game condition which diminishes agency to determine what effect, if any, player agency has on the retention of educational content and the play experience in educational games.

Introduction

Gaming is now prevalent enough in mainstream culture that it is an inevitable inclusion in the classroom as we seek to engage students and improve learning outcomes. In order to create effective educational games, we need to understand how game design elements impact aspects of learning.

Player agency, best defined as “the ability to change the course of one’s experience” (Thue et al, 2010), is an important game design element to investigate because it has the potential to increase a player’s sense of immersion in the game environment. Early research suggests that this immersion has positive implications for learning in educational games (Jabbar & Felicia, 2015). Player agency may also influence motivation and attention of students if it increases the play experience of the educational game.

Current Study

The current study seeks to investigate 1) whether player agency has an effect on retention of educational content in an educational game and 2) if the inclusion of elements which support player agency affect the play experience of educational games.
Experimental Conditions

We developed two versions of a short role-playing game designed to teach a middle school earth sciences class about hurricane formation by having them take the role of a meteorologist who is responsible for monitoring oceanic weather conditions from an observation lab on a small fictional island in the Atlantic (see Figure 1). In both games, students will research hurricane formation, collect atmospheric data, conduct weather simulations, and interview residents. However, the games differ after the initial introduction of the content as we used the narrative of the game to manipulate the amount of support for player agency in each condition.

In one version of the game, we promoted player agency by having the player choose whether to issue an evacuation order or shelter in place on the island. The player then makes additional decisions while coordinating the evacuation or shelter preparation sequence. These later decisions also have narrative consequences for some of the island’s residents. In the second version of the game, the player merely reports their data to their superiors at the fictional National Weather Authority and the narrative follows a linear path as they are ordered to carry out an evacuation. The player decisions during the evacuation are replaced with fetch-quests which do not include overt player choices.

The two experimental game conditions will be administered alongside a control condition. In the control condition, the students will use two interactive online activities developed by NOAA (“Hurricane Tracks for Idealized Environmental Flows,” n.d.) to help students understand hurricane formation. These online activities are what the cooperating teacher is currently using in the weather unit and represent business as usual in the classroom.
Methods

The participants will be 120 eighth grade science students, randomized at the classroom level, from a suburban middle school in the greater Twin Cities area. The content of the game has been tailored to match what is typically covered in the cooperating teacher’s unit on weather systems and will be administered as part of the normal unit activities.

After completing the game or online activity, the students will complete the Play Experience Scale (Pavlas et al, 2012) which will be used to assess player agency and the overall play experience. Students will then complete a brief content assessment on the atmospheric conditions necessary for hurricane development. The content assessment will be re-administered one week later and a comparison of the scores will be used to assess content retention. Additionally, a selected group of students will be interviewed about their play experience to assist in identifying avenues for further development of the game.
Predictions

We predict that students playing the game designed to support player agency will retain more of the educational content than those playing the game which has diminished player agency or the control condition. We also predict that the students in the agency condition will report a better overall play experience than those in the other conditions.

References


Crossover Gamified Design

Learning and Assessment for Sustainable Engineering Education
Fariha Hayat Salman (Pennsylvania State University)

Abstract

This is a design-capture of a crossover gamified learning experience called GreenDesigners focused on sustainable engineering education for high school students. Located at a solar demonstration house, our design leverages the functionality of an Augmented Reality interface developed to coordinate learning of sustainable engineering design concepts and practices across real-world (informal) and classroom settings (formal). It is anticipated that such “seam-ful” (Dourish, 2001) crossover learning and assessment designs could enable a preparatory transition from informal, active learning activities to formal design-focused activities thus expanding learning opportunities for youth within STEM fields.

Introduction

This design-capture emerges from a research project called the GreenDesigners where we examine rich interactions in a place-dependent, gamified crossover learning design. We study how this designed learning experience equips science learners with sustainable engineering concepts and design practices to propose and create design-prototypes. Employing Next Generation Science Standards (NGSS), our study is focused on High School standards in Engineering Design and inquires: How do crossover gamified learning and assessment designs expand youth opportunities for learning discipline-specific concepts and practices in STEM fields? Participants observe sustainable technologies across the real world site of the solar house while interacting with an Augmented Reality (AR) gamified interface on handhelds (Figure 1) and generate data as learner analytics, video-based interactions, and design prototypes.

Figure 1. Mapped locations on the real-world site and AR interface GreenDesigners.
Conceptual Background

Expanding upon research on technologically-enhanced, placed-based, informal learning spaces (Dunleavy & Dede, 2014; Salman, 2014; Zimmerman et al, 2015), our study utilizes a design that coordinates STEM learning and assessment in the real world (informal) to that in the classroom (formal). Conceptually referred to as “crossover learning” (Sharples et al, 2015), this coordination promises authentic learner experience that flows as a dialogic continuum across formal and informal spaces and activities. Through our AR gamified interface, we augment learning and assessment components to address the current deficiencies in teaching and learning sustainable education (Batterman et al, 2011). Our design enables interconnections between sustainable engineering design concepts and practices for high school students through the “three spheres of activity for scientists and engineers” (NGSS Lead States, 2013).

Design Elements

Our presentation elaborated the following design elements and shared some insights from the usability testing process.

1. Place Dependence

With our focus on sustainable engineering design concepts and practices, we opted for a place-dependent learning design (Ardoin, 2006; Sobel, 2004) that leveraged the functionality of an AR game platform to augment unique design features of the MorningStar – Penn State’s solar demonstration house (Figure 1). Participant’s interaction with the solar house is guided by the interest-based roles they select at the onset. Progress through the physical and virtual levels of the learning and assessment tasks culminate in a design challenge where students propose sustainable design solutions based on their learning experience.

2. Gamified Curriculum

Our design draws upon the NGSS’s Engineering Design standards for high school [HS-ETS1-1, HS-ETS1-2, HS-ETS1-3]. Focal concepts for our study include: (a) active and passive solar designs (b) geographical design considerations- position of sun/natural light and wind direction (c) heat mapping in active & passive solar designs (d) insulation & thermal mass in the choice of materials (e) conductors vs. insulators. We present these as augmented images, videos and embedded assessments overlaid on the physical design features of the solar house (Figure 2). Focusing on engineering practices, these videos feature real life architectural engineers explaining the design decisions and trade-offs that went into the unique design of the solar house. Our gamified interface GreenDesigners (the game) is developed on an open sourced, visual programming, AR game platform developed by the MIT-STEP lab that allows the learning path to unfold and evolve with the learners’ self-driven role-based progressive interaction with the physical and digital artifacts. In this way, the interface leverages game elements such as: (a) scene setting (b) role-based player control (c) progress mechanics (d) collective intelligence response, (e) final challenge. Participants earn digital badges upon completion of learning levels. Our interface affords deeper insights into learners’ experience of the performance assessments through real-time learner analytics (Figure 2).
3. Seamful Crossover Learning & Assessment Design

The learning process is connected by means of engineering design concepts and practices across the outdoors, informal space and the indoors, formal classroom. The design is a “seam-ful” (Dourish, 2001) crossover of physical-digital, formal-informal where learners are made aware of the transitions spread over:

- the gamified trail across the real world site of *MorningStar*, the solar demonstration house
- the AR gamified interface of *GreenDesigners* (game played on handhelds)
- the embedded assessments at each content-spot
- the design-capstone task in the classroom

Research Methods and Study’s Significance

Within Design-based Research (Sandoval & Bell, 2004), non-experimental and qualitative methods are employed. Video based interaction analysis examine interactions as the learners engage with digitally augmented learning and assessment activities as they move through the real world site. Our study contributes to the development and research on digitally augmented crossover learning that is being seen as an impactful design for discipline-specific learning across real-world and classroom settings (Sharples et al, 2015). We anticipate that such designs will expand youth opportunities in the form of preparatory learning transition from a less formal to a formal learning space so that all learners capitalize on their STEM interests and skills.
Acknowledgments

*GreenDesigners* is funded through the RIG program spearheaded by the Pennsylvania State University’s Center for Online Innovations in Learning (COIL). Especially acknowledged is my project team:

https://coil.psu.edu/blog/greendesigners-augmented-reality-learning-experience-for-sustainable-engineering-design/

References


MasterSwords

Competition, collaboration, and community in a multimodal battle of words
Kristana Textor (The Warner School of Education, University of Rochester) & Lynn Gatto (The Warner School of Education, University of Rochester)

Abstract

This poster will explore how one group of urban elementary school students engage with a video game designed to foster literacy. Particular attention will be paid to the socially situated interactions surrounding the game’s competitive battle mode. Through our case study we hope to better understand how a fighting game mechanic that uses words and spelling might cultivate collaboration, community, and New Media Literacy in youth.

Rationale

As video games take a more central position in schools and society, it is becoming clearer to educators that they are capable of stimulating high levels of engagement and learning in youth. Beyond being sources of entertainment, some scholars claim that games are learning machines and even spaces where New Media Literacies can be developed (Gee, 2003). While many studies have been conducted on the literacy practices of secondary students (Lammers, Curwood, & Magnifico, 2012; Leander & Lovvorn, 2006; Steinkuehler, 2007; Steinkuehler, Black & Clinton, 2005; Steinkuehler & King, 2009; Squire, 2011) we argue that elementary aged school children are as of yet an understudied population. Exploring the idea of how a fighting game style “battle mode” might foster collaboration and community could be helpful to educators and better inform their practice as we move forward towards a more nuanced understanding of New Media Literacies.

Game Play & New Media Literacies

MasterSwords (Figure 1) is part of a learning package of iOS video games designed to promote ELA skills. The game transforms words into weapons as players battle zombies, goblins, and each other in multiplayer matches. Players journey through whimsical environments collecting gear and delivering taunts that put the words the player spells into meaningful context. Multiplayer matches can be initiated over Wi-Fi or on the same tablet via pass-and-play mode.

As researchers, we are not examining the impact that MasterSwords might have on test scores or traditional reading and writing skill and drill performance. Rather, this case study is designed to shed light on the relationship that elementary aged students have with video games and New Media
Literacies. Our definition of literacy incorporates the idea that literacy includes the authentic practices of meaning making through the constantly changing multimodalities (New London Group, 1996). This study investigates how students approach reading, writing, and multimodal aspects of new literacies during game play.

![Figure 1: A screen shot from MasterSwords.](image)

Methods & Participants

This research will attempt to answer the question: How does a competitive game mechanic affect the ways elementary aged youth approach collaboration, community, competition, and literacy? The case study involves ten fifth and sixth graders from an urban public school district in a medium sized city located in the Northeast United States. The students chosen are participants in a summer enrichment program that runs seasonally on a university campus. Researchers will meet with students monthly to play and discuss the game until the summer session, then once a week for six weeks in the summer. Data collected will include video footage of each meeting, and will be selectively transcribed, then coded using grounded theory principals (Glaser & Strauss, 1967). As patterns and themes emerge, selections of videotape will be transcribed for closer examination. Questions will focus on reading habits, attitude toward school, collaboration, in-game combat, strategy, sportsmanship, social relationships, mentorship, and communication.

Interested students will have the opportunity to operate the research video camera and interview each other during our sessions. This positions students to be participants and producers, not just consumers of media. Their participation as interviewers during meetings sheds light on what they view as important during game play. The topic of collaborative strategizing has already risen to the top of the list for many student interviewers.

Theoretical Framework

Games are social by design, and the learning that occurs within and surrounding them is inherently social (Gee, 2003). We posit that reading and writing are social practices, and as such should be examined through a socio-cultural lens. The relationship that the youth have with reading is more complex than building vocabulary or raising test scores. Because of the social nature of competition embedded within MasterSwords, we will utilize socio-cultural learning theories as a lens to examine this case study.
Findings

Initial observations have revealed that there is a high level of engagement for students when playing MasterSwords. Excitement and passions run incredibly high during game play. We speculate that the initial draw of a “battle mode”, even in a turn-based spelling game, proves almost irresistible to the young players. However, this competitive environment actually seems to foster a collaborative approach to problem solving. Strategy rises to the top of their chatter, with players shouting spelling suggestions for maximum points and damage regardless of team alliance. The students often lock in to the game’s mechanic of building powerful words.

Previously established social relationships between peers, mentors, and competitors appear to matter. No video game exists in a vacuum, all games and players carry social contexts with them. While MasterSwords is designed to foster a relationship with reading, we expect to find that the presence of a mentor is key to pushing students through more challenging aspects of reading and to actively encourage a positive relationship with literacies, old and new. For example, youth often describe their passion for manga to their mentor, who then helps connect this love back to literacy.

We have so far witnessed very limited fear of failure when students play MasterSwords. Even when a student submits a misspelled word during competition, they do not seem to be dissuaded by their mistakes. We have yet to see any students walk away or “rage quit” because of misspellings during game play. This poster will highlight examples of how and why MasterSwords keeps students engaged through a fighting game mechanic. Our hope is that a better understanding of competition and collaboration in video games could be beneficial to educational practitioners.

References


Beyond the Campus Walking Tour

An ARIS Augmented Learning Expedition

Sara Ringbauer (University of Missouri-Columbia), So Mi Kim (University of Missouri-Columbia), Fatih Demir (University of Missouri-Columbia), Michele Kroll (University of Missouri-Columbia), Shann Bosaller (University of Missouri-Columbia), Joe Griffin (University of Missouri-Columbia), Hao He (University of Missouri-Columbia), Nilay Muslu (University of Missouri-Columbia), & Isa Jahnke (University of Missouri-Columbia)

Abstract

We present an in-progress project for an Augmented Reality Game for young students visiting a university campus. The purpose of this game is to create an engaging experience for visiting high school students and others to learn about the culture of the university, to involve them as members in the university as a community of practice, and to help students make connections to the university through CrossActionSpaces. We discuss combining the augmented reality features of ARIS gaming platform with the Meaningful Learning with technology framework to achieve this goal.

Introduction

University campus tours often involve a tour guide walking backwards and pointing out the history of campus to prospective students. Some universities also offer online tours. We reconceived the university tour not only as a ‘lecture’ but as a Learning Expedition in the digital age (Jahnke & Norberg, 2013). We develop a university tour for students that combines elements of both an in person tour and a digital tour using the principles of Augmented Reality Gaming. The project goal is make the tour more meaningful to students in terms of becoming community members. We call it an Augmented Learning Expedition.

Theoretical Framework

The theoretical approaches that guide our design are threefold—the university as a community of practice (Wenger et al., 2002), the university as CrossActionSpaces (Jahnke, 2016), and meaningful learning with technology (Howland, Jonassen & Marra, 2012). First, we envision the campus tour as a learning process. Learning in this situation is not related to traditional lines of subjects and knowing; rather it blends into the process in which new students become part of the university community. By being situated and engaged in the community of practice (Lave & Wenger, 1991), students “interact, learn together, build relationships, and in the process develop a sense of belonging and mutual commitment” (Wenger et al., 2002, p.34). Our Augmented Learning Expedition incorporates the five elements of situated learning a) shared resources and artifacts, b) history, c) language, (e.g., technical terms) d) roles and responsibilities, and e) the social practice as interaction (Lave & Wenger, 1991).
Second, we assume that learning does not take place solely offline or purely online. We are living in a dualistic online-offline infosphere (Floridi, 2014), and therefore interaction turns to crossactions within and across communication spaces (Jahnke, 2016). We use augmented reality to bridge these online-offline communication spaces. Finally, we incorporate the affordances of Meaningful Learning with technology as proposed by Howland, Jonassen & Marra (2012) to guide the design of our Campus Learning Expedition (see Figure 1).

![Figure 1: The five affordances of Meaningful Learning with technology (Howland et al., 2012).](image)

### Selecting the ARIS Platform

Explorations with Google Glass and ReconNET Jet wearables revealed limitations with screen resolution, time to become familiar with the wearable interface, and need to write game software for those devices. These constraints eliminated wearables and we turned to designing for handheld technologies. The open-source ARIS platform (http://arisgames.org/) met all of our criteria and its features align well with Meaningful Learning (see Table 1) and our other theoretical frameworks.

<table>
<thead>
<tr>
<th>ARIS Game Features</th>
<th>Active (Manipulative/Observant)</th>
<th>Constructive (Articulative/Reflective)</th>
<th>Cooperative (Collaborative/Conversational)</th>
<th>Authentic (Complex/Contextual)</th>
<th>Intentional (Goal-Directed/Regulatory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaque</td>
<td>User selects plaque to view</td>
<td>Conversation with a university character</td>
<td>Context information</td>
<td>Game goal information</td>
<td></td>
</tr>
<tr>
<td>Conversations</td>
<td>Choices in conversations</td>
<td></td>
<td>Context information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notebook</td>
<td>Gather notes, photos, audio or video</td>
<td>Record reflections, tag items</td>
<td>Comment on other player's notebook entries</td>
<td>Location</td>
<td>Record game progress towards game goal</td>
</tr>
<tr>
<td>Groups</td>
<td>Players work together as a group</td>
<td></td>
<td>Items related to context</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Items</td>
<td>Pick up items from map</td>
<td>Share items with other players</td>
<td>Items collected for goal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 1. Alignment of ARIS game features and the five elements of Meaningful Learning*

### Design, Testing and Analysis

Step 1 of the design involved brainstorming five elements of situated learning: a) shared resources and
artifacts, b) history c) language d) roles and responsibilities, and e) the social practice as interaction. We used a brainwriting method to create game scenarios for each of the seven locations that included five elements of situated learning. Step 2 generated rapid paper prototypes. For Step 3, we held a workshop to learn ARIS Editor and turn the paper prototypes into scenes in our ARIS Augmented Learning Expedition.

Our ongoing project employs an iterative design-test-modify approach to assess the effectiveness of our Augmented Learning Expedition. The main goal of the usability testing is to create a user friendly game-based learning expedition for the prospective students. Our iterative usability testing will reveal design issues and user interface problems as well as collect user feedback. The revised expedition will be released once usability problems are fixed and all game expectations are met. One project takes place in July with 120 students simultaneously through the Campus Learning Expedition and in September 2016 with 40 students.

Our research questions include:

1. How do the five elements of community of practice (Lave and Wenger, 1991) and five characteristics of Meaningful Learning (Howland, Jonassen and Marra, 2012) in the Augmented Learning Expedition affect student engagement and connection to the university?

2. How do transitions between the physical world and virtual world of the ARIS game affect user flow experience toward CrossActionSpaces?

Our preliminary analysis will be based on user surveys, interviews, usability testing results, field observations and ARIS game logs. In our final paper, we will report the preliminary analysis results. We use this data to further refine the Augmented Learning Expedition and to create additional campus expeditions focusing on STEM subjects.

References


Proteus Play on a STEM-Game Platform

Examining the role of avatar identity and self-relevance on STEM attitudes and motivation

Letícia Cherchiglia (Michigan State University), Amanda Klug (Michigan State University), Will Renius (Michigan State University), Samantha Oldenburg (Michigan State University), Harrison Sanders (Michigan State University), Rachel Stacey (Michigan State University), Celina Wanek (Michigan State University), Michael Beyene (Michigan State University), & Rabindra Ratan (Michigan State University)

Abstract

This study examines how different aspects of avatar use on a science-game web platform influences motivation to play science games on this platform as well as STEM interest and STEM-learning self-efficacy. We developed a science-game web platform for this research on which we are testing our expectation that using a science-related avatar (compared to a general avatar), especially when this avatar is customized (not simply assigned), will lead to more positive effects on STEM-learning self-efficacy, STEM interest, and motivation to play STEM games.

Introduction

There is an increasing demand for professionals who, in addition to being capable of retaining information, are equipped with the knowledge and skills to understand, evaluate, and make thoughtful decisions based on information. These sets of skills are usually acquired by studying subjects such as Science, Technology, Engineering, and Math (collectively known as STEM). According to the U.S. Bureau of Labor Statistics (2014), if the growth rate of graduating STEM professionals and availability of STEM jobs stay the same, in five years there will be a shortage of professionals working in STEM fields. One approach to addressing this issue is to incentivize students to pursue STEM careers.

However, creating such incentives is a complex task. It involves empowering schools with technological resources while providing training and tools to teachers so they can properly engage students with STEM topics. This last step is especially important not only because students usually fail to see STEM subjects as starting points for their careers (U.S. Department of Education, 2015), but also because students who show interest in technology are more likely to pursue degrees in STEM fields in the future (Maltese & Tai, 2010).

One way of motivating middle school students to learn science is through digital games (Clark et al, 2009; Marino et al, 2013). The STEM Game Crew website (http://www.stemgamecrew.org) is an important platform for students to engage with educational game content, while making a strong connection between their actions and the scientific method. Future uses of this platform include
educational use for teachers as well as research on the effects of avatar use in educational contexts, based on the Proteus Effect (Yee & Bailenson, 2007) and Bandura’s (1977) Social Cognitive Theory (SCT).

The STEM Game Crew Website

The STEM Game Crew website is meant to complement Curious Crew, a science-education television show produced by WKAR, the public broadcasting station in Lansing, Michigan. The show follows Rob Stephenson, an award-winning educator, as he and the Curious Crew, middle school students from mid-Michigan, explore different scientific concepts during each episode.

According to Clark et al. (2009), games and simulations can be seen as useful tools for science learning not because they are better than traditional classroom teaching, but because they are so customizable (in terms of genre, target audience and expected outcomes) that they can provide many different and even individualized learning experiences. In addition, Marino et al. (2013) showed that students in general prefer learning science through digital games and believe that digital games can make learning science more fun. Building on these findings, the STEM Game Crew website displays links to more than 50 games related to 17 different STEM topics. The games that were chosen were intended to be as interactive, learning-oriented, and on-topic with the Curious Crew episodes as possibly.

The website also allows users to apply the scientific method with the games listed on this site: namely, players are asked to provide predictive hypotheses before playing the games and then report reflective observations afterwards. It is expected that by applying the STEM Game Crew scientific method students will learn how the method can be applied to many different situations, not only science experiments in the classroom.

Moreover, when registering in the STEM Game Crew website, users are asked to choose a username and an avatar. In the context of mediated environments, avatars are visual representations of users that can be either 2D (an image) or 3D (a model). Research shows that avatars can influence the user’s behavior based on the stereotypes associated with the avatar’s characteristics (Yee & Bailenson, 2007). The extent to which these effects of avatar use occur depend on the psychological attachment between the user’s perception of self and the avatar (Ratan & Dawson, 2015). Although the science games listed in the STEM Game Crew website do not incorporate the site users’ avatars, the users’ avatars are displayed together with their usernames when posting on the website. Thus, users are still attached to their avatars while using the website because they perceive their avatars as their representation of self with other site users. Such attachment can impact the motivation one has to engage in learning activities (Ratan et al., 2016).

Finally, the STEM Game Crew website can also be seen as a tool for changing user’s attitudes towards STEM. Social Cognitive Theory (SCT) explores how one’s learning, motivation and behavior can be affected by one’s self-efficacy and vicarious experience (Bandura, 1977). Playing science games in the website and posting ratings before and after playing are learning activities that can help users to better understand science topics, as well as reflect upon their own learning. Such activities can help change users’ belief in their own capacity to learn science content and their interest in STEM fields.

Thus, one goal of this study is to investigate how avatar type can motivate users of the STEM Game Crew website to play science games, as well as impact users’ self-efficacy and their interest for learning
STEM-related content. Another goal is to explore how avatar customization can impact the motivation to play science games in the *STEM Game Crew* website.

**STEM-learning self-efficacy and STEM interest**

Social Cognitive Theory (SCT; Bandura, 1977) can give us insight regarding how science learning can happen through digital games or other mediated environments. SCT states that human functioning is dynamic and one way of learning is to build self-efficacy. Self-efficacy is the belief that a specific behavior can be accomplished (Bandura, 1977).

Much research has been conducted on STEM self-efficacy and traditional learning environments (Diekman et al, 2010; MacPhee, Farro, & Canetto, 2013; Rittmayer & Beier, 2008; Soldner et al, 2012). These studies focus on augmenting STEM self-efficacy in order to achieve better learning or a higher interest in STEM careers. However, literature does not encompass STEM learning self-efficacy, defined in this study as the belief that an individual has a capability to learn STEM-related content. Moreover, the concept of STEM interest is usually considered with respect to STEM careers themselves (e.g., interest in becoming a computer engineer) or the interest in performing activities that are part of STEM careers (e.g., interest in computer programming). In this study, we define STEM interest as the interest an individual might have in the content of STEM fields. We believe that previous interest in science content can prime a user to play more STEM games (e.g., previous interest in physics content would increase the motivation to play physics games). Thus, we propose the following hypotheses, within the context of the *STEM Game Crew* website:

- **H1a:** The higher the STEM-learning self-efficacy, the more people will be motivated to play STEM games.
- **H1b:** The higher the STEM interest, the more people will be motivated to play STEM games.

**Avatars Effects**

One possible way of augmenting engagement in a science related virtual environment is through the use of avatars. Avatars are an important element of educational games because they potentially influence the user in meaningful ways. Specifically, the Proteus effect (Yee & Bailenson, 2007) is a phenomenon in which people conform to the behavioral expectations associated with their digital self-representation (e.g., participants in a mediated environment with taller avatars negotiated more aggressively in a subsequent unmediated task). The Proteus effect is potentially moderated by avatar self-relevance or “the extent to which the avatar user perceives the avatar as relevant to the self” (Ratan & Dawson, 2015). After exposure to an avatar, the higher the avatar self-relevance, the stronger the effects of the avatar’s characteristics on the user. Avatar self-relevance is connected to avatar identification (how much individuals perceive themselves as sharing characteristics with their avatars) and avatar embodiment (how much individuals feel capable of performing actions in the mediated environment through the avatar). This explains why avatar customization enhances avatar self-relevance (Ratan & Dawson, 2015). If users perceive their avatars as self-relevant, we would expect that they would be more motivated to use the avatar within the mediated environment. Thus, in the present context, we propose the following hypotheses:
• **H2:** The higher the avatar self-relevance, the more people will be motivated to play STEM games.

• **H3:** When compared to having an assigned avatar, having a customizable avatar will increase avatar self-relevance.

In this study, we explore how the constructs of STEM-learning self-efficacy and STEM interest can be impacted by aspects of avatar design due to the Proteus effect. If users show higher avatar self-relevance in the website, it is expected that users will conform more to the expectations associated with their avatar’s characteristics. Specifically, if users have an avatar that contains scientific characteristics, users may increase their STEM-learning self-efficacy and STEM interest. We refer to these avatars which contain scientific characteristics (e.g., are shaped as beakers) as science-related avatars, in comparison to simple-shape avatars who don’t have scientific characteristics (e.g., are shaped as squares). Thus, we propose the following hypotheses:

• **H4a:** Compared with using simple-shape avatars, using science-related avatars will increase STEM-learning self-efficacy.

• **H4b:** Compared with using simple-shape avatars, using science-related avatars will increase STEM interest.

The theoretical model for our study and our hypotheses can be seen below (see Figure 1). To simplify our model, STEM-learning self-efficacy and STEM interest were combined into STEM attitudes.

---

**Figure 1: Theoretical Model and Hypotheses.**

---

**Methods**

**Participants**

Participants for this study will be approximately 60 middle school-aged children from Greater Lansing who will be attending three different sessions of a technology Summer Camp at Michigan State University from July 11th to July 29th of 2016.
Design and Procedures

For this study, we are conducting a 2×2 online experiment by manipulating avatar type and avatar customization (see Table 1).

<table>
<thead>
<tr>
<th>Avatar Type</th>
<th>Non customizable science-related avatar</th>
<th>Customizable science-related avatar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non customizable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>simple-shape avatar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customizable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>simple-shape avatar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Experiment design.

Participants will be invited to take an online survey on a computer lab at Michigan State University. The first questions will be about STEM-learning self-efficacy and STEM interest. Then, participants will be asked to explore one of the four different versions of the STEM Game Crew website. Science-related avatars are defined as beakers and simple-shape avatars were defined as squares (see Figure 2). For the groups with customizable avatars, the customization could happen at any time in terms of avatar color, eyes, eyelashes, eyebrows, and mouth, with 10 different possibilities for each characteristic.

![Figure 2: Examples of science-related avatar (left) and simple-shape avatar (right).](image)

Users would be able to see their avatars and usernames in a designed area on the top of every page on the website (see Figure 3). Also, when visiting a game’s page, users would be able to see their avatars and usernames in a designed area on the right of the games’ information.
After registering in the website, participants will be asked to play three designated STEM games in the website, chosen based on the researchers’ ratings of how fun, educational, and interactive they were. For each game, participants would fill out a form before playing with predictive hypotheses about the game, and another form after playing with reflective observations about the game (see Figure 4). Participants will be also encouraged to explore the website and play more games. After exploring the website for 30 minutes, participants will go back to the survey and answer questions related with their motivation in the website, their perception of avatar self-relevance, STEM-learning self-efficacy, and STEM interest.

Figure 4: Hypothesis and Conclusion Forms
Measures

Motivation to play STEM games

In the survey, participants will be asked to report the games played in the website, as well as how long they played each game (in minutes), and how many levels they played in each game. The website was built using WordPress with Google Analytics and Google Tag Manager integration to track interactions between users and the website. This approach provides two separate measures of motivation to play STEM games – subjective and objective, respectively – and it was chosen building on the findings of a previous study (Kahn, Ratan, & Williams, 2014) suggesting that participants are sometimes biased in their self-report about video games and the direction of this bias can be informative about any cognitive dissonance they experience while playing.

STEM-learning self-efficacy

To measure STEM-learning self-efficacy, we will be using an adapted scale from Bandura’s (2006) children’s self-efficacy scale. Items for the question “How well do you think you would be able to perform the following tasks?” should be rated on a 5 point Likert-type scale, from “Not able at all” to “Absolutely able”. Items included learning related with STEM subjects (e.g., “Learn Math”, “Learn Computer Programming”) and non-STEM subjects (e.g., “Learn Arts”, “Learn English”). Participants will be asked the STEM-learning self-efficacy questions twice: before they engaged in activities in the website and afterwards.

STEM interest

To measure STEM interest, we will be using our own scale. Items for the question “How interesting do you find the content of the following fields?” should be rated on a 5 point Likert-type scale, from “Not interesting” to “Absolutely interesting”. Items include STEM fields (e.g., “Technology Related: Digital Art, Media and Technology, Video Games, etc.”) and non-STEM fields (e.g., “Humanities: Philosophy, Theology, History, etc.”). The STEM interest question will be asked twice, as done with STEM-learning self-efficacy questions.

Avatar self-relevance

To measure avatars self-relevance, we will be using Van Looy et al.’s (2012) scale for game character identification. Items for the question “Regarding your avatar in the website, rate how strongly you agree with each statement” should be rated on a 5 point Likert-type scale, from “Strongly Disagree” to “Strongly Agree”. Items include identification aspects (e.g., “my avatar is like me in many ways”), embodiment aspects (e.g., “I feel like I am inside my avatar when in the website”), and idealization aspects (e.g., “I would like to be more like my avatar”).
Results and Discussion

After data collection and analysis, we hope to have conclusive results about avatar effects on players regarding the STEM Game Crew website. Through the creation of this website, we hope to give educators and students an engaging platform for STEM learning. By engaging in learning STEM topics on this platform, students may also become more interested in STEM careers and this may contribute to the growth of the field.

Acknowledgments

The research that led to this study was partially funded by the Brazilian National Research Council (CNPq) under the Science Without Borders Program, MSU’s College of Communication Arts & Sciences, WKAR, the MSU Honors College, and the AT&T endowment to MSU’s Department of Media & Information.

References


Marino, M. T., Israel, M., Beecher, C. C., & Basham, J. D. (2013). Students’ and teachers’ perceptions of


Abstract

This paper explores into the constitutive entanglement of material (also digital) artifacts and activities of collaborative learning. Drawing on examples of students building the “University of the Future” in the virtual world of Minecraft, we depict how the epistemic function and the material qualities of the shared artifact are intertwined with the students’ efforts to articulate and transform their ideas and conception of the subject matter (the conception of higher education which underlies the “University of the Future”). Challenging techno-centric as well as human-centered notions of technology, we argue for an emergent nature of epistemic artifacts.

Introduction

The importance of shared artifacts as means to create common understanding, to ground discourse and to advance novel ideas has been widely acknowledged in the learning sciences (e.g. Stahl et al, 2014). Despite this fact and the proliferation of theoretical accounts that emphasize the socio-material dimension of educational processes (e.g. Fenwick, Edwards & Sawchuk, 2011) there is only limited insight on the interplay of the material nature of artifacts and the epistemic practices they are used in. Current research is still inclined to make a sharp distinction between artifacts as material objects with inherent and fairly stable properties (techno-centric) and the way these artifacts are used and made sense of by human actors (human-centered). Yet, both of these perspectives block sight for what Orlikowski (2007) has called the “constitutive entanglement” of the social and the material and therefore the fact that “practice is always bound with materiality” (p. 1436). The aim of this paper is to elaborate and provide illustrative examples on the constitutive entanglement of shared artifacts and students’ articulation and transformation of concepts in a open-ended, and creative learning process. The examples we analyze are taken from a design experiment on the use of a virtual environment for the collaborative development of innovative conceptions of higher education. In the respective course students were asked to advance their concept of higher education through building the ‘University of the Future’ in the virtual world of Minecraft (http://minecraft.net). Drawing on recordings of students’ activities, we depict how the role of the artifacts created by the students is not predetermined but in constant flux while at the same time bound and shaped by its enacted material properties. The examples also show that the materiality of an environment such as Minecraft, is crucial to the understanding of respective learning practices.
The Constitutive Entanglement of Artifacts and (Learning) Practices

Current conceptions of (knowledge) artifacts are facing two major challenges. The first challenge relates to the question of the impact of technologies and artifacts on human action and the users’ role in their appropriation and utilization. Authors such as Höning (2001) and Orlikowski (2007) have argued that the prevailing conceptions either adopt a techno-centric perspective, stressing the intentions and functionalities inscribed into an artifact, or emphasized the dynamic and situated nature of humans interacting with technology, relativizing the momentum of the artifact itself. Both of these perspectives are however limiting as they see the social and material as two distinct spheres and ignore their “constitutive entanglement in everyday life” (Orlikowski, 2007, p. 1437). Following Orlikowski (2007) the constitutive entanglement goes beyond the idea of a reciprocal interaction between the social actors and the material world, but presupposes that humans and artifacts are co-constitutive. Asking students to advance their conception of the future of higher education in the virtual world of Minecraft, from this perspective, hence has to be understood as a truly transactional process in which the participants enact the technology in a way they deem productive without knowing where this process will actually take them. The second challenge relates to the material qualities of artifacts, especially when talking about a digital gaming environment such as Minecraft. Even though conceptual frameworks such as ‘activity theory’, ‘distributed cognition’, and ‘actor-network theory’ have stressed the notion of materiality, they tend to conceive artifacts as vehicles of information or as tools with inscribed policies. In doing so, they bypass the question of what makes up their materiality. Toward this end Leonardi (2010) suggested a relational conception of materiality, according to which materiality is not premised on physical substance or matter but can be “defined in terms of practical instantiation or significance” (p. 11). According to this definition artifacts, including digital ones, are ‘material’ if they instantiate an otherwise abstract idea or make a difference to the situation at stake and are pertinent to the task at hand. Students’ creation of the ‘University of the Future’ in Minecraft therefore not only takes place in a material (even though largely virtual) environment, in that the software is significant to the situation, but also results in a material outcome in that the students’ creations are supposed to instantiate their abstract conceptions. To account for the constitutive entanglement of students’ practices and the artifacts they are creating and using, i.e. the virtual worlds they are building, we adopt a relational conception of an (knowledge) artifact’s function and qualities. According to this conception (cf. Figure 1), the (epistemic) function of an artifact and its qualities are not static attributes but are dynamically related to the transactions the artifact is used in and hence with reference to the actors involved and the object of interest the transaction is focused on.
Knowledge artifacts hence can be used not only as means to convey information or establish a common ground, but also to explore and experience possible worlds as well as to probe and test assumptions about a given subject matter and raise new questions. Due to the material nature of transactions, the creation and use of artifacts is inevitably shaped by the particular medium used, be it physical or digital. Consequently, the epistemic function of knowledge artifacts is not just a matter of its creators’ ingenuity, but also of the media used. Furthermore, this conception of knowledge artifacts gives room for the creation of entities, which transcend what already exists or is known. Knowledge artifacts in this sense are ‘productive things’, in that they are not mere representations of something else, but itself material instantiations of the unfolding epistemic object (cf. Knorr Cetina, 2001). As such they are both resistant as they cannot be formed arbitrarily as well as excessive in that they are amenable to open-ended processes of reinterpretation and reuse (Richter & Allert, 2016). Our interest is in the way shared artifacts and students’ conception of higher education are constitutively entangled in their efforts to create the ‘University of the Future’ in the virtual world of Minecraft. Toward this end the intent of our research is twofold. First, we aim to trace the epistemic role of Minecraft enacted by the students’, whether it is used (a) as a representational device to convey (pre-)established ideas, (b) as a means for communication in order to ground the participants joint discourse, and/or (c) as an epistemic object in its own right that is essentially “open, question-generating and complex” (Knorr Cetina, 2001, p. 181). Second, we aim to explore how the epistemic function is shaped by or related to the material qualities of Minecraft, be it in the way that it affords or constrains certain transactions or that it renders certain feature more or less significant.
Case Study: Context, Educational Setting and Method

To explore the constitutive entanglement of the work on a shared artifact with students’ articulation and transformation of concepts, we draw on three events of collaborative interaction in a bachelor-course on media education and educational computer science, which took place in winter term 2014/2015. As part of this course on digital-game-based learning, the students were asked to build a model of the ‘University of the Future’ in the virtual world of Minecraft. The activities were carried out in four groups of four to five students from the study programs of Educational Science as well as Computer Science and lasted for two months. Prior to the work in Minecraft, the students had been asked to reflect on their experience and perception of the university, using the “Stanford 2025” project as a trigger for discussion (stanford2025.com/). The students were introduced to Minecraft and taught the basic movement and actions in the virtual environment. Each group was provided with their own workstation, consisting of an interactive whiteboard and a PC. Using the university’s wireless LAN, students were also able to access Minecraft on their own devices on campus. During contact hours the lecturer and an assistant provided feedback and technical assistance. To ease and speed up the building process, students were also provided with WorldEdit, which allows the creation of geometrical figures by using commands, in addition to the manual arrangement of the virtual building blocks. The groups were assigned specific building areas, but were also able to visit the other group’s sites by using the teleportation hotspots in Minecraft. Minecraft was chosen as a virtual and game-based construction environment, as it is fairly easy to learn and use, enabling students to quickly start building their own models in a collaborative manner. From a pedagogical perspective the use of Minecraft was based on two premises. First, it was assumed that being forced to articulate their ideas for the future of higher education, in an uncommon format would allow students to spot and take up otherwise implicit ideas and conceptions. Second, it was assumed that the collaborative affordances of the environment and the assignment, would render salient potential differences in the participants’ conceptions and therefore trigger for further reflection. As part of a larger design experiment the activities of all four groups were recorded during those course sessions in which Minecraft was actively used. To trace students’ interactions throughout the physical and the virtual environment, video and audio recordings of the groups within the seminar rooms were combined with recordings of the activities in Minecraft, capturing the view that was actually shared via the interactive whiteboard. The recorded data was imported to Transana (transana.org/) and synchronized to align the video and audio data as well as the footage from the virtual camera. To explore into the epistemic role and material qualities of Minecraft in relation to students design decisions, the recorded material was screened for situations in which students were collaboratively talking about a design decision to be made or in which they were deliberating on a design decision they already made. Respective situations are of particular interest for the current analysis in that they require the students to, implicitly or explicitly, reason about the relevant qualities of the university of the future and how these could be materialized in Minecraft. Three sequences, in which students made active use of Minecraft while simultaneously pondering on specific design decisions, where selected for in-depth analysis.

Findings: Students Moves and Interactions

In the following we present and discuss three excerpts of students’ discourse while constructing their vision for the “University of the Future” in Minecraft. For each sequence we provide the footage from the virtual camera available to the students on the interactive whiteboard next to the transcript of their discussion.
Sequence 1 (Group 1, 05.02.2015, Runtime: 0:24:10 – 0:26:21)

The following discussion occurred in the last regular session of group 1. The group already created a campus and buildings, making extensive use of the Minecraft and WorldEdit software. In this sequence they discuss how to integrate additional buildings as well as the overall layout of the campus.

The questions the students are dealing with are entangled with the affordances of the virtual world, which eases the creation of geometric layouts. Design decisions are taken step by step as the group
raises questions through bringing forward the artifact. In this sequence the artifact is used as an epistemic object rather than a means of representation, in that its creation generates new questions in an open-ended process of inquiry. The arguments the group brings forward concern spatial aspects and geometrical forms and structures (“circle”, “square”, “round”, “squarish”), but are not related to conceptions of higher education. While the artifact enforces decision-making, the students also treat the artifact as a means for communication (“my idea”, “your idea”). Furthermore, S4 assigns the artifact to work as an epistemic object as it allows for insights no other representation can provide (neither his mind nor a previous draft): “I am eager to see how this is going to affect the visual appearance of our prototype” (41). While there is hardly any direct interaction with Minecraft during the discussion, the students are well aware of the kind of manipulations supported by the software.

Sequence 2 (Group 4, 05.02.2015, Runtime: 0:31:20 – 0:32:23)

This sequence also took place during the last regular session. Different parts of the group’s virtual campus are already finalized and the group is now reviewing the changes and additions made since their last joint meeting. The discussion focuses on the buildings created by S9.

In this sequence the group aims to narrow down an idea developed before. They already have a common history of developing the prototype and are aiming to ensure a common understanding, which they want to represent in the prototype to be communicated to others. The group treats the prototype as a means to represent a pre-established idea, whereas the artifact enforces a translation of their ideas into the digital medium. The idea is first represented in words and is then supposed to be materialized in Minecraft in order to be communicated to others. At the beginning of the sequence they doubt that the prototype already fully conveys the idea, which was established in the group, to others. By their design decision (line 3: “do you still want to put up a sign”), they want to make sure, that the idea is represented
unambiguously. However, at the end of the sequence, there is a notable shift in the way the artifact is used. In line 16 a quality is mentioned (individuality) which cannot directly be translated into the given medium. They refer to it as “our idea of individuality”. The prototype now works as means to negotiate understanding to ground the participants’ joint discourse. They ask each other how their idea of being individual can be materialized in the prototype and aim to avoid misunderstandings. In this sequence, the role of the artifact is multifunctional and in flux as the analytical problem becomes more complex. The notion of individuality, the students deem relevant, cannot be directly translated into the world of Minecraft (even if the students argue they could) but needs to be transformed in order to be materialized. The artifact calls for transformation even if the students suppose to be able to represent an abstract idea presented with words. Nevertheless, the group does not form arguments of how an individual lifestyle relates to learning and teaching.

**Sequence 3 (Group 2, 08.01.2015, Runtime: 0:02:49 – 0:06:22)**

The following sequence took place right in the beginning of the building phase. The students had already created a map of the envisioned campus on paper and are now discussing on how to realize their ideas in Minecraft.
In this sequence the students aim to represent their previously drafted ideas within the virtual world of **Minecraft**. Their discussion is based on their assumption that they will use the artifact as a representational device to reproduce (or reproduce partially) their pre-established idea (using words like “indicate”, “correspond”, “not final or complete”). “Not complete” implies that it could be complete – thus, even if it does not correspond, they implicitly presume that they could distinguish whether it will correspond or not. According to their arguments, building is only a question of adapting their pre-established idea to the specific scale, perspective and available space presented in **Minecraft**. As space can be enhanced subsequently in the virtual world, the group contends that they only have to choose a starting point: their discussion is based on the assumption that, if only the specific perspective and scale presented in **Minecraft** is understood well enough and if handling is figured out and if only the first step will be taken, they will be able to construct step by step what they already have in mind, translating it directly to the perspective presented in **Minecraft**. The idea is well established with words and in an outline on paper. The words used in the group discussion are quite common (and perfectly denote contemporary/typical universities) as long as they refer to their pre-established idea (such as “faculty”, “administration building” and “canteen”). But as soon as their process becomes transactional, being confronted with **Minecraft**’s materiality, they are not able to advance their knowledge object. Whenever they aim to start building they lack words. At the end of the sequence, there is no material outcome and prototype created within the virtual world. They did not manage to materialize any of the issues they discussed. Whenever they aim to materialize the verbal matter, questions arise which cannot be well addressed with the given words.

**Conclusions and Implications**

The creation and work on shared artifacts is essential to many forms of collaborative learning. This also holds for the use of virtual gaming environments such as **Minecraft**, which are already used as creative sandboxes for educational purposes and collaborative assignments (cf. Robinson, 2014).
However, without a clear understanding of the constitutive entanglement of material artifacts and the epistemic practices they are used in, it is difficult to assess the utility of respective environments and to device fruitful pedagogical strategies. The examples discussed in this paper illustrate that the material artifacts neither determine students’ practices in any straightforward manner nor are they fully at the students’ disposal and can be formed arbitrarily. Both, the function as well as material qualities are not static attributes, but bound to their actual utilization. As indicated, the artifacts do not simply fulfill an envisaged function, such as to represent students’ preconceived ideas about the university, but they might give rise to new questions due to their material form and corresponding resistance. In precluding direct translations, for example of abstract notions such as individuality, the material artifact can trigger more in depths elaborations and reflections. At the same time, the perceived qualities of the artifact might also foreground certain aspects, while masking others, such as the static and structural over procedural dimension in Minecraft. However, the creation and work on shared artifacts might be a necessary condition for collaboration, but not a sufficient one for learning. As I evident in the examples, students’ discourse entailed hardly any substantial argument for or against a certain design decision. As a consequence, asking students to create a shared artifact and to materialize their idea, does not ensure that the artifact becomes an epistemic object for articulating and transforming conceptions in the subject matter. In contrast to deterministic perspectives and a technicist form of education, it is also not a question of choosing the right material or artifacts to trigger the intended type of discourse. Instead, becoming serious about the constitutive entanglement of the material and the social requires the teacher to become sensitive to the processes of transaction in which the students are enrolled and to query into and challenge students’ argumentation in relation to the artifacts they are creating and the ideas they are materializing. An educational perspective then entails not simply to define the materials to be used („using the gaming environment“) but to become aware and responsive to the material qualities that emerge from the practices we and our students are involved in. In our further data analysis we focus on students’ arguments regarding their conception of the subject matter (pragmatic, social and pedagogical issues of higher education).

References


Towards Improved Literacy in Computer Programming Among Artists

Elliot Gertner (Ventura College) & Ventura Patrician Waterman (Santa Ana College)

Abstract

Artists are creative people who excel in creating very complex 3D images, animation and sound presentations but find it difficult and cumbersome to deal with low-level programming details. Visual programming techniques (also known as visual studios) are visual only to the coders with computer science backgrounds; to the artists, visual studios still look like a medical prescription and taste like medicine. Recent releases in visual game programming environments and game engines such as Unity, Unreal, and GameSalad appear to be promising to advance the art of programming to non-programmers. In this paper we share our plans and preliminary experience in those game engines to build a community college level course in programming for artists and other non-CS majors.

Introduction

Games/Interactive Media production requires both artists and computer programmers; however finding programmers to team with has become an increasingly difficult task. According to the Bureau of Labor Statistics, the demand for programmers is twice as large as the demand for multimedia artists. This trend continues today as there is a severe shortage of programmers. As a result, artists are finding themselves having to take on some of the responsibilities that were once handled solely by a programmer. Job postings for digital artists are now requesting applicants to possess a “working knowledge of computer programming”.

In pursuit of a game design course for artists and other non-programmers, we have reviewed existing literature on game development. The benefits of learning by using digital game design are described in Digital Games (Clark 2015). Preliminary experience in teaching high-school teachers to teach game design are described in The Iterative Design of Eight Week Course (Aubrecht, 2015). An interdisciplinary video game design program has been developed in the University of Texas as a collaborative program between the Computer Science and Arts Department (UT-RT, 2013-2016). An attempt to improve communication between Computer Science and Arts students has been developed in California State University Long Beach as an interdisciplinary course in Software Engineer (Gertner 2016). In addition to the research experiences described above we have also reviewed commercial instruction book of the type, Sams Teach yourself game development in 24 hours (Unity, Unreal, GameSalad). We contrast these high-level game engines with very low-level programming library such
as the Simple DirectMedia Library (SDL 2013) which is suitable to use with general programming languages. Using these experiences referenced above we plan to develop a community level course for artists, to teach them programming skills.

In the remaining portion of this paper we propose an outline of the course and invite the conference proceedings readers and conference audience to share comments with us. In particular, we focus on the logic control tools in game design. We found these tools in game engines are very high level but rigid in contrast to the programming language tools such as Simple DirectMedia Layer (SDL) that are low-level but very general – one can program anything (SDL 2013). The challenge is to find a happy medium, a general programming interface that is understood and liked by both the artists and computer programmers.

Course Outline

This section reviews two example of course outlines. Existing courses in video game programming are very similar to the courses in film production. Although the course below starts with an introduction to computer programming and ends with a game demo, the bulk of the material is about tools for digital media; see an example below.

Game engine-based course outline:

- *Introduction to Computer Games*
- *Animation Techniques*
- *Simulating Physics*
- *Graphical Sprites, Game Worlds, Game Intelligence*
- *Analysis, presentations and demos of Sample Games and Student Projects*

That the above looks like a movie production course is not a coincidence because the faculty in Arts have a lot of experience in movie production. This experience naturally leads to a course that looks like a video game production. Although such courses do teach some skills for jobs in video game studios, they do not teach programming. And the gap remains between the artists and computer programmers.

We have examined tutorials for game engineers such as GameSalad, and we found that the programming tools are often hidden in advanced sections that are frequently overlooked by both the faculty and students. Furthermore, programming tools are very rigid and do not lead themselves to general programming. For example, GameSalad limits the behaviors to the following three types: rules, persistent behaviors and action behaviors. These behaviors appear to be very limited to a computer programmer. This is in contrast to programming with SDL, which is oriented towards the programmers.

SDL Book Outline:

- *Introduction to SDL*
• Drawing
• Exploring movement
• Handling game states
• Data-driven design
• Game examples: creating Alien attack, creating Conan the caveman, etc…

SDL programming and game engine programming are two different worlds that are vastly apart, in spite of the fact that both intend to help an artist or a programmer to implement a video game.

Discussion

In this presentation we focus on the programming logic control tools in game engines such as Gamesalad, Unreal and Unity and compare it against generic programming tools and libraries such as the Simple DirectMedia Layer (SDL). We find that game engines are very high-level and easy to program but are not flexible, while SDL interfaces are very low-level but are difficult to program and are typically taught in the computer science departments. In this presentation, we are in search of a happy medium that is acceptable to both artists and computer programmers.

References


UT-RTF (2013-2016) Game and Mobile Media Applications Program (GAMMA). University of Texas Interdisciplinary undergraduate certificate program in video game design.


Mission HydroSci

Designing a Game for NGSS

James M. Laffey (University of Missouri), Troy Sadler (University of Missouri), Sean Goggins (University of Missouri), Joseph Griffin (University of Missouri), So Mi Kim (University of Missouri), Justin Sigoloff (University of Missouri), Eric, Wulff (University of Missouri), & Andrew Womack (University of Missouri)

Abstract

Mission HydroSci is a game-based 3D virtual environment for supporting student learning related to water systems and scientific argumentation. Scientific argumentation is a central epistemic practice within science and necessary for the kind of science learning envisioned by the Next Generation Science Standards (NGSS). Our poster discusses our progress in year 1 of a funded project to develop a game for middle school science as well as presents critical lessons learned.

Introduction

The recently developed Next Generation Science Standards (NGSS Lead States, 2013) provides a vision for science teaching and learning in the 21st century. Central to this vision is the necessary linkage of disciplinary core ideas, cross-cutting themes, and scientific practices. Based on this framework, the primary focus of science education should be to create opportunities for students to build understandings of the big ideas of science, apply principles that cut across science disciplines such as causal reasoning and scale, and employ scientific practices. Meeting these new science education goals requires rich learning contexts for exploring substantive science ideas through engagement in scientific practices. Virtual learning environments (VLE) can be leveraged to create these rich contexts and gameplay can motivate students to explore and build understanding of core ideas while using science practices to transform these environments and solve problems.

MHS is a game-based, 3D virtual learning environment and curriculum that instantiates the vision of integrating students learning of core ideas (water systems science) with the use of science practices (scientific argumentation). MHS is being developed for middle school science as a replacement unit of about 12 to 15 hours of instructional time. MHS is being developed in Unity and includes narrative-based game play, learning progressions for water systems science and scientific argumentation, a teacher support system, and learning analytics.
Game Play (brief)

Student-players will be engaged in a narrative about needing to explore, develop and manage water resources on a distant planet in the face of water shortages and subsequent strife on earth. The game play is setup as a series of missions such as exploring and defining the qualities of a watershed, tracking a pollutant in a watershed, and locating and developing an aquifer. These missions are the context and methods for meeting learning objectives and building understanding about water systems. As they undertake these missions the student-players are given construction, investigation and exploration tasks through which they acquire data. For example in a pollutant-tracking task they traverse the terrain of a watershed placing sensors at various points in the river and stream systems. The output of these sensors and their placement locations along with information collected from various non-player characters or resource materials become data and evidence for use in arguing where and how to eradicate the pollutant or for arguing that the problem has been solved and the mission can continue. Figure 2 shows some sample elements of the MHS environment.
Lessons Being Learned

In the short space of this 2-page poster prospectus we will limit our discussion to 2 key lessons. The first lesson is in the need for strong and persistent communication/feedback between the various sub teams of the project. As with many software development projects we began with a flexible but document driven process. The various sub teams would be responsible for generating design documents which would advance in technical detail until they specified the software to be produced. Unfortunately the coding, art development and narrative work for our 3D VLE has been rather time consuming and the sub teams contributing to the design were not getting feedback in sufficient time to understand how to design the next elements. This feedback process is critical for curriculum designers to see and understand what is possible and what are the implications of various design decisions. We knew that MHS was a co-construction and iterative task among curriculum, game narrative, art work, software development and analytics, but we were not being as successful as we needed for each element to get feedback for improvement and taking on the next challenge. We are taking several steps in response to this need for process improvement. We are redesigning some of the aspects of MHS so they will be easier and more rapidly developed. We are including more cognitive walkthroughs of the game play elements at earlier points in development so the full team can see and discuss what is being said and what is being heard from within the design documents. And finally, we are placing more emphasis on getting artwork rapidly into the process, from sketches that curriculum team members might make of river systems to 3D artwork being developed for representations in the game. These changes are helping to make feedback and communication in our design process more rapid, more targeted and more visual.

The second lesson addresses the need for developing a huge amount of artwork along with needing that artwork in early visuals used in the design process, storyboards, and quality assurance testing as well as having it ready for usability testing when kids will actually experience the game. The problem with only having art products ready for usability testing is that their integration with other elements of MHS, such as how well they represent the curriculum concept or how they shape the experience of the player cannot be understood until far down the road. Our approach to improving this process is to see the artwork more as a process than as a product and moving it through various iterations from concept art to initial 3D representation, to more and more textured versions.

Acknowledgements

The work described herein is supported by the US Department of Education’s Institute of Education Sciences (R305A150364) and Investing in Innovation (i3) program (U411C140081). The ideas expressed are those of our project team and do not necessarily reflect the views of the funders.

References

Testing an Educational Videogame in a Setting with Limited Technology Access

Hugo Enriquez (Universidad Galileo Guatemala) & Ali Lemus (Universidad Galileo Guatemala)

Abstract

Using videogames as a learning tool is not new and it has been shown to be effective in most cases; however the setting and environment in which these tools are used seems to have a great impact on the results. Using our own serious educational videogame, a study was conducted in a rural (low SES) school where students have limited access to computers and technology. The main objective was to assess if the involvement of students with videogames in rural schools could result in an increase in performance and such increase could be maintained. Results indicated that indeed there is an increase in performance and in most cases it is sustained.

Introduction

In a previous study the use of videogames in education seems to improve the user’s cognitive abilities, it has an impact in rational decision making and general performance in education (Spence & Feng, 2010). The capacity of affecting cognition and even the subject’s behavior resides not in the potential, but in the popularity of the game, (Green, Pouget, & Bavelier, 2010). The most interesting fact is that the combination of a game play experience, with the learning content, increases the general understanding of such material (Wouters et al, 2013). The majority of educational game developers choose the game’s content based on needs analysis, they develop the core game mechanic primarily with play testing and it is suggested that a systematic collaboration between teachers and game developers is essential to achieve better educational games (Kinzer, Hwang & Chantes, 2015).

Guatemala is an underdeveloped country, it struggles in a variety of fields most notably health and education (CIA World Fact Book). In 2015, only the 51.6% of the population lived an urban area, the country has a median age of 21.4 years and a fertility rate of 2.9 children born per woman. Rural schools in Guatemala have limited access to technology and most of the students from these schools have never use a computer before.
Objectives

The main objective of the study was to verify if the use of an educational videogame in a setting with limited access to technology (computers and internet) could have an impact in the learning process and if the impact would persist afterwards.

Procedure and Subjects

A new serious educational videogame, Cerebrex was developed in conjunction with Elemental Geeks, which consists of 12 minigames, each one of one minute duration and could be played indefinite times, the minigames focus on numeric, visuospatial, memory and rational areas. Cerebrex reached semifinals at the ECGBL (European Conference on Games Based Learning) in 2014. A rural school in Patzun, Guatemala was chosen for the study, since the school does not own a computer lab, simultaneous work and collaboration was held with the local municipality in order to have access to a public computer lab. An agreement was reached to allow the students to use their installations.

The target audience was 6th year students, a total of 118 students participated in the experiment. All students took the general aptitude test Factorial Evaluation of the Intellectual Aptitudes (FEIA, Santamria, et. al, 2005) in order to measure their cognitive abilities in the numeric, visuospatial, memory, verbal and rational areas. After taking the test the students were taught how to use the game and given access to the videogame for 10 weeks. After this period of time, all students took the general aptitude test again concluding phase 1. In phase 2, the access to the videogame was suspended for 10 weeks and at the end of this time, they took the aptitude test again.

Results

The mean age of the subjects was 13, with a range of 10 to 17 years old, 45% of the sample were girls and 55% were boys. The results showed that as hypothesized, playing the game had a marked increase in several of the subtests, and, what is more important this increment was sustained after 10 months. To see if the effects in phase 1 and 2 were significant an analysis of repeated measures was used. The difference is significant. Analyses were run also to look at the effect of age and gender, but those variables did not have an impact in the results.
Comparing the means from the results of the first and second testing, it was found that there was an increase, thus the student’s performance improved after playing Cerebrex for 10 weeks. Comparing means from the results of the second and third testing, it was found that there was an increase only in the visuospatial and numeric areas, the mean in the memory, verbal and rational areas slightly decreased. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean significant difference in all test areas, the numeric test ($F(1.95, 159.79) = 36.97, p = 0.00$), verbal $F(1.98, 162.31) = 28.04, p = 0.00$), in visuospatial ($F(1.98, 162.07) = 42.27, p = 0.00$), memory ($F(1.86, 152.10) = 9.51, p = 0.00$) and the rational area ($F(1.97, 161.30) = 7.89, p = 0.001$).

**Discussion and Conclusion**

The results of the study suggest that there was a statistical significant increase in performance, as was expected to be present during both, the second and third testing. Such increase occurred in all test areas, however it was unexpected the effect found in the verbal area, given that Cerebrex does not include any minigame that could be categorized as verbal or to specifically target verbal stimulation. Playing Cerebrex was a first time experience with computers for many students, this may be a limitation of the study and in a subsequent study should be considered. Changing the game mechanics for certain minigames could be an area for future work. Testing a completely new game, which can focus more on verbal stimulation, could be interesting to develop as these skills are of paramount importance to all future learning.

<table>
<thead>
<tr>
<th>Area</th>
<th>Phase</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numeric</td>
<td>1st Testing</td>
<td>3.94</td>
<td>1.91</td>
</tr>
<tr>
<td></td>
<td>2nd Testing</td>
<td>5.58</td>
<td>2.23</td>
</tr>
<tr>
<td></td>
<td>3rd Testing</td>
<td>6.43</td>
<td>2.31</td>
</tr>
<tr>
<td>Visuospatial</td>
<td>1st Testing</td>
<td>5.35</td>
<td>2.24</td>
</tr>
<tr>
<td></td>
<td>2nd Testing</td>
<td>7.81</td>
<td>3.77</td>
</tr>
<tr>
<td></td>
<td>3rd Testing</td>
<td>9.01</td>
<td>2.92</td>
</tr>
<tr>
<td>Memory</td>
<td>1st Testing</td>
<td>6.31</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td>2nd Testing</td>
<td>7.84</td>
<td>3.11</td>
</tr>
<tr>
<td></td>
<td>3rd Testing</td>
<td>7.52</td>
<td>2.58</td>
</tr>
<tr>
<td>Rational</td>
<td>1st Testing</td>
<td>5.53</td>
<td>2.53</td>
</tr>
<tr>
<td></td>
<td>2nd Testing</td>
<td>6.86</td>
<td>2.96</td>
</tr>
<tr>
<td></td>
<td>3rd Testing</td>
<td>6.43</td>
<td>2.67</td>
</tr>
<tr>
<td>Verbal</td>
<td>1st Testing</td>
<td>4.84</td>
<td>2.68</td>
</tr>
<tr>
<td></td>
<td>2nd Testing</td>
<td>7.14</td>
<td>3.26</td>
</tr>
<tr>
<td></td>
<td>3rd Testing</td>
<td>6.81</td>
<td>2.59</td>
</tr>
</tbody>
</table>

*Table 1. Summary of descriptive statistic results*
References


Paper presented at the 8th European Conference on Games Based Learning 2014 Berlin, Germany
Towards an Understanding of Player Decisions and Learning During Video Gameplay

The Gamer Response and Decision Framework

Sam von Gillern (Iowa State University)

Abstract

This paper presents the Gamer Response and Decision (GRAD) Framework as an approach to examining video gameplay experiences with an emphasis on gamer interpretation, decision-making, and learning processes during gameplay. The GRAD Framework draws from Rosenblatt’s Reader Response Theory and concepts from new literacies, psychology, and game studies. This framework posits each gamer has a unique experience during video gameplay, as all gamers have unique knowledge, experiences, skills, goals, and sense of agency and self-efficacy that influence their interpretations, decisions, and learning during gameplay. The gamer’s decisions affect how the game unfolds, which feed back to the gamer in the form of unique experiences and perceptions. Gamers learn about the video games and strategies for success through this recursive process of interpretation and decision making.

Introduction

Scholars have developed a deep interest and appreciation for video games in learning and teaching in recent years (Gee, 2007; Squire, 2011). Gee (2007) illustrates that video games incorporate learning principles, which engage gamers and help them progress during gameplay. Steinkuehler (2007) notes that gamers regularly communicate and interpret a variety of symbols during video gameplay, representing a “constellation of literacy practices.” The recognition that people learn and engage in valuable personal and social processes during gameplay is valuable, particularly given the immense popularity of video games.

The Gamer Response and Decision (GRAD) Framework

The GRAD Framework (see Figure 1) was inspired by Reader Response Theory (Rosenblatt, 1995) in conjunction with the recognition of the critical importance of gamers’ decisions during video gameplay. It also draws from a variety of ideas from new literacies, psychology, and game design, all to help illustrate the complex processes players experience during video gameplay. (Note: see von Gillern, in press for an in-depth examination of the GRAD Framework and its background.)

Playing and progressing in video games is a learning experience. The GRAD Framework posits this learning process is influenced by the gamer, his or her decisions, and the game. The gamer interprets
the game’s multimodal symbols, and makes decisions based on those symbols. The game responds by providing multimodal feedback, which the gamer learns from and uses to make further decisions. This is a cyclical process and a learning experience. Ultimately, the gamer’s decisions have a profound impact on how the game unfolds and their overall gameplay experience.

Gamer

Every person, every gamer is unique. Everyone has their own background, their own knowledge, experiences, skills, goals and sense of agency and self-efficacy. These features influence people’s perceptions and decisions in life, whether they are at school, the workplace, or even playing video games. Furthermore, these features impact how people learn, as, for example, one’s knowledge, skills, and goals influence how they interpret their environment and which opportunities they pursue. Thus, these are all important features that have significant implications for perceptions, decision-making, and learning processes both in everyday life and video gameplay.

Decisions

A gamer’s ability to make decisions that truly impact the game sets video games apart from more traditional media, such as movies, books, and music. These types of media are created and authored by individuals and groups, and the audience cannot change the outcome. Video games are different. Decisions are a critical part of video gameplay in which a gamer’s decisions (e.g., deciding to take a particular path, upgrading some avatar attributes instead of others, and choosing character dialogue) truly affect how the game unfolds. Furthermore, a gamer’s decisions influence which multimodal

Figure 1. The Gamer Response and Decision Framework (von Gillern, in Press). Reprinted with permission from Simulation & Gaming.
Game

Each game has its own unique combination of features that facilitate gamers’ interpretations, interactions, decisions, and learning. Gamers interpret these features through the game’s multimodal sensory display and feedback. This information conveys game mechanics, story and dramatic elements, opportunities for personalization, and opportunities for social engagement. In combination, these features can be interpreted as the game’s profile. As each game has a distinct profile and each gamer has a unique background that influences his or her gameplay decisions, every one’s video gameplay experiences are different.

Conclusion

The Gamer Response and Decision (GRAD) Framework illuminates complex features and processes of video gameplay experiences, including decision-making, multimodality, and learning. Given this, researchers from a variety of fields including education, game studies, and game design may find this framework useful in their investigations of how people play, make decisions, and learn while playing video games (see von Gillern, in press for potential GRAD Framework applications).

References


How Joint Media Engagement Helps Children “Cope with Pokes”
Ben J. Miller (University of Iowa), Kirsten Hanrahan (University of Iowa), Ann Marie McCarthy (University of Iowa), & Benjamin DeVane (University of Iowa)

Abstract

Most children experience painful medical procedures as part of their routine health maintenance. Adults can help reduce a child's distress through distraction coaching; a technique to divert their attention away from the painful stimulus and engage in something more rewarding. Mobile apps are widely available and a useful tool for capturing the attention of children in unique ways. The principles of Joint Media Engagement offer insights for increasing the efficacy of iPads in distraction coaching by promoting co-engagement of media that sustains a child’s attention during painful medical procedures.

Introduction

Most young children experience a number of painful medical procedures, such as immunizations and IVs, as part of their routine health maintenance. Inadequate pain management related to these needlestick procedures can create anxiety, behavioral distress, and may have negative long-term consequences for the child (Taddio et al., 2012). Despite research to support interventions for acute procedure-related pain in children, it remains undertreated (Stinson et al., 2008). Distraction, wherein attention is diverted away from the procedure, is a relatively simple and effective cognitive behavioral intervention for reducing pain and distress in young children (Stinson et al, 2008). Parents typically want to help their young child during medical procedures and many can be trained to be a “distraction coach” (DC) for their children (Kleiber et al., 2007). The increasing prevalence of mobile devices, such as the iPad, offers a unique tool for providing distraction via digital media and games.

Joint Media Engagement (JME) is a framework for learning with media that refers to the “spontaneous and designed experiences of people using media together…. [that] can happen anywhere and at any time” (Takeuchi & Stevens, p.9, 2011). In order for JME to occur there needs to be a partnership between adult and child that influences interest in the media and sustains mutual engagement. Principles of JME contend that the games and media should highlight a child’s interests, allow for multiple planes of engagement, and encourage cooperation towards a common goal through content with narratives that span time and settings while easily fitting into existing routines. Although JME has been researched in the home, little is known on how parents might utilize these strategies for sustaining their child’s interest during times of anxiety or distress. What strategies do adults use to engage children in iPad apps during needlestick procedures and how might they relate to principles of JME?
Problem/Purpose

Although parents recognize distraction can reduce distress, they are often unable to sustain their child’s attention throughout a painful medical procedure. This intervention employs a validated mobile web-app, called Children-Parents and Distraction (C-PaD), which is currently undergoing testing for feasibility in clinical settings in ongoing research (Hanrahan et al., 2012). The C-PaD app both teaches parents to use games and media as a distraction in a healthcare situation, and assesses a child’s risk for distress during a procedure. Parents decide whether they, or a trained healthcare professional (HCP), will act as the distraction coach for their child. This specific analysis provided a unique opportunity to observe what strategies adults employ with digital media in order to distract children during procedures.

Methodology

Six participants were adults who accompanied a child 4-10 years of age during a venipuncture procedure in the Pediatric Specialty Clinic at a Midwestern university teaching hospital. This sample was comprised of five individual parents and one trained HCP. After receiving education regarding distraction coaching participants determined who would be the DC during the procedure. This DC was then prompted to utilize game apps (e.g. arcade, puzzle, and endless running games) on the iPad to distract a child during a scheduled needlestick procedure. A research assistant recorded observations during the procedure regarding the child’s engagement with the iPad, the DC efforts to engage the child, and the apps used for distraction. After the venipuncture, all parents completed a 14 item evaluation of the C-PaD used for the primary research analysis. The evaluation was comprised of 12 yes-no questions, an open-ended question, and a rating of the child’s distress during the IV insertion.

Within 24 hours after the encounter, the adults were contacted by phone for a recorded interview. This interview consisted of 10 semi-structured questions that were designed to engage the participants in reflection about their experience with the iPad. Question examples include, “What strategies did you use to engage the child in the iPad apps?” and “What interfered with keeping the child’s attention on the iPad apps?” This focus on adult behaviors addresses the purpose of this study and its guiding research question. All phone interviews were audio recorded and transcribed. The open-ended responses from the interviews were coded using content analysis to further explain the quantitative data from the responses collected on the C-PaD.

Analysis

We are applying a mixed method approach to identify and evaluate the different strategies used to distract children with an iPad. Descriptive statistics will be utilized to analyze quantitative data from the C-PaD evaluation. Descriptive quantitative analyses regarding the parent evaluation is being conducted by the study team, and will be presented. Descriptive qualitative content analysis will be applied to qualitative data from the parent. Inductive content analysis was used to identify themes in the interviews via a process of open coding, category creation and a general abstraction of the meaning of the information.
Current Findings

Preliminary findings suggest that the parents (n=4) who chose to be the DC adopted passive strategies for distracting the child and took a hands-off stance toward game play. In contrast, the behaviors of the trained HCP were consistent with principles of JME. When the HCP was the DC (n=1), they highlighted the child’s interests, differentiated the roles of the child and DC, and encouraged cooperation towards a common goal, all while fitting it into the existing routine of the procedure. The parents acting as DC described their strategies as trying to “take their mind off things” and “hold the iPad in front of him”. These indicate the parents’ role as a passive support for engaging their child. However, the parent who chose for the HCP to be the DC was able to identify the behaviors consistent with principles of JME. This distinction in the parent reflections is interesting because it may indicate that being a DC limits their ability to identify useful strategies.

Preliminary Conclusions & Ongoing Research

This preliminary analysis suggests that while parents may not be able to initiate these JME strategies on their own, they are able to recognize their effectiveness when modeled by an experienced practitioner. We are still enrolling participants and further analysis and interpretation of the rest of this data is needed before the results can be reported completely. However, the implication of these initial findings is that the principles of JME may be a promising framework for the kind of interactions that best support distraction coaching using an iPad. Additionally, future education regarding distraction coaching using mobile devices might illustrate these principles as strategies that parents can use to facilitate more effective distraction and reduce distress.

References


How do Pre-K Teachers and Students Experience Literacy Games?

Exploring affordances of table games in a preschool classroom
Katherine Sydik (University of Nebraska-Lincoln)

Abstract

The purpose of this qualitative instrumental case study is to examine affordances of literacy table games in a preschool classroom environment and experiences of students and teachers playing the games. The study explores factors relating to games and play, developmentally appropriate practice, emergent literacy skills, motivation, cognition, and sociocultural considerations. Themes will be based on observations of classroom game play and interviews with preschool children and teachers. The study will provide a broader understanding of games-based play in early childhood classrooms, help to develop informed best practices for similar activities, and provide implications for future inquiry.

Background

Considerable disagreement exists regarding effective preschool instruction (Dickinson, 2002). There has been a dramatic shift toward earlier instruction over the last decade. Phonological awareness skills are important for early reading development. Failure to develop basic decoding skills by first grade is predictive of lifelong poor literacy (Lonigan & Shanigan, 2009). Partly as a result of this shift, there has been a significant backlash against teaching in preschool, pitting an “academic approach” to early childhood education against a “play approach” to early childhood education. Focus on cognitive skills may undermine important benefits of play non-cognitive skills such as social and emotional competencies (Ziegler & Bishop-Josep, 2004). The best approach, as recommended by the National Association for the Education of Young Children (NAEYC) may be a balance between skills instruction and play (Copple & Bredekamp, 2009). Games may serve as a valuable intersection between play and academic skill instruction, with advantages of learning actively through hands on manipulation, and opportunities to build foundational literacy skills through repeated practice that is not based around worksheets, drills, or standardized tests.

There is a wide body of research on benefits of play for children’s development, including literacy (Hirsh-Pasek et al., 2009; Roskos & Christie, 2000). Most of this research, however, has been focused on free play or dramatic play. Literacy games are frequently recommended best practices for early childhood education, but detailed descriptions are often not provided, or could be more accurately described as game-like activities than formal games with structured rules. Games-related research over the last decade has demonstrated many educational benefits of games, though most of this research focuses on digital games and does not typically address preschool age children (Gee, 2003). The report from the Joan Ganz Cooney Center showed that teachers are using games, but the report did not look at
games in non-digital format or at the preschool level (Takeuchi & Vaala, 2014). Research on table games with rules at the preschool age is limited. Different delivery methods, subject areas, and target audience could result in different outcomes. As noted by Pellegrini (2009), further research is needed to address gaps in the literature in the area of play and games.

**Purpose for the Study**

The purpose of this research is to understand the affordances of table games for early literacy instruction at a preschool level, and how these affordances positively or negatively impact the experiences of students and teachers playing the games. This study will inform early education teachers’ and parents’ expectations of good games for influencing children’s development, useful insights to game designers in developing literacy games better suited to the needs of the preschool age range, and add to the literature research on games and learning. The central research question this study explores is: “How are literacy table games experienced by learners and teachers in a preschool setting?” In particular, this study focuses on affordances of table games for preschool children related to factors of game play, developmentally appropriate practice, emergent literacy skills, motivation, cognition, and sociocultural contexts and the experiences and behaviors of preschool learners and teachers in these areas.

**Methods and Data Collection**

The current study was carried out at a (NAEYC) accredited laboratory preschool using a multiple instrumental case study qualitative design. Observation of experiences in naturalistic settings and open-ended questions allow an opportunity for participant voices to be heard, which should yield important insights in terms of motivation, learning, and pedagogy, and lead to deeper understanding of the needs of the preschool age range and which affordances of table games are suited to meet those needs. In order to gain multiple perspectives, both preschool children (primarily 4-5 years old) and their teachers were recruited using an opportunistic, purposeful sampling approach. Literacy tabletop games were demonstrated to teacher-facilitator participants before they were played with children. Later, teacher facilitator participants played the games with students in small groups while the researcher was present to observe. Play sessions were arranged and recorded for each game, and learner participants as well as teacher-facilitator participants were interviewed about their play experiences after the initial and subsequent game play sessions for each tabletop literacy game.

The games chosen for this research are *Appletters* (Nathanson, 2009), *The Super Why ABC Letter Game* (University Games, 2009), and *Tapple* (USAopoly, 2012). *Appletters* was chosen because children can actively engage with letter tiles as hands-on manipulatives. *The Super Why ABC Letter Game* was chosen because the simple roll-and-move mechanism may be familiar to some children, and multiple levels of challenge cards gives opportunity to flexibly target to individual children’s zone of proximal development. *Tapple* was chosen primarily to explore social interactions between children cooperating with their own team and competing against another team. While these games are among the most developmentally appropriate literacy board games currently commercially available, not all aspects of the games are ideal. The games to explore a wide set of affordances to give ideas for game design and pedagogy in terms of what is good, what should be avoided, and what could be improved. Teachers may make modifications to better suit the needs of the population and improve the game playing and learning experiences.
Final themes will be built inductively based on participant responses to semi-structured, open-ended questions. Codes at the paragraph or sentence level will be refined into themes using visual sorting methods and software. All forms of data collected in this study (interviews, observation field notes etc.) will be triangulated; Rich, detailed descriptions will be provided for the observations. Participant’s voices will be included to the greatest extent possible by providing direct quotes and using in-vivo language to represent codes, and themes. Emerging themes from the research relate to areas of activity and movement, peer helping, classroom management for games, game affordances, and experience gained through practice. Two qualitative peer reviewers will be sought to establish inter-rater reliability for codes and themes. Member checking of themes with teacher-facilitators is planned to assure participants’ experiences are accurately reflected (Creswell & Miller, 2000).

References


Literacy and Learning through Game Design

An Afterschool Twine Workshop

Kelly Tran (Arizona State University) & Mikaela Wallin (Arizona State University)

Abstract

This poster describes a research project based on an afterschool game design workshop. This workshop was intended to teach the tool Twine to 5th and 6th grade girls. Twine has been lauded as an accessible design tool, but thus far little research has been conducted on it. This mixed-methods study explores the ways in which girls engaged with the literacy and programming aspects of the tool, as well as the ways in which they brought their own Internet literacies and knowledge of pop culture to bear on the games which they made. Implications for teaching game design in and out of school will be discussed.

Twine

The game design tool Twine has been lauded as an accessible tool for game design (Anthropy, 2012; England, 2015; Ellison, 2013). The tool allows users to create text-based games and interactive stories by writing in plain English text. Stories written in Twine are similar to choose-your-own adventure books, in which the player is presented with choices about what to do in the story (for example, to cross the bridge, turn to page 34, to walk along the river, turn to page 85). Twine also allows users to use a basic, built-in programming language in order to use variables, if-then statements, and so on. With these, the game can keep track things that have happened in the game- whether a user has found a key to open a particular door, for example. Users can also add images, sounds, and videos to their games.

The tool has been taken up by a number of people who are not traditionally part of the game design community, including women (Kopas, 2015). However, little research has been done on women and girls making games with the tool. This poster is an overview of an after-school workshop held in a public school with 5th and 6th grade girls. In this six-week workshop, participants learned how to use the tool and make their own games and stories. Throughout the course of the workshop, the girls have used their existing knowledge of the Internet and technology in order to make their games.

Game Making for Literacy

While a number of scholars have framed game making as an important literacy practice (Gee, 2003; Salen, 2007; Squire, 2008), much less attention has been focused on the potential of video game making for learning. A number of authors (Gee & Tran, 2015; Burke & Kafai, 2014; Kafai & Peppler, 2012) have argued for the importance of making games for learning and literacy. This workshop was an attempt...
to give girls a space in which to construct their own knowledge and meaning in the context of making games. While each session of the workshop involved teaching the students how to use a particular feature of Twine, the girls were largely free to explore ideas and to access the Internet to look for information or inspiration.

Pop Culture and Literacy Practices

Many of the girls were interested in popular culture, such as music, movies, games, and books. A number of scholars (Black, 2007; Jenkins et al., 2006) have framed writing and production around pop culture as a rich literacy practice, and the ways in which girls practiced their literacy skills through making Twine games was a focus of the project. The girls drew inspiration from games that they played at home and with friends (Minecraft, Undertale) and from popular songs, which they watched videos of on YouTube during the sessions. They were also fans of popular internet memes, sometimes inserting references or humorous pictures into their stories.

This integration of their interests led many of the girls to express that the games workshop was a different space than school, even though it took place in their classroom. They expressed that it allowed them to experiment with ideas and explore topics they cared about. The fact that their games did not need to conform to school conventions (grammar, format, etc.) and did not have to be “school appropriate” (with rules such as “no one can be killed in your story”) meant that participants had a creative freedom which they reported enjoying.

Methods

This study employed a case study approach (Flyvbjerg, 2011). The individuals in the workshops (their individual interests and learning trajectories) as well as the overall workshop as a whole were both areas of interest. Data sources included field notes, video data, observations, and the games which students created.

Additionally, students all took an initial survey that assessed their interest in video games, stories, and computer programming. They also took a post survey which covered these same topics, as well as inquired about which topics and activities were favored by participants. All participants also took a follow-up survey that explored the questions of whether or not they continued to use Twine or any other game making tools after the workshop was over. This was followed by one final session- a focus group intended to further explore participants’ experience in the workshop and their interests and aspirations for game making in the future.

Findings and Discussion

Data analysis is still ongoing. The students’ games, and how these game were developed over time (games were collected from students after each session), were a central focus of the analysis. The questions of how girls developed literacy skills and game design skills, as well as their knowledge of how to use the tool, were key. Also of interest was the topic of girls’ games and how these relate to the girls’ everyday interests. The survey data, which were intended to be exploratory and descriptive, are currently being used to examine whether girls’ interest in stories, games, and programming evolved while participating in the workshop.
Finally, there are a number of implications that arise from this study. One, the girls’ enjoyment of and interest in exploring their own interests and topics in the workshop could have interesting implications for school, writing and even traditional literacy. Secondly, the enthusiasm that girls professed for programming and the creative potential of making games is noteworthy. Third, the notion of whether a workshop such as this could inspire girls’ continued engagement with and interest in game design beyond the end of the workshop will be discussed.

References


Out-of-school literacies back into classroom

Game, video and prosumer
Tieh-huai Chang (National Central University), Fei-Ching Chen (National Central University), & Ming-Fong Jan (National Central University)

Abstract

One of the core concerns in learning sciences is “What new types of learning have emerged in digital natives in the gaming generation?” There are varied ways to inquire into the question of they have learned. In 21 century, new way of reusing, remixing, and re-making information/game/image/video is in particular attractive to youths. This highlights the importance for educators and policy makers to understand where our youths are in terms of their capabilities to participate in the new media ecology. This capability can be conceptualized as prosumption. In this study, we empirically study the gaming generation bring their prosumption abilities into classroom. Prosumer is capable of intricately embedding his values and thoughts. Such insights are important and viewed as “a prerequisite” for effective participation in the 21st century information society.

Brief

The 21st century has marked an unprecedented advancement of new media. New media has become so pervasive that it has penetrated into every aspect of our society. New media literacy plays an essential role for any citizen to participate fully in the 21st century society. Researchers have documented that literacy has evolved historically in stages:

1. classic literacy (reading-writing-understanding);
2. audiovisual literacy (mostly related to electronic media);
3. digital literacy;
4. information literacy (mostly related to computer and digital media); and recently
5. new media literacy (mostly related to internet and the phenomenon of media convergence)(Chen, Wu, & Wang, 2011)

As Universitat Autònoma de Barcelona has suggested new media literacy can be viewed as a continuum from media “consuming” to media “prosuming” (Universitat Autònoma de Barcelona, 2007). “Consuming” media literacy refers to one’s ability to access media message and use media at various proficiency levels. The rapid advancement of information and communication technologies makes the issue of access less prominent.
“Prosuming” media literacy refers to one’s ability to produce media content, in addition to consuming skills. “Prosuming” is a notion first put forward by Toffler. A “prosumer” is both a producer and consumer whose “half of production is for exchange and half of production is for self-use”. Prosumers can produce customized media products themselves, taking full advantages brought about by new technologies.

Media prosumption has two aspects: creating/producing media content, and participating in media uses. For example, students may use media tools to create a “Game Tips” video clip and upload it to YouTube. The production involves the design of media content aligned with individual ideology, cultural background and purposes at hand. The consuming aspect is integrated and implied in the process of production.

In Taiwan, gaming generation students write Game Tips articles, make Game Tips video, record Game Tips live-show in their daily practice. Those not only are kind of interesting prosumption, but also is new type of learning. How people learn? Belonging to one of the core concerns of learning sciences (Wenger, 1998).

The aim of this study was to apply the concept “prosumption” to analyze the gaming generations’ perennial core enterprise, like re-creation comic story, remix parodies of MV/news, reusing game images etc. The selected case in this project is in a northern Taiwan national university teacher education course, students with rich experience about new media. To date, 24 participants were recruited. In this study, students need to design and manage a sixty minutes course based on their prosumption of some topic or media they really interesting. We conducted a series of data about their emerged teaching plan, presentation, peer-feedback, self-reflection, revised-plan, interviews, and field note to explore their practice experiences.

Prosumer is actively engaged in media-rich environment and effectively participates in new media space. He/she understands that he/she is constructing his interpretations and there is an ample space for negotiations in co-construction of understanding in a community. Prosumer is also capable of intricately embedding his values and thoughts and critically evaluates his language in conveying his beliefs and argument. Such insights are important and viewed as “a prerequisite” for effective participation in the 21st century information society.

The 21st century skills of new media literacy are the skills that provide citizens with the base of knowledge that they need to be effective participants in the 21st century around the world. It serves our purpose if this paper is stimulates more discussions on new media literacy, especially in prosumer – an essential skill that no one in the 21st century can afford not to have.

References


How a Storytelling Game is Played in a Preschool Classroom

Jeremy Sydik (University of Nebraska Lincoln)

Abstract

The purpose of this qualitative study will be to examine how early childhood learners and their teachers experience the play of a structured cooperative storytelling game in their shared classroom environment, with specific focus on cognitive and social knowledge construction. This study will use an instrumental case study approach to observe classroom game play sessions as well as qualitative interviews to explore the features of a cooperative storytelling game play activity, to ask how these features inform understanding of cognitive and social knowledge construction, to identify best practices for developing similar activities, and to identify implications for future inquiry. Thematic analysis of observations and interviews will be used to facilitate understanding of learner and teacher experiences in order to inform broader understanding of games-based play in early childhood classrooms.

Problem

Over the last twenty years, there have been many changes in the way that preschool and early grade school education approach academic skill development, focusing more heavily on explicit reading and mathematics instruction. As a consequence, and of deep concern to many educators, is the way in which skill oriented approaches have reduced the amount of time allocated toward play, particularly for early childhood learners. Some, such as Zigler & Bishop-Josef (2004) argue that this “evaporation” of play comes at too high a cost and that changes toward academic skill education have been at best ineffective in many cases, and may have an overall negative effect on school readiness.

Playing with Stories

The telling of stories is amongst the oldest tools for education and is still one of the primary methods of transferring content knowledge directly to learners as well as for modeling story elements in literacy development. While teachers often use storytelling only as an instructional technique, this use ignores the potential of learner-directed storytelling as a powerful framework for guiding knowledge construction from both cognitive and social perspectives.

One potential way to view this dual approach is in the context of Bruner’s narrative and paradigmatic
modes of thinking (Bruner, 1986). In Bruner’s model, the paradigmatic mode is representative of the practice of looking at story process as merely a bridge toward explicit literacy instruction. In contrast, the narrative mode—storytelling as a method for constructing notions of reality—speaks more strongly toward the other values of the storytelling practice that are readily practicable in dramatic and storytelling play experiences.

**Game as Structured Play**

One area of interest for bringing semi-structured play activities into the classroom is found in the area of games-based learning. This notion of games as a valuable tool in learning has been acknowledged in the learning sciences for nearly a century. Piaget (1965) specifically focused on how a system of rules and play with rules impacts moral development. Extending upon this work, Vygotsky (1966) proposed play more prominently as a central source and process of development in early childhood. Imaginative play is described in terms of the then-new model of the zone of proximal development. Vygotsky proposed that when children encounter a concept just beyond their ability to realize and while there is a desire for immediate realization of the concept, they use imaginative play to satisfy and explore the concept. This led him to comment “And so I would like to say that the creation of an imaginary situation is not a fortuitous fact in a child’s life; it is the first effect of the child’s emancipation from situational constraints” (p. 68).

**Statement of Purpose and Central Question**

In an educational era where the role of play and games-based learning in early childhood classrooms has been increasingly minimized in deference to so-called “academic” interventions, how can we better understand the role and utility of play in early education? Specifically:

- What can we understand about organized play in the form of a generative storytelling game?
- How does this inform our understanding of cognitive and social knowledge construction?
- What might be best practices in developing this form of activity for classroom use?
- What are the implications of these findings for future inquiry?

The central question of the present research is, with an eye toward issues of cognitive and social knowledge construction, how do early childhood learners and their teachers experience the play of a structured cooperative storytelling game using pictorial representations in their shared classroom environment? Specifically, how do the features of this form of play activity facilitate or guide social and cognitive construction of knowledge in the context of story generation and what are the positive and negative affordances of this approach?

**Methods and Data Collection**

A collective instrumental case study was selected to examine the central phenomenon at hand, the shared experience of young children and their teachers generating stories through the play of a table game. For the present work, the case is bounded by the play space of a single game session, where the
underlying issue is the emergent narrative play of the players. Sub-boundaries of the game play session are the experiences of the learners and of the teachers during game play. To obtain multiple perspectives of the phenomenon of creating stories through storytelling game play, both preschool learners and their teachers will be recruited. Participants will be selected purposely but opportunistically from the laboratory preschool of a large Midwestern university. Learners in the classroom are children primarily between the ages of 4 and 5 years. Teachers include the permanent staff of the laboratory school as well as teacher students, who teach at the school under the supervision of the permanent teaching staff in order to fulfill practicum requirements.

Following an introductory session to explain the game rules and interview regarding personal and teaching experiences with games and storytelling, each teacher will play at least two rounds of the game with learners in small groups of 3–6 children. Observations of the game play sessions will focus on the narrative constructed by players from the game symbols as well as the social construction of narrative by the group as elements are connected through the course of gameplay. At the end of each game session, learners will be interviewed as a group about the thoughts and feelings they experienced while playing the game. Further, the teachers will be interviewed one-on-one about their experiences and observations about the game session. An important part of this interview will be an opportunity for the teacher to give necessary clarifications regarding references or vocabulary local to the classroom culture that might be unclear to an outside observer. A follow-up interview will be conducted with the teachers to check for any other thoughts or considerations about the game sessions after they have been given time for reflection.

The game selected for classroom play was Rory’s Story Cubes (O’Connor, 2005). In terms of the theoretical model, this game provides a promising game space for narrative creation. It is minimally structured, allowing for player freedom. It has a short play time, allowing for more opportunities to create and contribute in a given time. Finally, it uses generalized pictorial elements which leave narrative options reasonably open while still providing a source for the learner to draw ideas from and eliminating dependency on the reading skills of the players.

Gathered observations and materials will be examined at unit level for emergent in-vivo language and imagery. This natural language will be translated into appropriate lean codes to extract themes for reflection in context of the central question. Particularly enlightening or representative quotes and observations reflecting these themes will also be noted for inclusion into the thematic descriptions. Understanding that each play experience will be unique, cross-case examination will then be performed, reviewing the codes and themes again to search for illuminating similarities and differences between the game play sessions. For validation and triangulation, initial drafts of case and theme discussions will be sent to the teacher participants for member checking and to ensure that their voices are appropriately reflected in the discussion. Because of the young age of the learners, the teacher participants and lab school director will also be asked to verify that the learners were accurately represented in the thematic analysis.

References


Building the Deck

Creating a Library Card Game for Outreach to Transfer Students
Kelly Giles (James Madison University Libraries & Educational Technologies), Kristen Shuyler (James Madison University Libraries & Educational Technologies), Andrew Evans (James Madison University Libraries & Educational Technologies), & Jon Reed (James Madison University Libraries & Educational Technologies)

Abstract

University librarians and staff drew upon previous experience with game-based learning to develop an orientation activity for transfer students. A card game was selected due to the large number of students expected and lack of computers in the available space. Apples to Apples-style cards were created using a free online card generator. Multiple decks were printed to accommodate up to 150 players. The game exposed transfer students to information about the campus library system in a low-key way that allowed players with different knowledge levels to socialize and compete against one another on an equal basis.

Background

Every August, James Madison University (JMU) provides a three-day orientation for transfer students. JMU Libraries participates in this event by offering an introduction to the campus library system as one of the concurrent sessions held during back-to-back 45-minute time slots. Past library orientations had consisted of a librarian giving a short talk and answering questions from students, but JMU Libraries has been exploring game-based learning (see McCabe & Wise, 2009; Giles, 2015) and it was hoped that a game could cover the same basic content in a more interactive and engaging manner. A game would also give transfer students an opportunity to get to know one another and build personal connections at their new school. Above all, this event was intended to help transfer students feel comfortable using the library.

About 50 students were expected for each session, although the Orientation Office had recommended preparing for up to 150 students. A game that involved exploring the library building (as in Giles, 2015) would be difficult with such a large group. Libraries at other institutions have used online games as part of their outreach efforts (Kearns, Kirsch, & Vidas, 2014; Martin & Martin, 2015), but there were no computers in the study area where the JMU Libraries orientation sessions were to be held. The most suitable activity for this event would be a tabletop game that required minimal set-up, was easy to explain, and could be played in small groups. Game materials would also need to be relatively inexpensive, as the budget was limited and multiple sets would be required to accommodate a large number of players.

Luckily, there was already a game of this nature in use at JMU Libraries, although it had not previously
been used for outreach. In 2014 a staff member created a card game for use at a student employee training event. This game, adapted from the popular party game *Apples to Apples*, involves selecting an answer card in response to question cards such as “What kinds of payments does the library accept for fines?” Some answer cards have factual information about JMU Libraries, while others reference popular culture and campus life. Players take turns judging which of the proposed answers they think is best. On a survey distributed at the end of the 2014 training event, a plurality (45%) of respondents said the game was the most helpful part of the evening (Evans & Giles, 2015).

Development

The working group for this project consisted of two librarians and two staff members, including the creator of the 2014 card game. As the game had originally been intended for library employees, the wording of many cards needed to be changed to reflect the perspective of library users. This earlier version also emphasized policies and had few questions about finding things in the library. Content was added to reflect the needs of transfer students, such as information about source types, plagiarism, subject specialist librarians, and how to connect to databases from off campus.

Cards were created using the online Fruit to Fruit Card Generator (http://a2a.browndogcomputing.com) and printed by the campus copy shop. After printing a “beta deck” the project team met to play through the game and make final revisions. An issue that quickly became apparent was the lack of any in-game mechanism for revealing the correct answer. There would not be sufficient staff available to serve as moderators for each group of players, as had been done at the 2014 training event. Ultimately it was decided that the correct answers would be printed on the backs of the question cards. The player serving as judge would keep the answer hidden. After the winner of the round was chosen, the correct answer could be revealed to the group.

Implementation

On orientation day, transfer students were greeted by employees as they entered the library and directed to sit at study tables in groups of four to six. Each group was provided with a sheet of instructions. After quick introductions and an explanation of the game from the session facilitators, the students began to play. The facilitators circulated around the room during the game to answer any questions that arose.

Students seemed to enjoy the activity, with lively conversation and laughter during the game. Some students asked facilitators detailed questions about the library that were inspired by the cards. Librarians and staff were able to conduct impromptu consultations for students curious about library services and resources. At the end of the session, each attendee received a handout of the questions from the game with the correct answers, a JMU Libraries bookmark, and a promotional Mason jar style water bottle.

Discussion

A card game was well suited to the time, space, and budget limitations for this project. Creating the cards was relatively inexpensive and did not require special technology skills. The popularity of *Apples to Apples* meant that little time had to be spent explaining the rules and students were able to help each other with questions about gameplay. This promoted conversation and allowed the game to continue with minimal interruption. The *Apples to Apples* format worked well for a short session where different
groups might be playing at different paces. If a group did not have time to play through the entire deck, a winner could still be declared based on who had been awarded the most answer cards.

The subjective nature of the judging and random selection of answer cards also meant that students with different knowledge levels could compete against one another. A player could win a round, or the entire game, without knowing the correct answers, as the judge might choose an incorrect but funny or plausible-sounding answer as the best one. In other instructional settings a game that rewarded the most knowledgeable player might be more appropriate, but a game where already knowing the right answer wasn’t required to win seemed a better way to welcome transfer students and help them to overcome library anxiety.

While further assessment of this game is needed to establish its effectiveness, the transfer students seemed engaged and entertained enough for the working group to consider this project a success. JMU Libraries plans to use the card game again for 2016 transfer student orientation, and one librarian has already used this game as an icebreaker activity in the classroom. Future projects may involve creating expansion packs for different subject areas with cards about discipline-specific library resources.

References


More than Me

Exploring Educational Possibilities through Multiplayer Location-Based Augmented Reality Games

Judy Perry (MIT Scheller Teacher Education Program), Lisa Stump (MIT Scheller Teacher Education Program), & Arjun Narayanan (MIT Scheller Teacher Education Program)

Abstract

Prior work on location-based augmented reality (AR) games demonstrates that even in simultaneous single-player games, in which non-networked mobile devices run independent parallel instances of a particular game, players can have meaningful educational outcomes. However, technical constraints of single-player modes constrain AR players’ role, peer, and team interactions, tasks within the game world, and place-based investigation. A digitally connected multiplayer game enables more nuanced, collaborative experiences by connecting players to a shared virtual world in which players communicate and coordinate across both physical and digital space, make choices affecting peer-players and the overall game state, and negotiate among limited virtual resources and shared spaces in the physical world. This poster describes the initial release of TaleBlazer multiplayer, outlines the rationale for its design affordances, and proposes future research around educational gameplay and game creation of complex location-based multiplayer AR games.

Background

Location-based augmented reality (AR) game platforms, such as ARIS, FreshAiR and TaleBlazer, track the current location of the player’s mobile device’s using GPS, QR codes, or other technologies, and provide digital content (e.g., interactions with NPCs, virtual objects, and digital information) based on the player’s real-world location. These immersive experiences leverage the interplay between the real and virtual, enabling game designers to craft experiences that integrate the real-world environment, including its landscape, natural elements, human artifacts, or history, into the overall gameplay experience (Klopfer & Sheldon, 2010; Holden et al, 2013).

Instructional Approaches in Single-player AR

Early work in AR games demonstrates how even single-player mobile AR games, which run their own non-networked instance of the game, offer meaningful social affordances as players coordinate and share information (Klopfer, 2008) and develop scientific argumentation skills (Squire & Jan, 2007). More broadly, researchers evaluating the educational applications of such AR games (Wu et al, 2013) classify three instructional approaches (roles, location, and tasks) where alignment across the technology, instructional approach, and learning experiences can promote educational outcomes. For
example, in Environmental Detectives (Klopfer, 2008), game designers create an immersive experience around investigation of a fictional toxic spill in which players take on a distinct role (e.g., a toxicologist) and investigate a specific location (e.g., a chemical spill on a college campus) through specific actions or tasks (gathering and interpreting virtual quantitative and qualitative information). Within AR games, collaboration and discourse among players can be vital to gameplay, enabling players to compare information, make decisions and more broadly to externalize their thinking and deepen engagement. Yet single-player modes may not offer players experiences which mirror more complex, real-world experiences such as communicating among a distributed team, sharing resources or allowing roles to perform unique tasks which impact each others’ game worlds.

Educational Affordances of One-World Multiplayer AR

The TaleBlazer team drew inspiration for its addition of multiplayer from two sources: prior work by the MIT research team as well as multiplayer features in other AR toolkits. First, researchers considered two examples of MIT’s prior work in which AR mobile game players were interconnected via a shared virtual world. In Outbreak @ MIT, players collectively sought to contain a potential disease outbreak while sharing limited virtual resources (Rosenbaum, Klopfer & Perry, 2007). In POSIT, players attempted to collect relevant information to sway public opinion on the hypothetical construction of a controversial Biosafety Level 4 research facility (Klopfer, 2008). The technological infrastructure of both games allowed players to impact their peers, collectively helping (or obstructing) one another (e.g., by sharing or hoarding resources, spreading or containing a contagion). These games also engaged with topics (social exchange of information and disease spread) that aligned well with highly interconnected peer and virtual NPC engagement. The TaleBlazer team also observed ways in which other AR toolkits such as ARIS enabled game designers to author multiplayer games, connecting peer-players to a shared server-based game world (Holden, 2015).

Design & Technical Considerations of Multiplayer AR

The single-player version of the TaleBlazer toolkit (upon which the multiplayer version is based) utilizes a block-based scripting language, enabling games to embed a relatively high degree of interconnected components. In addition to making simple point-to-point games, TaleBlazer designers can make games based on underlying models, a style which fits well with complex subjects such as ecology or economics. Thus, when the team sought to develop a first iteration of a multiplayer version of TaleBlazer, it extended its block-based scripting language, enabling game designers to include interaction between players, teams, and the overall game world.

Similar to ARIS, the multiplayer version of TaleBlazer utilizes a client/editor/server architecture (Holden, 2015) and initial work on the TaleBlazer multiplayer platform focused primarily on creating a technical infrastructure that enables players to reliably connect via an instance code to a centralized server maintaining a single multiplayer instance of a game. On the mobile portion of TaleBlazer, additional multiplayer UI elements enable players to communicate and coordinate via in-game text-based team or whole group chat, make decisions that affect peer-players (e.g., team traits, inventories, scores and goals), and negotiate among limited virtual resources (peer ‘give’ action). Players’ roles across a team also enable division of information or gameplay, dividing both the virtual space as well as the physical environment.
Proposed Future Research

Questions remain around developing a better understanding how complex multiplayer games might support collaborative learning among peer-players of location-based AR games, particularly within complex domains such as ecology or economics. Additional research can also help us better understand what conditions (what types of in-editor script blocks or related support materials) might be helpful in supporting adult or youth game creators in the design and programming of complex multiplayer games.

References


Life Beyond the Grant

Creative Dissemination Strategies

Susan Baron (Missouri Botanical Garden), Bob Coulter (Missouri Botanical Garden), Judy Perry (Massachusetts Institute of Technology), Eric Klopfer (Massachusetts Institute of Technology), & Lisa Stump (Massachusetts Institute of Technology)

Abstract

Over the past decade, the authors have collaborated on the development of location-based augmented reality games for use in formal and informal contexts. As their current grant is winding down, they have sought innovative ways to support expansion to new sites. To work toward that goal, they jointly offered an eight-week webinar series which included a mix of conceptual discussions, annotated examples of successful game projects, and hands-on practice with the game development tools. In this presentation, the structure of the webinar series and samples of the ancillary support materials will be shared, along with program evaluation data reflecting critical factors which contributed to successful replication at some sites, and delineation of obstacles which made transfer of innovative game-based tools to other sites difficult.

Project Overview

For more than a decade, the Missouri Botanical Garden and the Massachusetts Institute of Technology have collaborated to develop mobile location-based augmented reality games (Coulter et al, 2012; Coulter & Stauder, 2015). When playing one of these games, players are led by the GPS functionality embedded in a smartphone or tablet to find specific locations. Clues in the real world then combine with clues that appear on the device screen, challenging players to resolve a problem in a game-like environment. For example, in a game developed by the Missouri Botanical Garden, the visitor takes on the role of Hibiscus Mallow, a character from a parallel universe who was exploring on the grounds of the botanical garden. Suddenly the transporter breaks down, and Hibiscus needs to identify plants that will enable survival until the rescue ship arrives. Poor choices have dire consequences. Each game is designed to foster high engagement by presenting a series of interesting choices and through promoting both social and bodily-kinesthetic activity (Isbister, 2016). Through these play-based activities, participating youth take on a projective stance in the world (Gee, 2007) as they develop and deploy agency toward achieving valued outcomes.

The partners’ collaboration over the years has included the development of multiple iterations of a youth-friendly software platform for development of handheld augmented reality games, as well as a suite of prototype games. Beyond their own development efforts for local purposes, the partners have also worked toward providing support for implementation in a variety of other environments. These
have included formal school settings, semi-formal environments such as after-school and summer camp programs, and informal “free choice” settings including zoos and botanical gardens. Most recently, the partners have collaborated on a large-scale, National Science Foundation-funded effort to support informal science institutions located across the United States in developing games for use in camp programs and for free-choice visitors to play at the partner sites. As part of the camp programs, each partner embedded youth game development projects within their summer programs. Beyond the benefits of playing augmented reality games, these game development efforts are particularly fruitful, as they foster deeper understanding of relevant scientific and social issues (Li, 2014).

As the grant winds down, the lead partners have been working to establish a strong dissemination path that will enable other institutions to develop their own games and support youth game development efforts. In addition to the standard dissemination efforts (such as the development of a project web site and an array of conference presentations), the grant partners collaborated in 2015 to offer an eight-week webinar series for interested informal science institutions in the United States, Canada, and the United Kingdom. In all, we had 11 institutions and approximately 40 participants. Through working with the webinar participants, we gained a better understanding of the realities involved in bringing location-based augmented reality games to new programs in a cost-effective manner.

Dissemination Efforts

Our primary goal for dissemination was to stimulate engagement and awareness of handheld augmented reality gaming as a recreational and educational platform. Given the complexity of handheld game design (especially if it involves supporting youth as game designers), we felt that more was needed than simply offering a few online tutorials. After considering several options, we settled on an eight-week webinar series, which was offered in the fall of 2015. Each week had a specific theme, designed to build on what had come before:

Week 1: What is Taleblazer?
Week 2: Location
Week 3: Narrative
Week 4: Interesting and Meaningful Choices
Week 5: Outcomes and In-Game Feedback
Week 6: Ending the Game
Week 7: Testing and Revision
Week 8: Wrap-up

Building on our intention to equip participants to actually develop their own games, each week had assigned “homework” that would enable webinar participants to incrementally build toward a playable game on their institution grounds. Staff from each of the lead institutions held office hours to support this work. While some participants struggled to fit this extra work into their regular duties, we had a number of successful efforts, and the webinar series ended with a great deal of enthusiasm and
commitment to continuing game development efforts. Reflecting this, the lead partners have continued to provide support as participants move toward local game launches. Follow-up evaluation research currently being conducted is helping to identify what progress has been made, and what obstacles have impeded progress.

Product Development

Throughout the webinar series, we worked to refine our understanding of what material support new game designers would need. This led to the development of a series of staff-focused resources (such as game design templates and tutorials for use in developing games for public offerings). We also made template games and youth-focused tutorials that institutional staff could use to embed handheld game design projects in their summer camp or weekend program offerings. These have all been user-tested and revised as needed. While the initial testing of these materials showed that tween-age youth were able to develop credible, playable games in approximately four hours of focused effort, we will be including recommendations with the materials to help with specific areas of concern. These include challenges in (1) helping young designers better understand the affordances and limitations of the handheld gaming environment, (2) providing the baseline support needed to scaffold a successful initial game design effort, and (3) helping youth designers effectively test and revise games.

References


93.

Videogames and Distributed Teaching and Learning Systems

Jeffrey B. Holmes (Arizona State University), Kelly M. Tran (Arizona State University), & Elisabeth Gee (Arizona State University)

Abstract

This poster develops a theory of distributed teaching and learning systems (DTALS) and provides two case studies using the videogame Dota 2 and the game development program Twine. DTALS extends work on “Big ‘G’ games” and “affinity spaces” (Gee, 2003) with a particular emphasis on the teaching that occurs across a range of sites within and around videogames, and what that might tell us about teaching and learning more broadly. Furthermore, we are interested in understanding the relationships among these spaces, resources, practices, and people. Rather than viewing them as a haphazard collection of game-related teaching events or tools, we argue for understanding them as comprising a complex, dynamic, adaptive, and distributed system.

Young & Slota (2016) argue that researchers interested in the potential of games to support learning should attend not only to player-game interactions, but also to the “game ecosystem”, which they describe as interactions that emerge from game play but take place beyond the boundaries of the game. A game ecosystem has the potential to be quite vast, however, and here we propose the concept of “distributed teaching and learning system” as a means of directing attention more closely to the elements of this larger ecosystem that are organized around the purpose of teaching and learning. We wish to focus in particular on understanding teaching (and not “just” learning) as it is manifested and distributed across a wide range of spaces, resources, practices, and people. DTLS can support “learning pathways” to pursue deeper and richer learning experiences than what might be possible in isolation.

Features of Distributed Teaching and Learning Systems

One challenge in adopting a systems perspective is setting boundaries on the system of interest. All phenomena can be studied through a systems lens (Wilensky & Jacobson, 2014); systems exist within larger systems and can take many different forms. Typical approaches to defining a system involve identifying the system’s purpose; we have identified teaching as the central purpose of DTALS. DTALS can vary in the extent to which the entire system is intentionally designed to support teaching and learning, and can be spread across things like fan sites, tutorials, and other tools beyond more “traditional” forms found within a videogame like tutorials or a “help” section (what Gee refers to as the “Game” and the “game”, respectively). These elements become interconnected as players move across
them, link them, direct other players to them—they build a system “from the bottom up.” In other words, such DTALS have *emergent* properties, arising out of the interactions of originally disparate elements.

Other attributes of DTALS, as we define them, are that they are *complex* (there are diverse, multi-directional relationships among elements), *dynamic* (the elements in a DTALS and the relationships among elements are constantly changing), and *adaptive* (DTALS respond to changes in the larger environment; for example, an update to a game might make some teaching resources irrelevant and lead to the creation of new ones). Accordingly, DTALS can be described only approximately and at one particular time. New people, resources, tools, and affinity spaces are continually entering the system, and elements within the system are constantly changing. Any one person typically interacts with only one portion of the system, and thus individuals will have different conceptions of the system and its parts. Lastly, these systems are *distributed*, where the teaching that takes place through DTALS is distributed across space and place, both real and virtual. Second, teaching is distributed across human and technical agents. Thirdly, teaching is distributed temporally, across time. There is always some kind of teaching available to the potential learner, often “just-in-time”, on-demand, or just-in-case.

**Example Systems**

This poster includes two somewhat different systems below which will help us to illustrate features of DTALS. One of them, *Dota* 2, is a game “proper” with a robust player base and competitive esports communities; the other, *Twine*, is a text-based game development tool supported by many users across different websites and forums. We chose these examples because they cut across several important dimensions of DTALS (how they can be organized and designed, what people do with them, and so on) and demonstrate the variety and breadth of such systems in practice.

*Dota* 2 is a multiplayer online battle arena (MOBA) game in which two teams attempt to destroy the opposing team’s base while protecting their own. Part of what makes *Dota* 2 so interesting—and so illustrative of DTALS—is the many interrelated ways players can learn about the game and the communities of players, and how various sites are designed to teach them (Holmes, 2015). The game’s designer, Valve, included teaching-centered resources within the game (*designed* teaching elements). Valve also created somewhat unique features within the game client where players themselves carry out the teaching through a special coach mode, interactive player-created guides, and in-game streaming tools (*designed-for-emergent* teaching elements). Like many other games, *Dota* 2 has spawned many “big G” sites beyond the game. These are sites created by players to teach others and where new players can go to learn about the game as well as about the communities of players around it (what we have called *emergent* teaching elements). *Dota* 2 represents a rather strongly organized DTALS, with top-down, “sanctioned” elements like the in-game tutorial, as well as designed spaces for players to teach each other through the game client sponsored by Valve in addition to the many different affinity spaces that accompany so many other modern games. The game serves as a strong “anchor” with the DTALS.

*Twine* is a platform for authoring games and hypertext stories. This platform illustrates DTALS in several important ways that both compliment as well as contrast with *Dota* 2. First, the official materials offered for learning the platform are socially mediated, open for editing, and not the product of a single author. This stands in contrast to traditional teaching materials such as manuals and textbooks, but it also stands in contrast the top-down, designed systems around *Dota* 2. Second, *Twine* is a versatile platform
that is used by different people for many different reasons. For examples, seasoned game designers, novices who are using Twine as their first game design tool, and writers of interactive fiction all might use Twine and be part of the DTALS around it. Third, although the tool itself is rather easy to learn given the right materials, finding those materials and distinguishing relevant information from outdated information is no small task. The path of a learner through the teaching materials is a particularly interesting example of how a DTALS can be complex, requiring the learner to be self-directed in finding resources. Unlike with Dota 2, there is not a clear barrier between the designed and designed-for-emergent teaching systems.

Implications

A DTALS model provides several tantalizing implications for rethinking our current understanding of both game-based learning and more traditional school-centered teaching designs. First, in a DTALS learners can encounter teaching elements and “on-ramps” to learning from many different directions and in different sequences; each learning pathway may be unique to each learner. Designers (of games and of teaching events) must account for the various ways “in” to the learning. Second, DTALS can support many different ways of using the system and different purposes for learning (such as the Twine example); designers, learners, and researchers must contend with potential conflicts between these different agendas as well as leverage the opportunity to potentially cross different interests in order to grow shared interest, passions, and knowledge. Third, since DTALS can be distributed across many different sites, learners must be particularly savvy when judging the reliability, usefulness, and connections between various sites. This is potentially difficult for novice learners, who must rely on strong “top-down” designs (like the “sanctioned” ones Valve provides in Dota 2) or through various other social channels. Finally, and perhaps most importantly, a distributed system implies that no single entity, institution, or individual has a monopoly on creating, disseminating, or controlling when and how teaching and learning happens. A DTALS model suggests instead that teaching and learning are all around us, and we should pay attention to who makes and uses all of the various teaching and learning sites in order to both design new and emerging learning opportunities as well as critiques and adjustments of existing models.

References


Stereotypes, Games and Your Bladedancer Self

Using avatar customization to reduce stereotype threat effects

Joseph Fordham (Michigan State University), Rabindra Ratan (Michigan State University), Whitney Zhou (Michigan State University), Luke Sienko (Michigan State University), Kyle Silva (Michigan State University), Celina Wanek (Michigan State University), Madison Ozdych (Michigan State University), & Adam Cockman (Michigan State University)

Abstract

While a number of programs have recently been developed to use videogames as a possible catalyst in promoting more interest in STEM fields, the negative perceptions which women must overcome in STEM fields also resonate in videogame culture. We attempt to replicate previous findings that stereotype threat can influence both in-game performance as well as gendered perceptions of STEM fields. This replication also observes the role various forms of identity, expressed in-game through the use of avatars, can have on moderating the effects of these threats.

Introduction

An initial study (Ratan et al, 2015) suggests that the stereotypes surrounding videogame use may negatively influence STEM perceptions and aspirations when female players are confronted with stereotype threat. The present study builds on these findings in an attempt to both replicate these original results while also examining the potential role of avatar customization in moderating these effects.

Stereotype Threat in Games and STEM

Steele & Aronson (1995) define stereotype threat as, “being at risk of confirming, as self-characteristic, a negative stereotype about one’s group” (p. 797). In the context of videogames, women are typically underrepresented, within both the industry and games (Jenson & de Castell, 2010). Women players are more likely to face hostile comments and are commonly perceived as less knowledgeable and skilled than their male counterparts (Fox & Tang, 2014). As Steele & Aronson (1995) point out, constant exposure to these stereotypes can not only lead to decreased performance within a given task but also may eventually result in a complete disassociation within videogames and related fields. This provides a likely explanation for the number of researchers who find that women are less likely to consider themselves “gamers” and self-report less time spent playing games than men (Crawford & Gosling, 2005).

Similar stereotypical views are also present within STEM fields. Women tend to view these fields as
predominantly male-oriented and report feeling stressed and worried about how they are perceived by others (Master, Cheryan & Meltzoff, 2015). Given that stereotype threat in one area can extend into related domains, those pursuing a connection between videogames and STEM must consider the possible negative influence of these associations as well.

Identity, Stereotype Threat, and Avatars

The negative implications of stereotype threat have led many researchers to look for ways to help overcome these issues. A common strategy revolves around priming the “multifaceted nature of identity” (Mussweiler, Gabriel & Bodenhausen, 2000). Stereotype threat incites negative associations about a particular group to which an individual belongs – for instance, associating with being “female” can lead to the fear of being seen as inept at math by others (Rydell, McConnell & Beilock, 2009). Adaptation across various self-identities can help individuals overcome threatening situations (Mussweiler, Gabriel & Bodenhausen, 2000), but potential mechanisms for helping people shift between specific identities are understudied.

We propose that avatars, i.e., mediated self-representations, may serve such a purpose. Avatar characteristics prime associations with identities in ways that influence the avatar users’ self-perception and thus subsequent behavior (Yee & Bailenson, 2007). In the realm of stereotype threat, Lee & Nass (2012) found that individuals given a female avatar performed worse than those who used a male avatar in a competitive math task. Such effects are more likely when the user has customized the avatar (Ratan & Sah, 2015), likely because avatar customization increases the extent to which the avatar is perceived as relevant to the self (Ratan & Dawson, 2015).

Building on this idea, in the present research, we examine the potential that avatar customization can be used as a mechanism to reduce the harmful effects of stereotype threat.

• **Hypothesis 1**: The negative effects of stereotype threat induced in the gaming context will be manifested in A) gaming performance and B) gendered perceptions of STEM ability.

• **Hypothesis 2**: Compared to people who use an avatar that reflects actual-self characteristics, the negative effects of stereotype threat will be less severe for people who use A) an alter-ego avatar or B) an avatar that is designed to appear appropriate for the gaming context.

Method/Early Results

We are currently conducting a 2 (Stereotype threat/Non-stereotype threat) x 3 (Actual self/Alter-ego/Game-appropriate avatar) experiment to test our expectations. The design builds on our previous research on this topic (Ratan, et al., 2015). Namely, after receiving the stereotype threat prompt (or not), participants are prompted to create an avatar to use in the game (*Destiny*) according to their experimental condition. Measures of gameplay ability, STEM-gender perception and other metrics are taken before and after the 20-minute game play.

Although data collection is still in progress, initial results (n=30) suggest participants in the stereotype threat condition appear to play faster (significant), get more kills (marginally significant), and report less self-efficacy (marginally significant). Further, participants who customized game-appropriate avatars
appear to die more frequently than those in the other two conditions (marginally significant). These findings suggest that the eventual analysis with the full dataset will provide insight into (though not necessarily confirm) our hypotheses.

References


Let’s Be A Real Estate Entrepreneur!

A Game of Socially (Ir)Responsible Real Estate Development

Richard Eberhardt & Sara Verrilli

Abstract

Since the 2008 Olympics held in Beijing and the 2015 Tianjin explosion, real estate development in China has been critiqued by many people, both internally and externally of China. In this poster session, the authors will describe one element for teaching and outreach created for the MIT Real Estate Entrepreneurship Lab to engage Chinese students on topics of socially responsible real estate entrepreneurship and urban development, a multiplayer video game developed for tablets and mobile devices. The game will serve as the backbone for a 2-week summer workshop curriculum held at Chinese universities and high schools.

Background

Real estate games have a longstanding historical popularity, from Monopoly to the SimCity video game franchise. SimCity was initially published in 1989; the original game spawned a wide ranging franchise of games and inspired a now well established genre of games. While not developed with educational purposes in mind, both have been used in education (Minnery & Searle, 2014; Darr & Cohen, 2016).

In collaboration with the Samuel Tak Lee MIT Real Estate Entrepreneurship Lab and MIT’s Center for Real Estate, the MIT Game Lab and MIT Education Arcade are designing games to help Chinese students explore some of the systems involved in real estate entrepreneurship. This first game prototype emphasizes the interconnected nature of development, the need for investment capital to develop real estate, and understanding the social responsibility between real estate developers and the communities they serve.

The goal is to increase interest in the entrepreneurial side of real estate development while emphasizing the benefits of socially responsible real estate development. In this context, socially responsible real estate development means considering the needs of present and future residents of the communities being created as well as considering the environmental impact of both construction and completed development.
Modeling Real Estate Development – Simply

In order to encourage players to develop their own deeper understanding of real estate development (Gee, 2013), the game uses an abstract, simplified model of capital and reputation.

Players draw contract cards from the building decks and choose which to build on the shared city board, borrowing money at a fixed rate to start their career as developers. Buildings have a cash cost to build, and return cash and prestige to the player once built. Each building gives a different return of cash and prestige, depending on its type and original expense. Some buildings allow the builder to turn a significant profit; others are built at a loss but increase the player’s prestige greatly. Players can also choose to invest in infrastructure, which is always built at a loss but protects the city – and the players – from randomly occurring events. All buildings require cash to build, and as the game goes on buildings increase in cost and value. Players must carefully manage their available capital and debt in order to keep building, but the winner in the end is the player with the most prestige, not the most money.

While the game is a competitive one, the interactive nature of buildings and their locations encourage active social interaction between players. Encouraging other players to invest in needed infrastructure that one cannot currently afford, or trying to get players to place particularly beneficial buildings next to already built structures, creates a framework that encourages collaboration within the inherently competitive game.

Choosing where to build is almost as important as choosing what to build, as every building affects the value of buildings around it. Most buildings increase their neighbors’ values, so actions taken by the player almost always increase the cash flow and prestige of other players. A few buildings, particularly the very profitable but noisome factories, can decrease the prestige of their builders and those of neighboring buildings if not carefully placed.

Curriculum Integration

The game is positioned to be the backbone of a 2-week summer workshop at Chinese universities and high schools, run by the MIT Real Estate Entrepreneurship Lab. In the first days of camp, the game will be used as a playful means to introduce the students to key concepts and vocabulary used in the rest of the curriculum.

As the camp progresses, students will play the game periodically, following up gameplay sessions with facilitated debriefing (Thatcher, 1990; Crookall, 2010), particularly discussions about the strategies used by both themselves and their classmates. Between gameplay sessions, new concepts will be introduced, and when the students revisit the game, they will discuss both the realistic and unrealistic aspects of the game as compared to the case studies and examples discussed in class.

Once the students are fully competent with the game, and have been exposed to all the concepts covered in the camp curriculum, they will be asked to produce alternate versions of the game. There are many different directions the game could be taken to make it more ‘realistic’; it will be up to the students to decide how to interpret what they have learned in class and express what they think is the most important ‘improvement’ to the game.
First Test in China

The game was first tested with volunteer undergraduate students from the Inner Mongolia University of Technology in Hohhot and from Tsinghua University in Beijing. Students at both colleges came from their respective schools of architecture, representing the three primary majors of urban planning, architecture, and landscaping. These are students who are not usually looking to enter real estate graduate programs (programs largely composed of students from finance backgrounds). These students were already familiar with some of the socially responsible aspects of development but not necessarily familiar with basic financial understandings of capital and investment.

This first major test helped us confirm that our game both hit on the basic knowledge components we were hoping for, but was also able to spur ideas among the students to ‘improve’ the game by simulating more specific aspects of real estate development. While we did not test the ‘modify’ the game lesson plan, the students (some of whom would not consider themselves ‘gamers’ or extensive game players) could theorize game mechanics that would represent aspects of real estate development that they were already familiar with. Without too much prompting, some of the students were able to talk about the tensions that exist in capitalism between maximizing profit and better serving the communities.

Next Steps

The game is in continuous development, with its delivery for the summer camps serving as both the primary delivery mode but also a test bed for improvement. In this first year, development has focused on simple elements of capital and social responsibility related to location and zoning. Future development will focus not only on improving the game for clarity and polish, but also on adding new features to better illustrate elements of social responsibility within other aspects of real estate development, such as bidding for contracts and in building construction.

References


UAA Spirit Quest

Lessons from a Campus-wide Game Development Project

Jennifer C. Stone (University of Alaska Anchorage), Kenrick Mock (University of Alaska Anchorage), & Dave Dannenberg (University of Alaska Anchorage)

Abstract

This poster examines a campus-wide game development project at a comprehensive public university. The game, UAA Spirit Quest, incentivizes students to learn about campus services, faculty, student life, and the “habits of mind” of effective college students. The game also aligns with several campus initiatives related to general education and student success. The team that proposed and created the game comprises faculty and administrators from across campus, including departments of engineering, English, education, and developmental studies, as well as administrative units related to instructional technology, student services, learning resources, and general education. The poster discusses the process of conceptualizing and creating the game from multiple institutional perspectives, including the lead designer and project lead, the lead developer, and the lead administrative liaison. Together, these perspectives offer different points of view on the lessons learned as the team engaged in a complex game development project.

Gamifying Student Success

Over the past few decades, scholars have illuminated the ways that games can support learning and engagement (Gee, 2007; Squire, 2011; Steinkuehler, Squire, & Barab, 2012). Within the emerging field of games studies, scholars have investigated the potential of games and game-based principles for enhancing learning. One strand of research on “serious games” has looked at how games can be designed and used for solving major problems, supporting education, enhancing job training, and shaping public policy (McGonigal, 2011; Michael & Chen, 2005; Sawyer & Rejeski, 2002).

A well-designed game can be simultaneously addicting, rewarding, challenging, and fun. Gamification is a term that refers to the application of such gaming principles to non-game contexts with the goal of increasing engagement, motivating action, enhancing mastery, or solving problems. Educational interest in gamification has risen dramatically in recent years, with entire conferences and special journal editions devoted to the topic (Borges et al., 2014; Kapp, 2012; Kim, 2015). Gamification has been applied to courses in many disciplines by incorporating game features such as adventure roleplaying (Gellar-Goad, 2013), badges (Stone, 2015), experience points (Gehringer, 2013), or leaderboards (Barata et al., 2013) into curricula. Instructors have reported positive results that show improvement in attention, participation, and learning. Additionally, the principles of gamification appear particularly suited to the social motivations of Millennials (Bowser et al., 2013).
While the application of gaming in higher education is on the rise, the primary emphasis has been confined to the curriculum of a single classroom. In this project we developed a game that would be applicable beyond the classroom to engage all students in student success, reframe our general education requirements, and support a common first-year experience.

The **UAA Spirit Quest Initiative**

**UAA Spirit Quest** came out of an ongoing collaboration between Jennifer and Kenrick, along with a request to adapt a previous game to promote a newly opened academic coaching center. The team quickly realized that the game could more broadly integrate many important first-year experiences. The game engages students in a games-based experience that teaches the “habits of mind” of effective, informed, and persistent students (Council of Writing Program Administrators, 2011). **UAA Spirit Quest**, which is currently being designed, developed, and tested, capitalizes on the capacity of games and gamification principles to support learning and engagement.

In **UAA Spirit Quest**, the university’s spirit has been fractured and spread around the campus. Players need to help the school mascot on his quest to recover the spirit by engaging in quests related to six main attributes: 1) navigating the university (perception), 2) getting connected (social), 3) developing a sense of self (wisdom), 4) engaging in productive academic habits and connecting to academic resources (intellect), 5) developing healthy and balanced life habits (balance), and 6) making the most of the university through opportunities like undergraduate research and community engagement (strategy). Students earn badges related to each of these attributes by completing questlines. The Questlines and resulting badges tie together related quests and provide virtual rewards that acknowledge mastery of content. Each questline engages students in a series of activities related to the attribute. Quests vary in activity and difficulty, and for each questline students must earn a certain number of points to earn a badge.

**Lessons from UAA Spirit Quest**

The team that proposed and created the game includes faculty and administrators from across campus, including departments of engineering, English, education, and developmental studies, as well as administrative units related to instructional technology, student services, learning resources, and general education. The team of ten faculty, staff, students, and administrators collaborated to conceptualize the game, acquire funding, create the game, and test it with students.

The poster discusses the process of conceptualizing and creating the game from multiple institutional perspectives, including the lead designer and project lead (Jennifer), the lead developer (Kenrick), and the lead administrative liaison (Dave). Together, these perspectives offer different points of view on the lessons learned as the team engaged in a complex, campus-wide game development project. The poster focuses on how the team negotiated institutional boundaries, developed consistent design and development processes, and adapted as the game project grew from a simple project to highlight a single campus resource to a campus-wide initiative.

**References**

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2013). Improving participation and learning with...


Acknowledgments

This project was supported by an Innovate Award from the Office of Research at the University of
Alaska Anchorage. Special thanks to the remaining UAA Spirit Quest team, including Kevin Bartlett, Whitney Brown, John Cripps, Sharon Emmerichs, Trish Grega, Dan Kline, and Claudia Pearson.
Parent-child Joint App Use and Early Numeracy Development

Yile Zhou (The University of Iowa) & Benjamin DeVane (The University of Iowa)

Abstract

This qualitative case study was conducted to explore parent-child interaction in intergenerational play of numeracy-related Apps. A Chinese mother and her preschool-age son in a Midwestern university town were observed using several numeracy-related mobile game apps together. Our analysis of the observations and the interview with the mother revealed that parents might mediate preschooler’s App play, but their engagement might take a different shape than what Joint Media Engagement theory envisions. It provided insights about designing good App number-related games for parents and children to engage together.

Introduction

In the past decade, new technologies, such as iPad, have changed young children’s learning experience. However, few studies have investigated the intergenerational use of digital tools in early numeracy activities, which serves as the most critical learning environment before formal schooling. This qualitative case study was to explore, in a cross-cultural context, parent-child interaction around play of commercial, numeracy-related mobile game apps. The guiding question was: how do parents influence children’s numeracy development through playing numeracy-related apps together? This study was conducted in the context of a larger research project on cross-cultural perspectives on parental involvement in numeracy activities. In this paper, we suggest that, while parents mediate preschooler’s numeracy-related App use, sometimes parental engagement may be different than ideals of intergenerational play.

Theoretical framework

Joint Media Engagement (JME) research shows that adults may increase children’s media engagement by a) allowing children the opportunity to initiate and guide the media interaction; and b) being co-participants in media activities (Takeuchi & Stevens, 2011). Studies of parent-child play suggest that collaborative intergenerational activities are beneficial for children’s learning (Siyahhan et al., 2010).

In numeracy development, children’s early indirect experiences with numbers, especially in the context
of games, were found to be important contributors to their numeracy skills (LeFevre et al., 2009). Based on JME theory, we can assume that engaging parents in children’s app play potentially enhances early numeracy development, provided parents support children’s learning in a suitable way. Thus, it is reasonable to explore how parents interact with their preschoolers when playing App games together, and how such interactions would influence preschooler’s numeracy experience from the JME perspective.

Methods

The participants were a Chinese mother and her 4-year-old son in a Midwestern university town. Data were collected through two naturalistic observations and a semi-structured interview. In the first observation, the mother and the son played the game app “Teach Me: Kindergarten”, which they often used together at home. In the second observation, we provided them two game apps, “Team Umizoomi Math: Zoom into Numbers” and “Monkey Math School Sunshine. The interview with the mother concerned her opinions about early math learning apps, home numeracy experiences, and mother-child interaction in these experiences. The data were transcribed and analyzed using Merriam’s (2014) step-by-step process. Through analytical coding, we came up with two major themes.

Findings

Theme 1: Mother mediating child’s App use

In their joint use of game apps, the mother thoroughly mediated her son’s play and actions, determining how her son interacted with the tool, in three ways. First, the mother paid attention to the content of each game app and chose what she believed beneficial. In giving instructions, the mother controlled the materials with which the boy interacted. For example:

“You have played the counting game and the car racing game. Let’s see what else you can play here. You can go back to the city and play something else.” She clicked the back button and chose an addition game. “That seems interesting.” (Observation 2)

Second, the mother provided indirect, yet competent, assistance for the boy when he had a hard time or made a mistake, which could be viewed as the scaffolding. During these occasions, the mother gave him a hint instead of telling the right answer directly. For example:

When playing “Monkey Math School Sunshine”, the boy could not figure out a pattern problem. The mother did not show the correct answer. Instead, she said, “Look at the first one. What’s that?” “Seahorse.” “Great! What’s after the seahorse?” “Jellyfish.” “Good! So here is a seahorse again. What should follow?” “Hmm, jellyfish!” (Observation 2)

Third, outside the game the mother sometimes initiated other numeracy-related activities for the boy. For instance, she asked the boy to count how many badges he won, which was not a required task in the game.
Theme 2: Mother’s partial engagement in the app play

During the observations, the mother did not seem to be very interested in playing the game apps. For example, after the boy understood how to play the different games in a new app, the mother took out her phone and started reading news. In the interview, the mother to describe how they used iPad together at home,

“I think it’s important for me to see what App he is playing with. So when he uses the iPad to learn, I always sit next to him, like here, and pay attention to his learning process. Sometimes I’m busy doing my housework at home. I will ask him to sit in a place closed to me so that I can monitor him.” (Interview)

It seemed that the mother regarded herself more as a monitor than as a joint player. She used the Apps with her boy just because she wanted to know what learning materials he was exposed to. She was not motivated by the Apps itself. Her engagement in using the numeracy-related Apps was not enough.

Conclusion and significance

The findings supported our argument that parents might mediate preschooler’s numeracy-related App use, but the parental participating in Joint Media Engagement might only be partial. The mother’s leading role determined what contents or stimulus the child was exposed to when using the Apps. Her scaffolding facilitated the child’s interaction with the Apps as well as his numeracy understanding. However, the mother’s partial engagement would influence the quality of JME. The current early math game App designs usually only focus on the children and ignore the parents. The addition of game mechanics that keep parents engaged, and different roles for parents and children, could facilitate joint engagement.

References


Engaging Virtual Classrooms Using Player Archetypes
Stephen Mallory (University of Texas at Dallas)

Abstract

Digital games are an ideal form of media which presents engaging content, in that they can create enriching applications of taught information beyond the confines of the classroom. Massively Multiplayer Online Games (MMOs) engage players on multiple levels by allowing players to explore worlds, reach achievements, overcome challenges, interact with other players, and create unique micro cultures. These explicitly designed cultures have the capacity to be more than an educational experience for one student, they give multiple students the ability to interact, learn and apply what they’ve learned together at a global level (Squire, 2012). As a former AAA and mobile game designer, I will review the core concepts of MMO design as they relate to the psychological state of flow and overlay the Bartle taxonomy of player types to illustrate how each aspect can work together to create an optimal experience for play and learning.

Overview

Based on my experience as a professional game designer, educational games are traditionally designed to engage a single player and to extend the classroom learning cycle away from the school house. This focus on the individual student is eliminating the engaging potential of a multiplayer game or virtual classroom where play and education are brought together. Games like Quest Atlantis (Barab, 2000) integrate massively multiplayer game design principles, but tend to be outliers in larger educational applications.

These qualities overlap with the psychological concept of flow (Csikzentmihalyi, 2008). Engaging content that generates flow, as it relates to digital games, consist of the following four qualities (Baron, 2012):

1. Explicitly delineated goals with easy to follow rules.
2. Attainable goals within the rules.
3. Clear, usable and relevant feedback.
4. Minimal player distraction.

Virtual worlds have an additional layer of consideration, illustrating four categories of behavior by
participants. These archetypes (Bartle, 2004) generalize ways in which participants play within virtual worlds or MMOs.

**Explorers, Goals and Rules**

For a player to enter into a state of flow, the rules of play and the goals they generate must be concrete, achievable and rewarding (Schell, 2015). Clear goals and rules aid in establishing methods of control of the players (Riegle, 2006) and educators alike within a digital game and MMO. Virtual communities, however, require educators to cede some control of the place space. Explorers establish the boundaries of the game, and communicate these goals and rules to the Socializers.

Certainly, this desire to explore can be illustrated explicitly in the popularity of games like Minecraft (Mojang, 2011). Minecraft is deceptively weak when it comes to embracing the player types beyond explorers and requires the player to be far more self-directed than other games. That isn’t necessarily a weakness, nor does it undermine the use of Minecraft as an educational tool (Mojang, 2016) (University of Texas at Dallas, 2015).

**Achievers and Attainable Goals**

When playing digital games, if the player cannot attain the goals presented by the challenges of the game, then the player will not continue playing the game. The goal that the player is striving toward is centrally tied to the idea that the participants are critical to progress through the game, where what they know is directly related to what they can do and ultimately what they can become (Barab S. P., 2012). Achievers use the goals established by the game designers as proof of capability and skill within the game, and determine by action if the goals are attainable through play.

In educational games, the presentation of goals for achievers is hit or miss. The Radix Endeavor (Filament Games, 2014) provides an experience that is similar to World of Warcraft (Blizzard Entertainment, 2004). Where the game fails to embrace the concept of achievement is providing players goals to achieve beyond the initial quest line in the game. Because Radix has eschewed the concept of character classes found in other MMOs, every character has the same achievement goals and capabilities, giving little variation or depth of play.

**Socializers and Feedback**

Socializers are “people for whom the greatest reward is interacting with other people, through the medium of the virtual world” (Bartle, 2004). These people craft and maintain the affinity groups and affinity spaces within which learning takes place. The idea of collective intelligence is that “knowledge is distributed among collectives rather than in individual heads” (Squire, 2012). The socializer is then the organizer and creator of the “intelligent things” that the collectives create by applying their brainpower to problems (Squire, 2012).

Without appropriate feedback, players lose this sense of agency and slip out of flow. This can be mediated by an instructor providing timely information or quick access to external information sources,
there is the chance that a player’s game is doomed from the start, requiring a complete restart. Feedback by the game, therefore, is a source of information that the socializers relay to the rest of the game community. When feedback breaks down, any game is frustrating (EduWeb, 2015) with little value as an educational experience, virtual or otherwise.

**Killers and Minimizing Distraction**

Killers are not necessarily the most educationally relevant archetype on first blush. The term “Dominator” is replacing “Killer” in the lexicon (Bartle, 2004), as these players spend their energies controlling or dominating the play of others. Even then, the notion of developing a game in which one of the designed interactions is players imposing their will on others would be met with concern.

Games should minimize distractions and emphasize players entering a state of flow. In terms of game design, that is a focus on removing mechanics or systems that distracts players from the core experience of the game and ensures that the player is balanced between challenge and boredom (Schell, 2015). Affecting other players keeps the Dominator in flow. Dominators, by affecting others, refocus other players back into flow.

**References**


Ethics Simulators

Utilizing Digital Games to Study Ethical Decision Making in an Immersive Context

Allison Reeck (Inver Hills Community College) & Dr. Chelsea Lovejoy (University of Wisconsin – Stout)

Abstract

This study used a digital game to create a contextually rich environment in which to study ethical decision-making. A digital game was used as a simulation to investigate the effect of exposure to an ethical code prior to decision-making in a work context. Participants were undergraduate college students enrolled in psychology courses. Immersing participants in an environment with competing incentives and social cues was expected to elicit more natural responses. The game environment also provided participants with the opportunity to make a series of decisions. Results of the study examined the level of immersion and interest in the topic that participants experienced while playing the game as well as the types of decisions they made playing the game. Decision-making behavior was examined based on scores, behavior, and perceptions about the activity in a post-activity survey.

Computer Games as a Research Tool

One common method for assessing moral decision-making is to use hypothetical scenarios or vignettes to examine self-reports of how participants would potentially respond when placed in an ethically challenging situation (Lievens, Sackett, & Buyse, 2009; McKinney, Emerson, & Neubert, 2010; Siyahhan, Barab, & James, 2011). This is a practical method but has some potential drawbacks. A vignette cannot carry the full situational context that would be influencing a real life decision. This lack of context in hypothetical scenarios can increase participants’ tendencies toward analytical and abstract decisions, instead of an engaged, realistic decision-making (Siyahhan, Barab, & James, 2011).

Another issue with the use of vignettes is that participants may be motivated to provide the most correct answer instead of their most likely behavior (Lievens, Sackett, & Buyse, 2009). An additional challenge in decision-making research is the number of decisions participants will make during an experiment; sometimes as few as one (Mazar, Amir, & Ariely, 2008; Siyahhan, Barab, & James, 2011; Zhong, 2011). While this data is useful it can only establish a short term pattern of decision-making. In a working situation an individual will be making many decisions, within a similar context, over an extended period of time.

One way to account for many of these methodological issues is to use a computer game or simulation. A game provides participants with a consistent decision context. Similar to real situations, games may include conflicting influences (players can receive points for either ethical or unethical actions). Games can also reduce analytical response by imposing a limited timeframe for decisions; and have the potential
to evoke an empathetic response. By using a game which incorporates an ethically complex reward system, characters designed to elicit empathy, and a mentally challenging task we hoped to obtain more realistic participant responses.

The purpose of the current study was two-fold. The first goal was to examine perceptions of engagement and involvement with the task by utilizing a digital game as the means to examining decision-making behavior. The second goal was to examine how ethical decision making is influenced by the introduction of an ethics code. An ethical code is likely to influence ethical decisions and behavior by increasing the saliency of ethics, and through creation or support of social norms. As this influence could affect different types of behaviors, a series of hypotheses were proposed to examine the effects of exposure to an ethical code on different behaviors. It was predicted that participants who read an ethical code would earn a higher in game ethics score (Karma Rank) relative to those who do not read an ethical code. Additionally, because interventions can have differential effects on specific behaviors the behaviors which are incorporated in the global measurement were examined independently (hiring child workers, use of harmful factory items, hiring safety workers, training workers, worker hydration, amount of worker death or injury).

Method

This study was conducted in a university classroom setting. Participants were divided into two groups, those who read an ethical code prior to game play \( n = 56 \) and those who did not \( n = 32 \). Participants played the online game Sweatshop on their laptop computers and took an online survey to provide information on their game play. Throughout the game, players made decisions that influenced the health, safety, and satisfaction of their workers. The player’s objective in the game was to complete the work contract for each level while acquiring points based on work speed, work quality, and cash accumulated. The goal of this study was to examine player’s level of engagement and types of ethical decisions made with in the game. Specifically, did players prioritize worker health and wellbeing compared to profit as represented by the accumulation of points.

Results

ANOVA was used to explore differences in group behaviors within the game. Specifically participants usage of in game features (hiring child workers, use of harmful factory items, hiring safety workers, training workers, worker hydration, amount of worker death or injury) were compared. There were no significant differences in reported game behaviors between participants who read an ethical code prior to game play and those who did not. Statistical power was limited by the small sample size.

Participants were also assessed based on their level of engagement with the task and the importance of understanding issues of ethical decision making in a work-setting. Participants were assessed based on their engagement with the “For Real” information that was embedded in the game. Participants who reported reading the “For Real” information between levels (experimental \( n = 48 \), control \( n = 26 \)) were asked “How did you feel about the ’For Real’ information the game presented?” The most common theme was Knowledge; comments in this theme referred to the information presented being new or engaging and were split into the sub-themes Informative (experimental 15%, control 12%) and Interesting. Informative. Some respondents referred to the information presented as informative, including comments about the need to increase awareness of these conditions. Interesting. Only those
in the experimental group referred to the information presented as interesting (17%), suggesting a more personal engagement with the information. Under the main theme **Emotional**, both groups indicated that the information produced some sort of **Emotional Response** (experimental 8%, control 12%); but unique to the experimental group were comments describing the information as **Sad** (19%). **Sad.** Sad was the only descriptive word that occurred often enough to be identified as a separate sub-theme. Emotional connection to a situation has been identified as increasing the likelihood of an individual deciding to behave ethically. The higher frequency of comments in the experimental group identifying presented information as interesting, emotional, and sad suggest a more personal and engaged reaction to the information among participants who read the ethical code. Together, these findings lend support to the idea that games can provide an immersive way to understand differences in ethical decision making.

**References**


ETC Press is a publishing imprint with a twist. We publish books, but we’re also interested in the participatory future of content creation across multiple media. We are an academic, open source, multimedia, publishing imprint affiliated with the Entertainment Technology Center (ETC) at Carnegie Mellon University (CMU) and in partnership with Lulu.com. ETC Press has an affiliation with the Institute for the Future of the Book and MediaCommons, sharing in the exploration of the evolution of discourse. ETC Press also has an agreement with the Association for Computing Machinery (ACM) to place ETC Press publications in the ACM Digital Library.

ETC Press publications will focus on issues revolving around entertainment technologies as they are applied across a variety of fields. We are looking to develop a range of texts and media that are innovative and insightful. We are interested in creating projects with Sophie and with In Media Res, and we will accept submissions and publish work in a variety of media (textual, electronic, digital, etc.), and we work with The Game Crafter to produce tabletop games.

Authors publishing with ETC Press retain ownership of their intellectual property. ETC Press publishes a version of the text with author permission and ETC Press publications will be released under one of two Creative Commons licenses:

- **Attribution-NoDerivativeWorks-NonCommercial**: This license allows for published works to remain intact, but versions can be created.
- **Attribution-NonCommercial-ShareAlike**: This license allows for authors to retain editorial control of their creations while also encouraging readers to collaboratively rewrite content.

Every text is available for free download, and we price our titles as inexpensively as possible, because we want people to have access to them. We’re most interested in the sharing and spreading of ideas.

This is definitely an experiment in the notion of publishing, and we invite people to participate. We are exploring what it means to “publish” across multiple media and multiple versions. We believe this is the future of publication, bridging virtual and physical media with fluid versions of publications as well as enabling the creative blurring of what constitutes reading and writing.

http://press.etc.cmu.edu/