GAMES+LEARNING+SOCIETY CONFERENCE 2011

Conference PROCEEDINGS

GLS 7.0

JUNE 15 TO 17, 2011

MADISON, WISCONSIN

www.glsconference.org

Proceedings
GLS 7.0
Games + Learning + Society Conference

Madison, Wisconsin
June 15 - 17, 2011

Editors
Constance Steinkuehler
Crystle Martin
Amanda Ochsner

Games + Learning + Society Conference

ETC Press

2011

ISSN 2164-6651 (Print)
ISSN 2164-666X (Online)

Preface

This is the first volume of the annual proceedings for the Games+Learning+Society (GLS). The GLS conference is a premier event for those from both academia and industry interested in videogames and learning. The GLS conference is one of the few destinations where the people who create high-quality digital learning media can gather for a serious think about what is happening in the field and how the field can serve the public interest. The conference offers an opportunity for in-depth conversation and social networking across diverse disciplines including game studies, education research, learning sciences, industry, government, educational practice, media design, and business.

The GLS conference offers a host of session types from traditional presentations and symposia to unique session formats like the Fireside Chat, where the audience can engage in an informal discussion with the speaker, or the Micropresentation, which is 20 slides at 20 seconds per slide based on the Pecha Kucha style talk. This year we introduced several new session formats, which included Hall of Failure, a session type devoted to discussing what went wrong and where things broke; and Big Debates, which offer a chance for discussion on key issues in the field. Two other session types, which were added last year, deserve special mention: the Well Played session, created by Drew Davidson from Carnegie Mellon University, based on his *Well Played* book series, with papers from the Well Played sessions GLS 7.0 being featured in the first issue of the new Well Played journal. The second session type is the Games and Art Exhibition which features art that offers new interpretations on games and play. In the following proceedings papers, many of these session types are represented, offering a strong sampling of some of the best work on games and learning that's happening right now.

We would like to thank the conference sponsors for their support in helping to make the conference a success. They include the Bill & Melinda Gates Foundation, The John D. and Catherine T. MacArthur Foundation, SCE, Pragmatic, Pearson, Filament Games, and PDS. We would also like to thank the presenters for their submissions to this first volume. Finally, we would like to thank Drew Davidson and ETC Press for publishing the proceedings.

Constance Steinkuehler, Crystle Martin, and Amanda Ochsner

Table of Contents

Long Papers

Collection, Creation and Community: A Discussion on Collectible Card Games 3
Sonam Adinolf, Selen Turkay

Controlling Your Game Controls: Interface and Customization 13
Sonam Adinolf, Selen Turkay

The Seven Circumstances of Game-Based Learning (a Worked Example and an Invitation) 23
Dylan Arena

Research Results for Mecanika: A Game to Learn Newtonian Concepts 31
François Boucher-Genesse, Martin Riopel, Patrice Potvin

Reframing Interaction: Designing for Disciplinary Participation 39
Lisa Brahms, Ben Chang, Nian-Shing Chen, Ming-Puu Chen, Hao-Jan Howard Chen

Modeling but NOT Measuring Engagement in Computer Games 55
Mark Chen, Beth E. Kolko, Elisabeth Cuddihy, Eliana Medina

Bio-Gaming: Videogames as Tool to Teach Cell Biology 65
Javier A. Corredor

The Lost Binder: Communicating Ethnographic Research With Games 73
Raphael D'Amico

Urban Game Design as a Tool for Creativity, Collaboration, and Learning Among Youth 83
Ingrid Erickson, Joan Ganz, LeAnne Wagner, Hillary Kolos, Kan Yang Li

Critical Gameplay Gone Critically Wrong: Third World Shooter 91
Lindsay Grace

Game Design for Cultural Studies: An Experiential Approach to Critical Thinking 97
Sabine Harrer

Gaming, World Building, and Narrative: Using Role-playing Games to Teach Fiction Writing 103
Trent Hergenrader

Racing Games for Exploring Kinematics: A Computational Thinking Approach 109
Nathan R. Holbert

***Tug-of-War*: a Card Game for Pulling Students to Fractions Fluency** 119
Osvaldo Jiménez, Dylan Arena, Ugochi Acholonu

Games for Learning in Embodied Mixed-Reality Environments: Principles and Results 129
Mina C. Johnson-Glenberg, Tatyana Koziupa, David Birchfield, Kyle Li

Insights into Learning Offered by the Dispositions of Second-Generation "Newbie" Gamers 139
Shawna K. Kelly

Writing the Games-Based Dissertation 147
Shawna Kelly, Moses Wolfenstein, Mark Chen, Shira Chess, Cynthia D'Angelo, Todd Harper

Space Vector: A Videogame to Teach Introductory Physics 153
Eric Keylor, Shauna Sweet

Promoting Human Rights while Polarizing Political Perceptions with a Serious Game 161
Elias Klemperer, Richard LeDonne, Erik Nilsen

Information Literacy and Online Reading Comprehension: Two Interconnected Practices 169
Crystle Martin, Constance Steinkuehler

Conflict Resolution with a Serious Game for Peace 175
Erik Nilsen, Richard LeDonne, Elias Klemperer & Seth Olund

A Data-Driven Taxonomy of Undergraduate Student Videogame Enjoyment 185
John M. Quick, Robert K. Atkinson

Simulating Failure: Why Simulations Don't Always Work 191
Carlton Reeve

The Challenge of Assessing Learning in Open Games: HORTUS as a Case Study 201
Dr. Franziska Spring, Dr. James W. Pellegrino

Let Me Know When She Stops Talking: U sing Games for Learning Without Colonizing Play 211
Constance Steinkuehler, Elizabeth King, Esra Alagoz, Gabriella Anton, Sarah Chu, Jonathan Elmergreen, Danielle Fahser-Herro, Shannon Harris, Crystle Martin, Amanda Ochsner, Yoonsin Oh, V. Elizabeth Owen, David Simkins, Caroline Williams, & Bei Zhang

Mixed Methods to Study Games and Learning 223
Constance Steinkuehler, Elizabeth King, Crystle Martin, Yoonsin Oh, Sarah Chu, Caroline Williams, Amanda Ochsner, Shannon Harris, V. Elizabeth Owen, Gabriella Anton, & Jonathan Elmergreen

Enabling Educators to Customize the Game Environment 231
Mark Stenerson, William Schneller, Eve Syrkin Wurtele

High-Resolution Feedback using Tactile Semaphores 239
Reza Taghavi

Short Papers

Conversations 251
Lindsay Grace

Critical Gameplay: Art Games in Instruction 253
Lindsay Grace

Music Box: Emergent Behavior 257
Lindsay Grace

Polyglot Cubed 259
Lindsay Grace

Bank-It: A Mobile Financial Literacy Game 261
Marquina M. Iliev-Piselli, Cameron L. Fadjo, Joey J. Lee

Curatorial Statement for Games+Learning+Society Art Exhibition 265
Arnold Martin

Fantasy Defense 267
Arnold Martin

Wiki for Designing Games at Summer Camp 269
Evgeny Patarakin, Boris Yarmakhov

Play to Order: What Huizinga Has to Say about Gamification 273
Cody Reimer

LONG PAPERS

Collection, Creation and Community: A Discussion on Collectible Card Games

Sonam Adinolf, Selen Turkay, Teachers College, Columbia University
Email: sza2105@columbia.edu, st2282@columbia.edu

Abstract

Collectible or Trading Card Games (CCGs or TCGs) are enormously popular. They achieve numbers of players normally associated with online digital games. Yet they are sparsely researched and rarely utilized in the growing field of games and learning. This paper aims to present the motivational and powerful aspects CCGs and start a discussion on what these games can potentially bring to a learning ecology. While doing so we will also present preliminary results from a mixed method survey study with a multiplayer CCG, Vampire the Eternal Struggle (V:TES).

Introduction

A trading card game, customizable card game, or collectible card game (CCG) combines collection of trading cards with strategic deck building and gameplay. The invention of trading cards goes back to the 19th century thanks to competition among tobacco companies (Blum, 1995). Over time, these cards evolved into the collectible phenomenon now known as the trading card game (TCG) (Lenarcic & Mackay-Scollay, 2005, p. 65). The first known game to fit the definition of a CCG was *The Base Ball Card Game* produced by The Allegheny Card Co. and registered on April 5, 1904 (David-Marshall, van Dreunen & Wang, 2010). The CCG concept as we are familiar today came much later. In 1993, Richard Garfield introduced *Magic the Gathering*, a collectible card game (CCG), to the world. By 1996, it had grown to the point where it had high–stakes tournaments. As of 2009, Wizards of the Coast, the publisher of the game, estimated a 6 million global player base. As *Magic's* popularity grew, numerous other CCG's have spawned over almost two decades with player–bases ranging from tens of thousands to millions. In this paper, we will be using CCG and TCG interchangeably.

The worldwide market for CCGs is above $2.1 billion and sales are estimated to be around $800 million for 2008 in North America (David-Marshall, van Dreunen & Wang, 2010). The number of CCGs increases every year thanks to their low production cost and being add-ons to virtual worlds or massively multiplayer online games such as World of Warcraft. Please refer to David-Marshall et al. (2010)'s white paper on TCG industry for a comprehensive overview.

Despite the popularity of CCGs, there are very few examples of thought pieces or experimental studies with CCGs. In today's world of a thousand activities for both children and adults, educators need to investigate alternate paths for learning. CCGs are one such path: One which has received little attention from educators so far. This paper delves into various questions including types of CCGs, what makes them unique, and their possible educational merits. In addition, we will present preliminary results from an online survey study with V:TES players (N=290). Participants were asked about their motivation to play the game and their strategies to build decks in 5-point and 7-point Likert scale questions and open-ended questions. We will present quotes from open-ended questions from the study throughout the paper.

Background

What aspects of CCGs make them so popular that people will spend years playing them and buying expansions? A quick look at this question reveals two interlocked features in all CCGs. First, they're collectible. Most CCGs involve random collection through a "booster pack" system while some games you simply buy non–random packs to obtain cards. The second feature is customization. Once players have collected enough cards, they choose which of those cards they will use in their decks. This lends a sense of ownership to the game, as players have the opportunity to demonstrate their skills, as players *and* as creators. Even between relatively similar deck designs, individual tastes and choices can be seen.

The popularity of *Pokémon* and *Yugioh* among school age children, despite their complexity, intrigued many academics. For instance, *Pokémon's* metanarrative of the acquisition, training, and competing of hundreds of "pocket monsters," each with its own unique statistics and evolutionary potential, demands a mastery of complex knowledge and active interaction on the part of its intended audience(s) that is unique for a line of children's toys (Tobin, 2004). Ito's (2005) ethnographic studies on *Yugioh* illustrated how various mechanics of the game contributed to its market penetration of Japanese youth.

Most CCGs are played by two players. Multiplayer CCGs bring different dynamics into game play, marrying the need for social interaction to achieve players' goals with effective deck construction. V:TES may be the best balanced multiplayer CCG on the market. It allows multiple strategies, from politics to pure combat but in most cases requires a player to negotiate his/her goals by making deals and strategic planning.

Next, we will talk about collection, creation and community aspect of CCGs in a bit ore detail.

Collection

Why are they *collectible* card games? That answer is the same as why people collect anything: coins, stamps, models of famous buildings. The CCG taps into the same collecting instinct that exists in many of us. Most involve random collection through a "booster pack" system while some games you simply buy non–random packs to obtain cards. In the case of random boosters, the lure of rarer cards can provide incentive to collect. With pretty art, and varying rarity, it is easy to capture our attention. The ongoing production of successive expansion sets will keep us coming back for more tapping into player curiosity and challenge to get cards they need. Collection of the cards is basically a pre-cursor in order to have enough cards to be able to create a deck and play the game. As players acquire booster packs to find whatever they need, they also accumulate cards that they don't need. This has created a second market for CCGs. Many players sell individual cards or their collections if they decide to quit or they need cash.

Collection seems to be the least motivating for players among three aspects. Specifically, 36% of the V:TES players indicated that they like the collection aspect of the game to a moderate or large extent. This may mean that players still buy cards or trade them but it is not one of the main driving reasons that they play the game.

Creation

> "…often some interesting side-piece that I added just to try it out works better than the original idea itself and the deck slowly melds into a different concept." - V:TES, Female, 20.

Once you've got some cards, what do you do with them? A player can't use all of her/his cards in a single deck; most games have rules about maximum deck size. Plus, due to probability distributions, larger decks perform less reliably than smaller ones. The number of "perfect hands" in any given deck is comparatively small, while the permutations of lower quality hands balloons quickly as the number of cards increases. The player "… is also a designer (bringing a deck of their own construction to the table), a mechanic (re-working their own and other's ideas), a coach and a student…" (Lenarcic & Mackay-Scollay 2005, p. 68)

The possibilities are vast when considering all the combinations of cards players can put into a deck. What avenues players choose to pursue can allow them to try many different themes. Alternately, they can often try variations on the same theme. As many CCGs followed Magic: The Gathering's lead, printing card backs the same from the beginning of their release, players can put cards from any expansion into their play decks. This decision and creation process allows players to take ownership of the game far more than many other types of game. Players, as they get more experienced in the CCG, prefer tinkering with different cards and building their own decks rather than playing other players' decks. Figure 1 shows V:TES players' practices regarding how they build decks. Deck building and social aspect can go hand-in-hand as other players often give feedback on adding or removing different cards in order to make the deck more effective at its goal.

Deck building seems to be one of the aspects V:TES players really like about the game. Specifically, 73% of participants in the survey indicated that they like the deck building aspect of the game moderate to large extent. The creation and deck building aspect is an iterative process and oftentimes the idea or theme of the deck can turn into something completely different after iterations. Also, based on whom the player plays with, the deck may perform differently. This shows more in the multiplayer games but we would say it is a general fact about CCG decks.

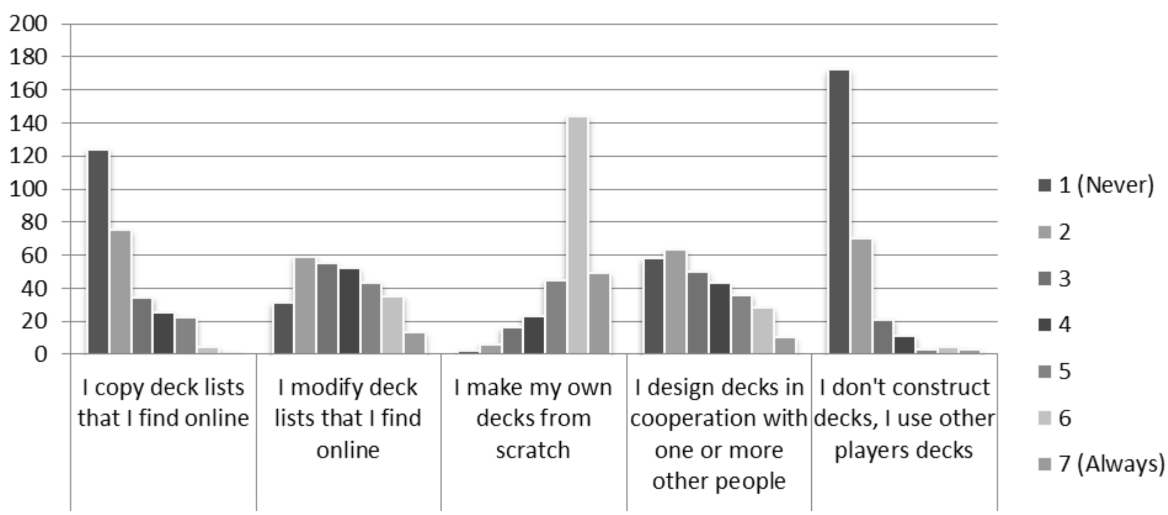


***Figure 1*. Participants answes about their common practice on building decks.**

Community

> "It's a mean game that I can play with friends I love. It's nice to not have to be nice all the time." -V:TES player, Female, 19.

Most CCGs involve conflict of some kind. So, they require two or more players at a time. While the players may be enemies during play, they may be friends, mentors, or collaborators in the broader context of the play community.

Most of the existing literature on CCG's includes material about the social aspects of games and community. This is true for several reasons. First, CCG's are among the most popular face to face games. This makes them prime candidates for comparison to digital games, which, while some have social aspects, still have a geographic separation. Second, CCG's are often part of larger "media mixes" (Ito, 2005) including television, comics, digital games, and CCG's. This greater saturation has allowed many games greater penetration into various social groups.

If we are to divide the social aspect into two, it would be at the game play level and at the larger social interaction level such as discussions at social networking sites or game forums. At the game play level, it can be competitive; expectation of drawing the card needed just in time is one of the exciting moments of CCGs.

The community aspect of V:TES seems to be the most fun and motivating for players. 76% of the V:TES players in the survey indicated that they like the community aspect of the game to a moderate to large extent. Many players travel to play tournaments, or, when visiting another city, they look up V:TES players to play with. For instance, both authors of the paper are active V:TES players and when they visited Madison-Wisconsin for the GLS conference they contacted local players to have a few game with them. This seems to be a common theme among other V:TES players. As a male player states: "…I've never seen any other game, or non-religious community where you can call someone you've never met and sleep at his place in the evening." The game as the common denominator has made the players a big family around the world.

Fans contribute significantly to CCG communities. For example, Bisz (2009) talks about how fans of Middle-earth CCG, a CCG based on J.R.R.Tolkein's Middle-Earth, continue to keep the game alive in any way they can, such as creating game art and organizing tournaments, and participating in discussion forums.

Game play aspect of CCGs can be challenging. In Lazzaro's (2004) classification of fun of playing games, CCGs mostly fall under hard fun. Players invest a lot into games, from collection to deck building to game play. For example, in V:TES a game session can go up to 2 hours, and tournaments can take up to 8 hours. The amount of thinking, strategizing, making deals and trying to win while every other player is also trying to win is surely hard fun. However, V:TES players seem to really like this kind of fun as 88% of them said they liked the game-play aspect of the game to a moderate to large extent.

> "Multi-player interaction requires a different skill set from just math and algorithms. But math is important too, which is why I don't win every game (hah)..." - V:TES player, Male, 45.

Dynamics

A CCG is generally made up of several components such as the rules governing the game, cards, Intellectual Property (the theme, or content), and sometimes: Beads/counters, dice or other secondary paraphernalia (David-Marshall, van Dreunen & Wang, 2010). In their play, CCG's share several elements or regions. Each player has a deck of cards not yet drawn, a hand of cards, a play area where a player plays his cards, a discard of cards that have left play.

There is also a shared battle area in many CCGs, where players' sides come into conflict.

CCGs require at least two players to play. Many were designed for two players such as Pokemon or Magic the Gathering. Others, such as Shadow Fist or V:TES were designed for more than two players. Based on the rules and the number of players in the game, the table dynamics change. Figure 2 shows the dynamics of attack, defense, and possible cooperation in two different CCG's. As you can see, the relationships in a two player game are symmetric. In V:TES, which uses a predator-prey system, the attack and defense relations are asymmetric. There may also be cooperation between cross-table players due to self interest against a mutual enemy.

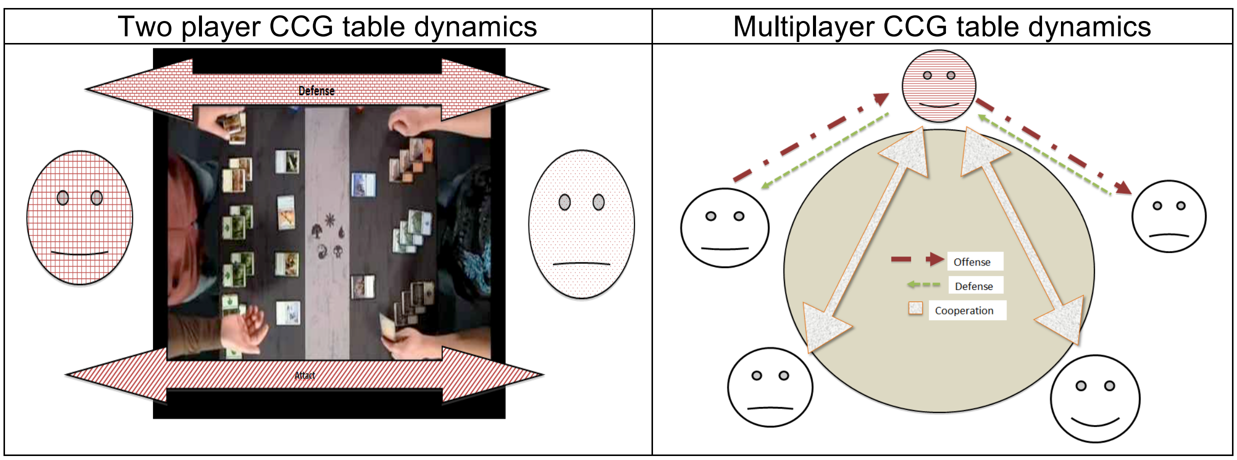


***Figure 2*. Magic the Gathering table dynamic (left) and V:TES table dynamic (right)**

CCGs and Learning

Can CCGs with educational themes or content be financially sustainable, while maintaining their effectiveness as educational tools? What benefits can CCGs without traditional educational content offer learners?

Strengths

The possible benefits inherent in CCGs have been speculated on, and in some cases programs have been implemented based on this (Lenarcic & Mackay-Scollay, 2005, p. 67). The genre, as a whole, requires its players to develop the following in varying degrees: analytic thinking, empathy, social manipulation and communication.

Learning Aspect 1: Motivation

Malone (1980) identified three aspects of games that make them motivating to players: fantasy, challenge and curiosity. While examining the collection, creation and community aspects of CCGs, we can see that each of these stages can be motivational in themselves based on Malone's (1980) model.

Using the motivational aspect as a learning aspect may take two different paths. One might be to create CCGs with some kind of educational content. This would aim to take advantage of the fact that large numbers of students are familiar with CCGs, either by playing them or by observing others play. Therefore, it is likely that if the game is well-designed, they will play the game and learn. Another is that CCGs can be used as reward systems at schools (Chen, Kuo, Chang, & Heh, 2009). Students may be provided with certain types of cards as a result of their academic progress or behavior. They may then play these cards with others. If we assume the motivational aspect of collection and creation, students will do their best to acquire more cards to compete with their friends.

Learning Aspect 2: Social

Experienced players share insights into game mechanics with less experienced players. Concrete examples allow less experienced player to see principles in practice. The following social behaviors are often practiced or developed by players:

- Cognitive apprenticeship
- Negotiation and persuasion
- Cooperation through mutual self interest
- Creative socializing

Possible uses for learning are improving communication and negotiation skills.

Learning Aspect 3: Play dynamics and mechanics

Notable properties of CCG game systems include:

- Pithy representation of information via symbols and keywords
- Resource management

Possible uses for learning would be practice of estimation skills and basic statistics, as well as strategy development and increased metacognive awareness. Scientific representations might be used as symbols on cards. At the survey 57% of the participants reported that when they make a mistake they try to remember in the future how to avoid it. Training of such skills might be useful for school aged children both when they solve school subject related problems and when they proceed into their outside lives.

Learning Aspect 4: External/Non-Play Mechanics

As we discussed previously, CCG's generally include:

- Collection of cards
- Iterative creation and testing (deck building)

Possible uses for learning would be iterative design, or possibly including an educational playload in cards "flavor text" (usually a quote or otherwise thematic bit of text to place the card in a narrative context) and including important historical figures as art.

Game based learning has never been this popular. Using digital games for learning or gamifying education are topics we come across in mass media and academic papers. When comparing with design and development of digital games, designing a custom CCG has lower requirements for teachers. It may require paper, computer and printers. For example, Steinman and Blastos (2002) developed a card game which was reminiscent of CCGs but without card collection and deck creation. They basically used the card design of CCGs such as art (e.g., Hepatitis B virus), picture of the target organ (e.g., liver), what the effect of the card is, what the restrictions are so on and so forth. Basically, they were able to achieve pithy representation of information by using symbols and keywords. Authors found that the card game was effective to teach basic facts and concepts about host defense to adolescents. Students also found the cards very informative. Learning symbols on cards is similar to the concept of learning and using icons on computers.

As we mentioned, the popularity of Pokémon and Yugioh among school age children is vast. Using this popularity, educational institutions may partner with CCG companies to make expansions on science or history topics. One example to this was the partnership between NASA and Pokémon. NASA's Center for Distance Learning and the Pokémon Trading Card Game developed an in-school program that incorporated science, technology, engineering, and mathematics (STEM) themes into activity units for K-6 students. Specifically, activities aimed to help students learn the science behind DNA and other topics. (Land, Anderer & Nelson, 2005).

An example of CCG that started keeping learning aspect in mind is Phylo game (phylogame, 2011) which is described as "a card game that makes use of the wonderful, complex, and inspiring things that inform the notion of biodiversity" on the website. It is a community project which can be contributed by anyone and can be played by printing cards. The website contains any information from rules to example card decks to be able to play the game.

Digital CCGs

With the advancements in Internet technologies, online CCGs have become common in recent years. While they have tremendous potential, they lack the rigorous design of some better CCGs. Some games implemented hybrid aspect where players can use cards offline and online. Johansson (2009) reports that some players of the Eye of Judgment could cheat because the camera used by the game system was not sensitive enough to identify photocopy cards from original cards. Other games, such as Chaotic, feature physical cards that have a unique code and therefore can be uploaded online by using this code. The latter system may work better as it is less likely that players may cheat to use rare cards.

Digital CCGs improve a weakness of CCGs where you need someone to play the game. On the other hand, games like V:TES may suffer when put into an online presence as a game session is long and players may feel less responsible with their turns. In fact, the current online system for V:TES is a fan created site called JOL. Players indicated that they like the accessibility so that they can try out new deck ideas and play with people anywhere in the world, but they dislike not being able to see other players and the fact that game sessions take a long time. Also, since the game often requires negotiations and making deals, it may be quite impractical to pursue certain strategies.

"…playing on JOL, I often can't be bothered to make a deal because it takes too much typing to come to an agreement" – V:TES, Male, 37.

When we talk about educational uses, the strategy of Chaotic may work, as students not only would get physical cards but they would access them through their computers if they want to play with their friends. This may even make the games more motivating for them to play.

Discussion: Misconceptions

There seem to be a few common misconceptions about CCGs. One regards what actually constitutes a CCG. Steinman & Blastos (2002) designed, researched and published a paper on "A trading-card game teaching about host defence[sic]." The game described was *not*, in fact, a trading card game. It *was* a card game, with symbols similar to those used in many TCGs. However, there was no *trading*, nor collection, nor deck construction. Indeed, both players used cards from the same deck. This is not an isolated case.

There is also sometimes incomplete understanding of a game's rules. For example, talking of Magic: The Gathering: "…like most games the first person to act has a slight advantage…"(Lenarcic & Mackay-Scollay, 2005, p.68). This is partially true. Many systems of games favor the person who plays first. CCGs are among the most self-aware of this fact, and many have rules which penalize the first player to help balance matters. In some games, like Magic, the penalty (the first player does not draw a card on their first turn) is outweighed by the advantage. In others, like V:TES, the penalty is more keenly felt; the first player only gets one "transfer" to start bringing vampires into play, while second, third, and fourth players get successively more.

Some feel the need to justify the study of play. "Within the animal kingdom, a satisfactory evolutionary rationale for play's emergence has been mired by the paradox of its association with amusement."(Burkhardt, 2005 in Lenarcic & Mackay-Scollay, 2005) We think that this is an unnecessary defense. One need merely look at sexual reproduction to see that association with amusement is in no way a paradox for evolutionary emergence. In fact, in that case evolution has given amusement as an incentive for a necessary activity. We make no claim either way about play as a necessity.

Lastly, there is a misconception shared by some designers and researchers: that rarer is better. To clarify, they believe that rare cards should be more powerful than uncommon or common cards. Instinctively this feels right, but it is a pitfall that most good CCG's have learned to avoid (some from painful experience). Let's look at why. Assume you play a CCG. Your friend, Timmy, expresses interest in learning how to play. You lend him a deck, and he plays a few games. He enjoys it. "This is great! How much would it cost for me to get started?" You now have two answers. If the CCG is following the "rarer is better" philosophy, you will have to inform Timmy that he'll need to buy a few hundred dollars-worth of packs just to get enough rares to make a decent deck that won't lose all the time.

What's the other option? The designers want players to covet rares (so they'll keep buying cards), so if they're not going to make them more powerful, they need to use some ingenuity and make them more *interesting*. Rares need to allow more options to a player, without making them incredibly powerful (or if they are powerful, design them so that players only want one or two, not a whole bunch). Wizards of the Coast learned that lesson fairly well after their initial printings of Magic. White Wolf has been quite good about it with V:TES.

Conclusion

CCGs are engaging, social, community building games. Millions of people collect the cards, build decks with them, talk with their friends about them, and play with them. Not only that, but they are portable, and require little equipment, which puts them ahead of even mobile applications in terms of accessibility. Finally, from a design point of view, they are simpler and cheaper than digital games, as they cut out one third of the digital production trifecta: designer, artist, *coder.*

Given all these factors, add to them this: CCGs already have some learning built in to them. They are built on analytical processes, and they require assimilation and interpretation of symbols. With all these things in favor, it seems odd that there has been little interest in researching them, or licensing existing games to produce expansions flavored for the material that they want to prime students for. We're certainly interested in seeing this happen in the near future.

References

Bisz, J. (2009). The birth of a community, the death of the win: Player production of the Middle-earth Collectible Card Game. Transformative Works and Cultures, 2. Retrieved from http://journal.transformativeworks.org/index.php/twc/article/view/90/99

Blum, A. (1995). Cigarette cards - irony in propaganda. Tobacco Control, 4, 117-118.

Chen, P., Kuo, R., Chang, M., & Heh, J.-S. (2009). Designing a Trading Card Game as educational reward system to improve students' learning motivations. In Z. P. e. al. (Ed.), Transactions on Edutainment III (pp. 116-128).

David-Marshall, B., Dreunen, J. v., & Wang, M. (2010). Trading Card Game Industry - From the T to the C to the G. Retrieved from http://www.superdataresearch.com/wp-content/uploads/2009/08/TCG2010.pdf

Ito, M. (2005). Technologies of the childhood imagination: Yugioh, media mixes, and everyday cultural production. In Joe Karaganis and Natalie Jeremijenko (Eds), Structures of participation in digital culture. Duke University Press.

Johansson, S. J. (2009). What Makes Online Collectible Card Games Fun to Play? Paper presented at the DiGRA 2009.

Lenarcic, J & Mackay-Scollay, J (2005). Trading Card Games as a social learning tool. Australian Journal of emerging Technologies, 3(2), 64-76.

Land, K., Anreder, L. & Nelson, M (2005). NASA and the Pokémon Trading Card Game team to explain science to children. Retrieved from http://www.nasa.gov/home/hqnews/2005/mar/HQ_05056_NASA_and_Pokemon.html

Malone, T.W. (1980). *What makes things fun to learn? Heuristics for designing instructional computer games*, Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems, p.162-169, September 18-19, 1980, Palo Alto, California, United States

Phylo the Trading Card Game (2011). Retrieved from http://phylogame.org

Steinman, R. A., & Blastos, M. T. (2002). A trading-card game teaching about host defence. Medical Education, 36, 1201-1208.

Tobin, J. (2004). Pikachu's global adventure: The rise and fall of Pokémon. Durham, N.C.: Duke University Press.

Controlling Your Game Controls: Interface and Customization

Sonam Adinolf, Selen Turkay, Teachers College, Columbia University
Email: st2282@columbia.edu, sza2105@columbia.edu

Abstract

A game's interface is where players communicate with the game, so it has intrinsic importance to players. As player interactions in a game get more advanced, so does the complexity of the game interface. Massively Multiplayer Online game (MMO) interfaces are at the top of the complexity pyramid as they can display plentiful information such as character skills, stats, maps, chat windows. As the interface gets more complex, so does the merits of customizable interfaces. This paper reports results from a study which investigated the importance of interfaces and interface customization for MMO players using an online mixed method survey. Results validate that interface quality is important for players and interface customization is a desirable feature for player engagement and motivation to play MMOs. Further results are discussed in the paper.

Background

"I enjoy customizing the interface to maximize usability and provide information that's useful for improving gameplay." – (M117, WoW) [1]

In games, as with all products, usability is a top priority. Interface design has a large impact on a game's usability, and hence its playability. Just as people are less likely to use a mouse that gives them arm pain, they will shy away from headache interfaces. The quality of the game interface affects players' gaming experience as it impacts a game's playability.

The results of several studies on student control in Computer Based Instruction(CBI) point to positive effects of this control on elements of instruction (e.g., Corbalan, Kester & van Merrienboer, 2006; Kinzie, Sullivan & Berdel, 1988). Theories such as Flow theory (Csikszentmihalyi,1990) and Self Determination Theory (Deci & Ryan,1985) also point to the importance of user control for enjoyment and motivation. Still, while theories and CBI research exist implying that customization may lead to identification and ownership, and is related to motivation and achievement, research examining specific uses and effects of various types of customization in games is lacking.

Many games, especially massively multiplayer online games (MMOGs), offer players ways to customize their experiences, either through built-in options or the ability to create or obtain add-on software modules. This ability to customize allows players to personalize their avatars/characters and control aspects of their play experience. Doing so could lead to players identifying more closely with a game and "taking ownership" of it.

In this study, we decided to work with massively multiplayer online role playing games (MMORPGs) because of their complex systems and range of choices that they provide to players. MMORPGs are persistent, networked, interactive, narrative environments that support large numbers of people, either synchronously or asynchronously. MMORPGs allow players to move and interact in simulated realistic or fantasy environments through their game characters (or avatars). These features enable players to experiment in these simulated worlds.

Four games were used in the study reported here. These games were Blizzard's (2011) *World of Warcraft* (WoW), NC Soft's (2011) *City of Heroes/Villains* (CoX), Turbine's (2011) *Lord of the Rings Online* (LotRO), and *Dungeons & Dragons Online* (DDO). All belong to the same genre of digital games, MMORPGs. However, they belong to different sub-genres. WoW has a fantasy setting, taking place in the elf and dragon inhabited world of Azeroth. We chose WoW because it is the most popular MMO with over 10 million players. CoX has a superhero theme, with super heroes and super villains going about their extraordinary activities in Paragon City. We chose CoX because it has one of the most flexible avatar appearance customization tools among MMOs. LotRO is an MMO based on the books by J.R.R. Tolkien. Before the game was released, two visually spectacular movies were shot. We chose LotRO for the study because of its high avatar body customization, and also because it has far more narrative and solo content than the others. DDO is, as its name suggests, an online version of the popular pencil and paper RPG, Dungeons and Dragons. We chose DDO because it is a popular Free-to-Play game, which is a category we think worthwhile to investigate.

All four games have similar mechanics, allowing players to create and evolve characters. However, the degree of user control in various areas differs greatly. For example, the user control during character creation in CoX is widely acknowledged as among the most flexible in the field of gaming. Every body part can be colored to the user's preference, and most parts can have a variety of textures applied to them (e.g. scales and metallic shine). Control over height, weight, race, build, and skin color make LotRO the most body customizable game in our set, and cosmetic costumes make it a close second to CoX in the clothing customization area. After the initial steps when beginning the game, WoW has far greater options. It allows for massive customization of the interface. It supports user created addons (or mods) and macros. There is a wide variety of gear to choose from for characters to wear, though the appearance of that gear is not customizable as it is in some games. Finally, "re-speccing," the act of resetting the talents (or in the case of CoX, power sets) of characters is much more easily accomplished in WoW.

This paper reports results of a survey study with WoW, CoX, LotRO and DDO players regarding the importance of interface quality and interface customization (we will refer to WoW/CoX/LotRO/DDO as 'the game' or 'their game' while talking about these games in the rest of this paper). These results are a subset of a larger study about motivational and engaging effects of customization in MMOs, and how these factors are related to each other. In this study, the following operational definitions apply:

- Motivation is the desire of a player to come back and play a game repeatedly.
- Engagement is the state of mind that keeps a player playing during a given session.
- Enjoyment, perhaps the most subjective and elusive to define, is defined as having fun and being satisfied with doing an activity.

While doing that, we group customization into 3 broad categories (Turkay & Adinolf, 2010):

> Type I: Customization that affects game mechanics and dynamics directly, therefore, has a direct effect on players' game play. Customizing talent trees in WoW is an example of this type of customization.
>
> This type of customization mostly effect how player character can do in the game and may closely related to control of the character.
>
> Type II: Customization that does not affect game mechanics and dynamics. Avatar customization is an example to this type of customization. Although this type of customization is not directly affecting game play, it may affect players' enjoyment of the game.
>
> Type III: Customization that does not affect game mechanics and dynamics directly but may affect player performance, therefore, may have an effect on players' game play experience. Interface customization falls in this third category.

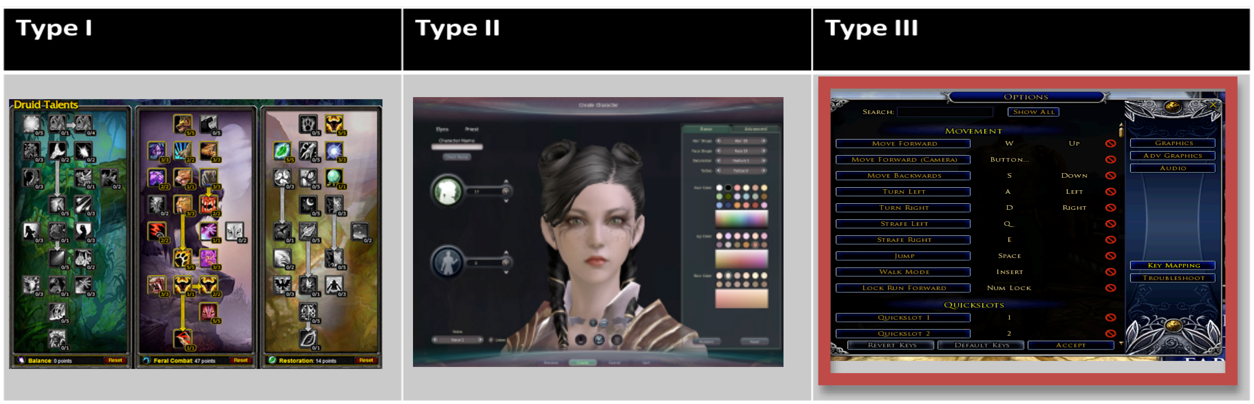


Figure 1. Types of customization in MMOs. Talent tree customization window in WoW, avatar appearance customization window in Aeon, and interface customization window in LotRO.

User Interfaces

When talking about computers, interface can include both hardware and software. The mouse, keyboard, or other controller people use, the monitor they look at, and the speakers they listen to are all interface. At the software level, the buttons they click, the fields they type in, the things they drag around, and the information displayed make up that level of interface. In this paper, we will be talking primarily about software interface, specifically game interfaces. Interface connects the player to the mechanics of the game and it determines the flow of the player experience. For the sake of brevity, we will not talk about the relationship between gameplay and interface but instead we refer the reader to Juul and Norton (2009)'s piece where authors talk extensively about the close relationship between gameplay and interface examining various games.

A game's interface can include passive components, usually informational displays, and active components, game controls. For example, on the interface of Pong, the score board is passive, while the controls to move the paddle up and down are active. Counterstrike, a first person shooter (FPS), has a slightly more complicated interface: Players control the view and their aim by moving the mouse; they can make their character walk, run, crouch and jump using the keyboard; and they can shoot by pressing their mouse button. There's also more information: Life, armor, time remaining, hostage meter, money, and ammunition. As the interactions and number of game assets to control or pay attention increase, the complexity of the interfaces also increases. As we move towards more complex interfaces, MMORPGs occupy top levels of complex interfaces pyramid. For example, WoW interface can have dozens of buttons, and hundreds of pieces of information. Below is a screen capture from WoW raid group.

As we move from Pong interface to FPS, players are given the chance to alter movement controls to suit their style, but the all the information you need is displayed at all times. In many MMOs, players have potentially dozens of abilities to assign controls to and have items they can acquire with active abilities that they need to assign to controls. There are numerous attributes of a player's character, and his/her interactions with the world, which a player may or may not be interested in seeing displayed.

As the level of complexity of interactions goes up, so does the possibility of cognitive overload. Attempting to process all the information on the interface may slow players' reaction time.

One way of dealing with or easing the effect of cognitive overload might be to allow players or games to customize the interface. The latter approach is often called a personalization or system driven customization (Blom & Monk, 2003). We will talk about user-driven interface customization which gives players option to control how their game UI will look and how they will interact and control game features through key bindings.

***Figure 2*. A cluttered World of Warcraft interface.**

Customization and User Control

Emerging technologies such as mobile phones, web portals, and games introduced broad possibilities for customization. Customization is about providing direct control of a system to the user. Studies on customization have included the appearance customization of mobile phones (Blom, & Monk, 2003), web portals (Sundar & Marathe, 2010), avatars (Vasalou & Joinson, 2009), and user interfaces (Findlater & McGrenere, 2010). Customizable systems give high priority to user control and involvement, and essentially make users the sources of their interaction with systems (Sundar, 2008). According to Sundar's (2008) agency model of customization, customizable options imbue users with a strong sense of agency and allow them to spell out personal preferences on interfaces. Today, most interfaces offer some sort of customization possibilities, ranging from simple font or color change on desktops and Web pages to more involved modifications (mods) in videogames.

When people customize, they basically make choices among given options. A large body of research suggests that providing individuals with choices leads to better performance and more intrinsic motivation when performing tasks as well as more overall satisfaction. Making choices also increase sense of control and persistence (Cordova & Lepper, 1996).

Sense of control/perceived control is related to many positive outcomes such as achievement, persistence, motivation and self-esteem (Skinner, 1996). It is proposed that because of the association of control with confidence, control promotes engagement and therefore fosters learning (Hedman & Sharafi, 2004). Self Determination Theory (Deci & Ryan, 1985), a meta-motivation theory, also suggests that autonomy is crucial for people's motivation, implying that if people feel control over an activity, they will feel more motivated to come back to do the same activity.

Three types of control that are relevant to games are decisional, cognitive and behavioral control (Averill, 1973). Decisional control was defined as the ''…range of choice or number of options open to an individual'' (p. 298). Increasing the number of features to customize in a game can increase decisional control. However, decisional control may decrease if the numbers of possible choices are increased too far. Players may feel unsatisfied (Schwartz, 2000) and too many unrelated choices may disengage users (Iyengar & Lepper, 2000). However, this may not be as detrimental since players usually are given options to re-do things. For example, in WoW, users can specialize in a certain skill such as healing or damage. If the user decides to choose a skill on their talent trees that will not be useful for their specialty, they can always re-do it through "re-speccing" their talents (and paying some in-game money).

Behavioral control is defined as ''direct action on the environment'' (p. 286). Being able to control game assets such as player character is related to behavioral control. Cognitive control deals with the ''interpretation of events'' (p. 286). A game's interface may affect cognitive control since it provides information for play. Assuming that media redundancy is managed on a game interface, increasing the number of assets on an interface may increase cognitive control as it provides more information about the state of the game play. Increasing the number of features on the game interface can therefore either support or undermine the players' sense of control. MMOs in particular require interpreting several pieces of information at the same time, so many user interfaces may look like the one shown in Figure 2. Therefore, it may be useful to allow players to choose the information they want to display on their game interface and how they want to display it. All three types of control can be manipulated through giving players different ways to customize their interface and game controls.

Interface Customization (Type III)

Customizable systems allow users to make changes to the form and content of interfaces. Hsu & Chen (2009) suggested that customizability should be design criteria for both passive and active parts of videogame interfaces. In fact, for many applications, interface customization is one of the most common types of customization and it can be also categorized into surface level customization and deep level customization (Bentley & Dourish, 1995). Surface level customization allows users to change cosmetic features from pre-given options. Deep level customization may require integration of external programs such as add-ons. WoW is unique among MMOs, allowing players to integrate mods which can change their game interface and may affect players experience with the game. This makes add-ons an important part of WoW players' game experience. There have been countless mods created, many of which are now widely used. Web sites like *www.curse.com* feature hundreds of mods for different purposes. In addition to using mods, creating them is also a popular practice among WoW community. In fact, to promote this practice, joystiq.com selects the best WoW UI each week out of tens of mods uploaded by players and announces the winner on their website. Because of their flexibility, adaptable interfaces can provide enjoyable experiences for players both at the level of customization and as a result of customization. The malleability of WoW UI provides players with more freedom to play their game and change it. This allows opportunities for players to create their own style interfaces which will increase the sense of belonging to the game.

Unfamiliar and complex interfaces may result in frustration and cognitive overload in MMOs (Ang, Zaphiris & Mahmood, 2006). Interface customization may allow players to manage and process information by allowing a closer match between users' cognitive resources and the cognitive demands of their gameplay experience.

To sum up, previous studies indicate that interface customization can be important to game play as it can provide attractiveness and functionality, as well as familiarity and ownership. The following section explains data collection methods, participants and data analysis.

Methodology, Participants and Data Analysis

A mixed survey method was used to collect data from online forums through snowball sampling. These forums were public and private WoW guild forums, and the official CoX, LotRO and DDO forums. Participation was voluntary and participants did not receive any payment or other compensation for their participation. The surveys asked questions about participants' demographic information. This included: age and educational background, their game characters, play styles, their enjoyment of game play based on different game features, their motivations to play, and the game features that they would like to customize.

As part of a larger survey, we asked four Likert scale and 2 open-ended questions regarding interface, motivation, engagement and interface customization (in the findings, we will refer to "4" in the Likert scale as "moderate extent" and "5" as "large extent".) Using ranges (e.g., 18 to 21 or 50 and over), participants indicated their age. Results show that participants ages ranged from 18 to over 50, with the largest percentage being between 26 and 30 years of age (21.1%). 20.1% of the respondents were between ages 21 and 25. This reflects almost identical trends when compared to existing data (Yee, 2006). We found out that some people who log on to gaming forums are former players, so we did not limit participants to current game players.

We also wanted to know whether the importance of interface on player engagement and motivation and effect of interface customization is different for expert players than the general population[3]. This combination of questions and their results then formed the basis of categorizing players into experts and others. Specifically, we gathered data on player expertise with four main questions: the number of months they played/have played the game being surveyed, the average number of hours they spent/spend playing this game, the level of knowledge they think they had about WoW/CoX/LotRO/DDO (from very low to very high – 7 levels), and the level of their characters. We defined expert players as those who played more than 20 hours a week, who played/have played the game for more than 2 years, who reported their knowledge of the game as "high" or "very high" and who had a game character of the highest level. Based on these criteria, we ended up with 100 expert players among our participants.

We analyzed the survey data using the quantitative data analysis software SPSS 17.0. Qualitative data (open ended questions) were analyzed with Nvivo 8, using inductive codes. Specifically, open ended questions were read several times by the author to identify themes and categories. In order to test for differences across the four games, analysis of variance (ANOVA) was performed, and differences between males' and females' responses were analyzed by an independent t-test.

There were 871 participants (129 female, 742 male). Out of those, 500 were WoW players (83 female, 417 male), 198 were CoX players (27 female, 171 male), 92 were LotRO (10 female, 82 male), and 81 were DDO (9 female, 72 male) players.

Findings

Findings indicate that interface customization is related to sense of control. As a male WoW player puts it, "Interface affects the core mechanics of the game, so flexibility here is desirable to allow for a player to process game information and interact" (M397). This is relevant to cognitive control. As related to behavioral control another WoW player states, "Interface customization: I like it when I can choose how am I going to control my character" (M172, WoW). Below we will examine the importance of interface for participants' engagement and motivation across gender, age, experience and four games.

Engagement and Motivation

"Interface should be very well designed … it needs to be as usable and customizable as possible." (M427, WoW)

Among all the participants, 34.8% said the interface affects their engagement in the game from a moderate to a large degree ($M = 3.11$). Effect of ability to control game play and effect of interface quality for engagement are correlated significantly ($p<0.001$; $r=0.294$).

The game interface also proved to be important for players' motivation to play the game. Specifically, 63.8% of the players reported that the interface was important from a moderate to a large extent as an influence for them to come back and play the game.

We found no statistically significant difference between male and female players' rating of the effect of interface customization on their engagement or motivation. The same was true for age. This indicates that value of interface quality for player engagement and motivation does not depend on player age or gender. However, ANOVA revealed significant differences between games on how much the interface affects player's engagement in their game. Specifically, WoW players think the interface plays a more important role in their engagement than LotRO ($p < 0.01$; $t = 3.215$) and DDO player do ($p < 0.001$; $t = 3.899$). WoW provides the most flexibility with interface and this might be one reason for their value of interface for their engagement. It seems that the extent of customization ability given to the players to modify certain feature influences how much players think that feature affects their engagement. Another possibility is that people who value interface control are more attracted to games with greater control. Of expert players, 59% said that usability of the interface is important for their engagement in the game (M = 3.591). This is slightly higher than the general population. One possible reason might be that the interface can allow expert players to fine tune their game-play and allows their game-play to be more efficient.

Customization

"You never get the "perfect" interface. There is always one little thing you want to "tweak". I find it fun to try and reach that ultimate UI." (F604, CoX)

In terms of interface customization, 54.2% of the players enjoy customizing their game interface from a moderate to a large degree. WoW mods[3] can't change the game world, but they do allow users to create modules and interface items to customize their game experience. Mods give WoW players an enormous amount of latitude when it comes to interface customization. This was reflected in our results. Significantly more WoW players than CoX/LotRO/DDO players favored interface customization as an important feature ($p<0.001$). ANOVA revealed significant differences among four game groups in terms of how much they would like further interface customization, $F(3, 868) = 7.834$, $p < 0.001$. Tukey's post hoc analysis test showed that WoW players want to have further interface customization options for their game more than CoX players do ($M_{WoW} = 3.27$; $M_{CoX} = 2.73$; $p < 0.001$). WoW players emphasized how important interface customization is for them in quotes such as: "A customizable interface is very important to me. The ability to move and configure action bars, as well as the ability to have information presented in a specific way, is essential" (M48, WoW). Players of CoX and DDO emphasized their desire for interface customization in open ended questions. Limitations of the interface was an issue for them. The following quote is representative of players' complaints about DDO interface: "…one of the largest features lacking from the game [DDO] is interface customization. The ability to scale the interface for different resolutions would be a great place to start. Being able to look at the downstream functions and customize graphics and sounds and customize the interface for upstream commands would be stellar" (M740, DDO). There was no significant gender or age difference in enjoyment of customizing game interface or desire to further customize the game interface.

90% of WoW players indicated that they use mods when playing the game. In fact, comments like "Mods, I cannot play WOW without an interface add-on" was very common.

Findings show a relationship with importance of interface for player motivation, engagement, enjoyment of customization and further desire to customize interface. For instance, if players enjoy customizing their game interfaces, interface quality is important for their motivation ($p<0.001$; $r=0.513$) and for their engagement ($p<0.001$; $r=0.404$). If players find the interface to be an important feature of the game for their motivation, they want to be able to customize it further ($p < 0.001$; $r = 0.385$).

When we asked what and why players enjoy customizing the most on an open ended question, five main features emerged: avatar appearance – type II (31.2%), talents/super powers – type I (22%), interface – type III (19.2%), character name – type II (10.5%) and character race/class – type I (8.1%). Other responses were more specific, for example, customizations of pets and music. Most stated reasons for interface customization were making game play more effective and aesthetics.

Conclusion and Discussion

"Interface - a game has to be easy to play or it loses my interest." (F295, WoW)

The quality of the game interface affects players' gaming experience as it impacts a game's playability. Challenge is one of the elements that makes games fun and motivating but challenge should not at the level of understanding and learning the game interface.

Complexity of MMO gameplay requires splitting attention among various game events and information displays. This calls for effort to make MMO interfaces more customizable in order to allow players to adjust what they see, and how they want to control their characters and use the given interface. This study showed evidence that interface customization is enjoyable to MMO players and being able to customize game interface and controls may affect players' engagement and motivation.

Another need for customizable game interfaces might be for players with disabilities, like this WoW player states "Customizable interfaces make me happy. I'm colorblind. I really need it most of the time."(M102)

Innovations in new technologies enable users to do several things that they were not able to do a decade ago. Game interfaces and how we interact with games are changing as new technologies like touch screens or control-free game systems like Kinect becomes more common place. Flexibility of interface and controls might be crucial for the success of games for these new systems.

Endnotes

(1) Through the rest of this paper, participant identifications are indicated as (M#, Game) or (F#, Game). M = male; F = female; # is a participant's identification number on the data sheet; game is the one they filled out the survey for.

(2) Mod or modification is a term generally applied to PC games. Mods are made by the general public or a developer, and can be entirely new games in themselves, but mods are not standalone software and require the user to have the original release in order to run (Sotamaa, 2007).

(3) By general population, we mean the entire pool of participants in this study.

References

Ang, C. S., Zaphiris, P., & Mahmood, S. (2006). *Cognitive Load Issues in MMORPGs.* Paper presented at the FNG2006, Preston, England.

Averill, J. R. (1973). Personal control over aversive stimuli and its relationship to stress. *Psychology Bulletin, 80*(4), 286–303.

Bentley, R & Dourish, P. (1995) Medium versus mechanism: Supporting collaboration through customization. In Proceedings of ECSCW '95, 133–148. Kluwer Academic, September 1995.

Blom, J. O., & Monk, A. F. (2003). Theory of Personalization of Appearance: Why Users Personalize Their PCs and Mobile Phones. *Human-Computer Interaction*, *18*, 193-228.

Corbalan, G., Kester, L., & van Merriënboer, J. J. G. (2006). Towards a personalized task selection model with shared instructional control. *Instructional Science, 34*, 399–422.

Cordova D.I., Lepper, M.R. (1996). Intrinsic motivation and the process of learning: beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology, 19*(88), 715–30.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York: Harper&Row.

Deci, E.L. & Ryan, R.M. (1985). *Intrinsic motivation and self-determination in human behavior,* New York, NY: Plenum Press.

Findlater, L., McGrenere, J. (2010). Beyond performance: Feature awareness in personalized interfaces. *International Journal of Human-Computer Studies (IJHCS)*, *68*, 121-137.

Hedman, L. & Sharafi, P. (2004). Early use of Internet-based educational resources: effects on students' engagement modes and flow experience*. Behaviour & Information Technology*, 23(2), 137-146.

Hsu, C.-C., & Chen, E. C.-H. (2009). *Exploring the Elements and Design Criteria of Massively-Multiplayer Online Role-Playing Game(MMORPG) Interfaces*. Paper presented at the Human-Computer Interaction, Part IV.

Iyengar, S.S., & Lepper, M. R. (2000). When choice is demotivating: Can one desire too much of a good thing? *Journal of Personality and Social Psychology, 79*, 995–1006.

Jonassen, D.H. (1999). Designing constructivist learning environments. In C.M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory.* Vol. II (pp.215-240). Hillsdale,NJ: Lawrence Erlbaum Associates

Juul, J., & Norton, M. (2009). *Easy to Use and Incredibly Difficult: On the Mythical Border between Interface and Gameplay.* Paper presented at the ICFDG 2009.

Kinzie, M. B., Sullivan, H. J., & Berdel, R. L. (1988). Learner control and achievement in science computer assisted instruction. *Journal of Educational Psychology, 80*(3), 299-303.

Schwartz B. (2000). Self-determination: the tyranny of freedom. *American Psychology*, *5*(1), 79-88.

Skinner E.A. (1996). A guide to constructs of control. *Journal of Personality and Social Psychology, 71*, 549–570.

Sotamaa, O. (2007) On modder labour, commodification of play, and mod competitions. *First Monday, 12*(9).Retrieved from http://www.uic.edu/htbin/cgiwrap/bin/ojs/index.php/fm/ article/view/2006/1881

Sundar, S. S. (2008). Self as source: Agency and customization in interactive media. In E. Konijn, S. Utz, M. Tanis, & S. Barnes (Eds.), *Mediated interpersonal communication* (pp. 58–74). New York: Routledge.

Sundar, S. S., & Marathe, S. S. (2010). Personalization versus customization: The importance of agency, privacy, and power usage. *Human Communication Research, 36*, 298–322.

Turkay, S. & Adinolf, S. (2010). Enjoyment of customization in multi user online games: A survey study with World of Warcraft and City of Heroes/Villains players*.* In the *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2010* (pp. 592-601). Chesapeake, VA: AACE.

Vasalou, A., Joinson, A. (2009). Me, myself and I: The role of interactional context on self-presentation through avatars. *Computers in Human Behavior, 25,* 510-520.

Yee, N (2006). The Demographics, Motivations and Derived Experiences of Users in Massively Multiplayer Online Graphical Environments. *PRESENCE: Teleoperators and Virtual Environments*, *15*, 309-329.

The Seven Circumstances of Game-Based Learning (a Worked Example and an Invitation)

Dylan Arena, Stanford University School of Education, Email: darena@stanford.edu

Abstract

In this worked example, I propose a framework for characterizing the learning that occurs in particular uses of a game for educational purposes. The framework is based upon the ancient Greek rhetorical structure that evolved into the "five W's" of modern journalism (who, what, when, where, why—the Greeks also had "how" and "with what"). This framework is just one (worked) example of how we might achieve the larger aim of this proposal, which is to encourage game designers and researchers to be explicit about the theories of learning, goals, and contexts that undergird their designs or analyses, which might help the field of game-based learning research to develop a common language and facilitate exploration of the many regions of what I consider a high-dimensional space. In this example I describe the seven circumstances of game-based learning and offer examples of how we might locate particular games within this space.

The Seven Circumstances

The claim that "games are good for learning" is hopelessly vague. Game designers know that there is neither a universally representative game nor a universally representative gamer, and educational researchers know that there is neither a monolithic construct called learning nor a single target learner (Klopfer, Osterweil, & Salen, 2009). Instead, there are taxonomies, matrices, dimensions, categories, genres, styles—of games, of gamers, of learners, and of learning. One simple and potentially useful structure for thinking about the many different ways games can be used for learning is that of the seven circumstances of a rhetorical hypothesis. This structure, developed by the ancient Greeks (and the ancestor of the five W's of journalism), consists of the following questions: who, what, when, where, why, in what way (i.e., how), and by what means (i.e., with what) (Robertson, 1946). For the purposes of structuring the space of game-based learning, we can formulate those seven questions as follows:

Who is the learner?

This question refers not only to demographic features of the learner (e.g., age, gender, cultures) but also his or her prior experiences in the learning domain (prior exposure, self-concept, etc.).

What is being learned?

This question refers both to the curricular content of the game—e.g., mathematics or social studies—and also to the nature of that content: is the game intended to reinforce low-level procedural skills, to encourage a certain type of thinking, or perhaps to instill a particular set of values? (The question of what is being learned also depends strongly upon the theory or theories of learning underpinning the game's educational use. For example, as Kirriemuir and McFarlane (2004) point out, behaviorist, cognitive, and socio-cultural paradigms might have drastically different definitions for what constitutes learning in a given context.)

When does the learning occur?

Some games are intended to reinforce learning that has already occurred before gameplay; other games are intended to deliver the bulk of a curricular unit during gameplay itself; and still other games may be intended primarily to provide experiences that will support learning after gameplay.

Where does the learning occur?

Similarly, some games are designed to deliver complete learning experiences entirely inside the game itself; other games rely on what Gee (2005) has called the affinity space surrounding the game (the social interactions that spontaneously arise around good games); and yet other games depend upon an explicit curriculum designed to complement the game.

Why is the learner playing?

This question considers the learner's motivations: whether gameplay is voluntary or compulsory, curricular or extracurricular, intrinsically or extrinsically motivated, etc. (Note that a learner's answer to this question might not be what an outsider would expect: e.g., Barab, Gresalfi, and Ingram-Goble (2010) report children in a game-based learning experiment responding that they were playing a game "because they wanted to" even though they had actually been required to play the game.)

How does the learning occur?

Games may deliver their learning content in a number of ways, such as repetition, drill-and-practice, direct instruction, free or guided exploration, and/or trial-and-error. Of particular importance here is the question of whether the game's learning content is divorced from or integrated into the game's core mechanics (Habgood, Ainsworth, & Benford, 2005).

With what does the learning occur?

This question differentiates among purpose-built games (games that are designed and implemented from scratch for educational purposes); "modded" games (games that are the result of customization of existing commercial games); and commercial, off-the-shelf games (games that are repurposed essentially unchanged for educational purposes).

Elements of Success in Various Regions of the Space

Using these seven questions, we can characterize and evaluate examples of game-based learning that occupy different positions in what we can consider a high-dimensional space (1). Just as there is no single type of game or of learning, there is no single recipe for success in game-based learning. Different types (and uses) of games have been and can be successful in achieving different goals. As Klopfer et al. (2009) write:

> Some recipes work really well for some groups of people, in certain contexts, with particular expectations. Similarly, in creating experiences that are both fun and filled with learning, the success of different recipes (mixes of media, immersion, styles of games, learning goals, mixtures of content, etc.) depends quite a bit on the audience, context, content, goals, and facilitation.

I will now present examples of games that are effective supports for various kinds of learning. Some of these games are humble in their aims, some quite ambitious; some of these games reflect fairly traditional pedagogical design, while others exemplify newer design strategies for engaging 21st century learners. I hope that these examples will illustrate that there is no single path to success in game-based learning.

Successes in Using Games to Teach "Traditionally"

Simple drill-and-practice games that are little more than flashcards can be fun and effective ways of helping a learner memorize or solidify his or her knowledge of simple facts such as word definitions or math facts.

Periodic Table of the Elements

The first level of the website-based game *Periodic Table of the Elements* (*PTE*) (available for play at http://www.sheppardsoftware.com/Elementsgames.htm) involves nothing more than clicking on the chemical symbol that corresponds to the name of particular element (e.g., "Pb" for lead). On subsequent levels, players type in the name of an element whose position on the Periodic Table is highlighted, then drag and drop chemical symbols into the appropriate positions on the Periodic Table, and finally type in the name of an element given only its atomic number or atomic mass. In addition to these levels, the game offers different speed options, rudimentary scorekeeping (number correct, percent correct, elapsed time), and various audiovisual feedback elements for right and wrong answers. The rules and mechanics of this game are simple, even mundane, and obviously reminiscent of traditional school tests. Yet the game is useful: it succeeds at its goal of providing learners with practice storing and retrieving facts about the Periodic Table.

We can apply our seven circumstances framework to locate *PTE* in the space of educational games. *Who?* The requirement that the learners understand English and have Internet access constrains the population somewhat, and the game's narrow content focus makes it most interesting for students in introductory Chemistry courses, probably at the high school or community college level. The simplicity of the game's mechanics—essentially digital flashcards and matching—and the range of levels means that it can accommodate learners with a wide variety of achievement histories in the science domain, from high achieving high school students to struggling remedial students. *What?* The primary learning content of the game is facts about each known element: its chemical symbol, location on the Periodic Table, and basic atomic properties. *When? PTE* does include a separate introductory lesson in the Periodic Table, but the vast majority of players probably come to the game having already been exposed to this in their classes. Most of the learning that occurs in *PTE* happens during gameplay itself. *Where?* The pre-gameplay learning will probably have occurred as part of a formal curriculum; the during-gameplay learning occurs within the game rather than in any surrounding affinity space or formal curriculum. *Why?* Learners probably play *PTE* voluntarily, outside of school, for instrumental reasons (i.e., because the game is useful rather than because the game is fun). *How? PTE*'s main learning mechanism is simple trial-and-error with the possibility of repetition (if a learner gets a question wrong, that question is flagged so that the learner can revisit it later). *With what? PTE* is a purpose-built educational game: it was initially intended by its designers to be used for an educational purpose.

Medical Procedural Simulations

Another simple type of educational game is that of a procedural simulation, which can help with automatization of surgical techniques or other procedural skills (2). Rather than focus on any single simulation, I will consider features of effective medical simulations in general to map their location in the space of educational games. A recent review of 109 studies of such simulations (Issenberg, McGaghie, Petrusa, Lee, & Scalese, 2005) lists the following features as leading to effective learning (in decreasing order of importance):

1. Feedback is provided during the learning experience.
2. Learners engage in repetitive practice.
3. The simulation is integrated into the medical curriculum.
4. Learners practice with increasing levels of difficulty.
5. The simulation is adaptable to multiple learning strategies.
6. The simulation captures clinical variation.
7. The simulation is embedded in a controlled environment.
8. The simulation permits individualized learning.
9. Learning outcomes are clearly defined and measured.
10. The simulator is a high-fidelity approximation of clinical practice.

As with *PTE*, we can locate effective medical simulations in our high-dimensional space. *Who?* Learners using these simulations are almost exclusively medical students or practicing physicians. *What?* The learning content of the simulations is procedural skills relevant to various medical practices such as surgery or anesthesiology. *When?* While some base of relevant procedural skills is expected to have been acquired before gameplay, the bulk of the learning—in the form of procedural fluency—is intended to occur during gameplay. *Where?* The pregameplay learning will probably have occurred as part of a formal curriculum; the during-gameplay learning occurs largely within the game, although the third feature listed above suggests that this learning is intended to be supported by an accompanying formal curriculum as well. *Why?* Learners use these simulations primarily because they are required elements of medical training or professional development. Learners might very well also be motivated by the instrumental value of these simulations, which are demonstrably effective in improving the learners' skills. *How?* The first and second features listed above suggest that the primary mechanism for learning is repetitive practice with immediate feedback. The eighth feature listed above suggests that this practice probably occurs at a level of difficulty that is optimally challenging for each learner, producing a flow state (Csikszentmihalyi, 1988). And because the core game mechanic in each simulation *is* the learning content—e.g., in a surgical simulation, the core mechanic is the performance of various procedural elements of a surgical operation—the learning content and game mechanics are intrinsically integrated. *With what?* These simulations are probably all purpose-built for use in medical training.

Successes in Reaching for Higher Hanging Fruit

The examples of *PTE* and medical procedural simulations are intended to demonstrate success in reaching for low-hanging fruit. We know how to use games to teach simple facts or procedural skills, with only slight tweaks on effective pedagogical practices that have existed for centuries. Game-based learning researchers have set their sights higher, though, to determine what features might characterize a "good" game for learning more complex things, including the skills and dispositions students need in the 21st century. These efforts have led to published guidance from several research groups. For example, Futurelab identifies "key issues in developing games for learning" (Kirriemuir & McFarlane, 2004, p. 19); the Education Arcade proposes "Learning Games Design Principles" (Klopfer et al., p. 28); and the Games for Learning Institute has even tried to create a "universal" rubric for evaluating learning games using a set of 17 design patterns that good learning games may have (Kinzer, Hoffman, Turkay, Nagle, & Gunbas, 2010).

Some of these principles have already been touched upon in this discussion: e.g., attainment of Csikszentmihalyi's (1988) flow state is a much sought-after goal not just for medical procedural simulations but for most of today's serious games (Kirriemuir & McFarlane, 2004), as is Habgood et al.'s (2005) intrinsic integration of game mechanics and learning content (see also Habgood & Ainsworth, 2011), which bears a family resemblance to Klopfer et al.'s (2009) focus on "finding the fun in [the] learning" (p. 27) and designing around that. Another principle that has been mentioned in passing but not fully explicated is situating learning in a meaningful context, so that a learner knows exactly how to use the knowledge and skills he or she is acquiring (Gee, 2003). An extension of this is an emphasis on allowing a learner to playfully assume powerful new projective identities (Gee, 2003)—hybrid identities of self-as-protagonist in the game's narrative—that allow the learner to perceive the world according to particular epistemic frames (Shaffer, Squire, Halverson, & Gee, 2005; Shaffer, 2007). These principles are not universal. Not every good learning game will have them. They have, however, been found to work, as shown in the following examples.

Zombie Division

Multiplication, division, and factoring are procedures in the elementary mathematics curriculum that can be successfully reinforced with simple drill-and-practice games like the venerable *Math Blaster* franchise from the edutainment era. Habgood (2007), by way of demonstrating the value of intrinsic integration of learning content and game mechanics for his doctoral dissertation, set out to improve upon this model by creating the 3-D adventure game *Zombie Division* (*ZD*). In a representative game from the *Math Blaster* series, the learner might take on the role of a space pilot shooting asteroids that have numbers displayed on them. In *ZD*, the learner takes on the role of a Greek hero, fighting with sword, shield, and armored gauntlet against a horde of zombie skeletons that have numbers displayed on their chests. In *Math Blaster*, the learner might be required to shoot the asteroid whose number represents the answer to a displayed division or factoring problem (e.g., "Which number is a factor of 27?"). This same game mechanic, however, could work unchanged for, say, a spelling problem: the mechanic is not intrinsically integrated with the learning content. The way *ZD* presents the same factoring problem is not as a question but simply by displaying the number 27 on the chest of an approaching zombie skeleton. The learner answers this problem by selecting the appropriate attack to destroy the enemy: the sword (with two ends) represents the factor 2; the shield (with a triangle emblazoned on it) represents the factor 3; and the gauntlet (with five fingers) represents the factor 5. To destroy a skeleton with the number 27 on its chest, the learner must use a shield bash, effectively factoring by 3. In both games, the learner practices factoring while having fun. In *ZD*, though, the learning content is intrinsically integrated into the game mechanics.

Bringing our seven circumstances framework to bear on *ZD* highlights its differences from a game like *Math Blaster*, which is a close neighbor of both *ZD* and *PTE* in the high-dimensional space (although for different reasons). *Who?* Learners playing *ZD* are upper elementary students who are proficient in but not masters of basic multiplication and division. *What?* *ZD* is intended to reinforce the mathematical skill of identifying factors of a number. *When?* Although some learning is assumed to have occurred before gameplay, the primary focus of *ZD* is learning (in the form of increased fluency) during gameplay. *Where?* Most of the learning in *ZD* will occur within the game; however, researchers also included a teacher-led reflection session after students' first exposure to the game but before the bulk of their gameplay (Habgood, 2007; Habgood & Ainsworth, 2011), which locates some learning outside of both the game and its affinity space in a separate formal curriculum. *Why?* Learners may be required to play *ZD* by their math teachers, but the game could also be offered as an option in an informal learning context such as an afterschool computer club. (In fact, researchers offered *ZD* as one option among many during free computer lab time and measured the amount of time students spent playing it to estimate intrinsic motivation.) *How?* Learning occurs in *ZD* mainly through intrinsically integrated drill-and-practice. *With what?* *ZD* is a purpose-built game, designed to explore the value of intrinsic integration of gameplay and content.

Quest Atlantis

A game that incorporates both intrinsic integration and the acquisition of epistemic frames is *Quest Atlantis* (*QA*) (Barab et al., 2010). *QA* is a massively multiplayer online role-playing game (MMORPG), a genre that is currently dominated in the commercial industry by the game *World of Warcraft*. In *QA*, thousands of children from all over the world participate in a shared narrative about restoring power to a magical artifact that will make the planet New Atlantis into an ecological paradise. The way learners make progress toward this goal is by completing quests and missions that are tied to particular curricular units. For example, in one quest, learners must investigate a serious decline in the fish population in a national park. Learners are hired for this quest as environmental scientists, and to succeed in the quest they must take ownership of that role, which entails coming to see the world as an environmental scientist might—i.e., taking on a projective identity of self-as-scientist and thereby appropriating the epistemic frame of an environmental scientist. To demonstrate the pedagogical value of this learning paradigm for her doctoral dissertation, Arici (2008) conducted a two-week comparison study with sixth-graders. Four intact science classes taught by the same teacher were randomly assigned to either the *QA* or traditional version of a water-quality unit. Pretests showed no significant differences by condition. Posttests showed significant learning for both conditions, with the *QA* condition scoring significantly higher than the traditional condition and retaining significantly more information at the time of a delayed posttest. In addition to outscoring their traditional-condition counterparts, students in the *QA* condition were more engaged, as demonstrated by surveys as well as the fact that approximately 75% of the students in the *QA* condition chose to complete optional activities in the game for no credit, whereas only 4% of the students in the traditional condition completed a similar optional assignment for extra credit. This work suggests that offering learners the opportunity to take on projective identities as professionals, whose actions have meaningful consequences, even if only in an imaginary world, can be a powerful design choice (Barab et al., 2010; Shaffer, 2007). A seven circumstances interrogation of *QA* shows it to be relatively similar to *ZD*, but with some notable distinctions. *Who?* *QA* supports learners from elementary to high school, but the bulk of its learners are middle school students. Basic familiarity with the relevant science content is all that is expected by way of prior achievement. *What?* "Questers" in *QA* learn facts and skills related to the practice of inquiry-based science and science reporting (different quests offer different specific content). Learners also identify and engage with different identities and epistemologies as part of their appropriation of epistemic frames as researchers, journalists, advocates, etc. *When?* Most learning in *QA* happens during gameplay. *Where?* Learning in *QA* happens at all three levels: within the game itself, in online message boards that serve as part of the affinity space of the game, and in formal curricula designed to complement gameplay. *Why?* Learners typically play *QA* as part of required curricular units in school, but once involved in this way, "questers" often log in to participate in extracurricular quests from home (Barab et al., 2010); i.e., gameplay is initially compulsory but often eventually elective—and, as noted above, intrinsically motivating. *How?* Learning in *QA* is inquiry-based; learners construct their own knowledge by interacting with non-player characters (NPCs) and other players as part of elaborate narratives. Within *QA*, they gather information through experiments, interviews, and archival research to form and then test hypotheses or to support arguments. *With what?* *QA* is a purpose-built game, designed from the ground up to test theories of learning.

Conclusion

It is perhaps obvious that games such as *Periodic Table of the Elements* and *Quest Atlantis* exist in quite different regions of the space of game-based learning. Without some common language to describe these two games, though, it would be difficult to specify the nature of these differences. The seven circumstances framework I have proposed to characterize game-based learning allows us to examine the claim that both of these games are "good" with respect to a certain set of goals, in a certain context, according to certain theories of learning. This framework is only one example of how this common language might be developed. My hope is that this example serves as an invitation to other researchers to take up, improve upon, or propose an alternative to the framework, in the spirit of the worked-examples project (Gee, 2010).

Endnotes

(1) This discussion focuses on digital games, but the framework I propose would work equally well for non-digital games.

(2) A reader might object here that a procedural simulation is not a game. Attempts have been made to differentiate games from non-games, but in general the community has chosen to err on the side of overinclusion. In that spirit, procedural simulations have enough game-like features—high interactivity, creation of a flow state (Csikszentmihalyi,1988), immediate feedback, etc.—to be included in the taxonomy of serious games created by Sawyer and Smith (2008).

References

Arici, A. (2008). Meeting kids at their own game: A comparison of learning and engagement in traditional and 3D MUVE educational-gaming contexts. Unpublished doctoral dissertation, University of Indiana, Bloomington.

Barab, S. A., Gresalfi, M., & Ingram-Goble, A. (2010). Transformational play: Using games to position person, content, and context. *Educational Researcher, 39*(7), 525-536.

Csikszentmihalyi, M. (1988). The flow experience and human psychology. In M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.), *Optimal experience* (p. 15-35). Cambridge, UK: Cambridge University Press.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy* (1st ed.). New York, NY: Palgrave Macmillan.

Gee, J. P. (2005). Semiotic social spaces and affinity spaces from The Age of Mythology to today's schools. In D. Barton & K. Tusting (Eds.), *Beyond communities of practice: Language, power, and social context* (p. 214-232). Cambridge, UK: Cambridge University Press.

Gee, J.P. (2010). New digital media and learning as an emerging area and "Worked Examples" as one way forward. MIT Press.

Habgood, M. P. J. (2007). The effective integration of digital games and learning content. Unpublished doctoral dissertation, University of Nottingham, UK.

Habgood, M. P. J., & Ainsworth, S. E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. *Journal of the Learning Sciences, 20*(2), 169-206.

Habgood, M. P. J., Ainsworth, S. E., & Benford, S. (2005). Endogenous fantasy and learning in digital games. *Simulation & Gaming, 36*(4), 483-498.

Issenberg, S. B., McGaghie, W. C., Petrusa, E. R., Lee, G. D., & Scalese, R. J. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review. *Med Teach, 27*, 10-28.

Kinzer, C., Hoffman, D., Turkay, S., Nagle, C., & Gunbas, N. (2010, June). Toward a universal game design assessment tool: Establishing a game design patterns rubric. Paper presented at the Games, Learning, and Society Conference 6.0, Madison, WI.

Kirriemuir, J., & McFarlane, A. (2004). Literature review in games and learning (Technical Report). NESTA Futurelab.

Klopfer, E., Osterweil, S., & Salen, K. (2009). Moving learning games forward (Technical Report). The Education Arcade.

Robertson, D. W. (1946). A note on the classical origin of 'circumstances' in the medieval confessional. *Studies in Philology, 43*, 6-14.

Sawyer, B., & Smith, P. (2008). Serious games taxonomy. Retrieved December 22, 2010, from: http://www.dmill.com/presentations/serious-games-taxonomy-2008.pdf.

Shaffer, D. W. (2007). *How computer games help children learn* (1st ed.). Palgrave Macmillan.

Shaffer, D. W., Squire, K. D., Halverson, R., & Gee, J. P. (2005). Videogames and the future of learning. *Phi Delta Kappan, 87*(2), 104-111.

Acknowledgments

Most of the interesting ideas in this paper came from other people (all properly cited, of course), but I owe a particular debt to conversations with James Paul Gee. This work was partially supported by the MacArthur Foundation's Digital Media and Learning initiative.

Research Results for Mecanika: A Game to Learn Newtonian Concepts

François Boucher-Genesse, Martin Riopel, Patrice Potvin, Université du Québec à Montréal,
Email : francoisbg@gmail.com, riopel.martin@uqam.ca, potvin.patrice@uqam.ca

Abstract

A large body of research in mechanics indicates that interactive engagement teaching methods usually have higher chances of influencing students' conceptions than direct instruction. A few researchers specifically studied the impact of videogames on Newtonian Physics instruction through empirical means, with some limited success. *Mecanika* is a free online game that sets itself apart from previous work by simply offering puzzling physics situations, without attempting to explain the theory in the game. Students who used the game as homework, facilitated with classroom debriefings and guidebooks, wielded significantly higher gain than a control group on the standard Force Concept Inventory test. Students who only played as homework registered a similar gain, even though *Mecanika* was never mentioned the classroom. This gain was unexpected, since the game does not make any physics concept explicit, and was designed to be integrated in a classroom setting.

Mecanika trailer: www.youtube.com/watch?v=0yCTHV9Qv44
The game: www.gameforscience.ca/physica

The state of physics education

Many educators are advocating a qualitative and conceptual approach to understand Newtonians physics, which does not start with mathematical formulas, but rather with experiences, laboratories and demonstrations focused on students' conceptions (diSessa, 2001). Basing themselves on this large body of research, the Organisation for Economic Co-operation and Development recommends we make teaching physics more attractive, and focus on conceptions (OECD, 2008). These conceptions are often referred to as common sense intuitions based on observations made in everyday life. An example of a classic erroneous conception (hereby referenced as misconception) is to think that two balls of different weights, dropped at the same time from the same height, will hit the floor at different times.

Hestenes published a test that could reliably be used to assess whether students held conceptions that were Newtonians or erroneous: the Force Concept Inventory (Hestenes, Wells, & Swackhamer, 1992). The test is even recognized by its detractors to be the best available tool to assess mechanics teaching efficiency (Heller & Huffman, 1995). Perhaps the most interesting finding that followed is that traditional instruction (e.g., passive-student lectures, recipe labs, and algorithmic-problem exams) fail to convey much conceptual understanding of physics to the average student. Interactive-Engagement methods (i.e., methods designed at least in part to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors), however, were found to be much more successful (Hake, 1998).

Mecanika

A few researchers specifically studied the impact of videogames on Newtonian Physics instruction through empirical means (Potvin & et al., 2010; Rieber & Noah, 1997; White, 1984), although the most recent results were achieved by Clark & et al. (2010) with *SURGE*. We started to work on our own mechanics game, *Mecanika*, around the same time as work on *SURGE* began, and took a different approach by simply offering puzzling physics situations, without attempting to explain them explicitly in the game. The game also differentiates itself from the others by being a reflexive puzzle game: players do not have to react to quick events, and need to pause to predict the outcome of their actions.

***Figure 1*. A classic mistake in level B1 (backgrounds removed), which is related to the "last force to act determines motion" misconception**

The game's goal is to create a path of robots that will direct scouts over a set of stars. The scouts are produced by the top-left machine in Figure 1, and are basically inert boxes. In this simple introduction level, for example, you start the level in a zero-gravity environment with a punching robot already placed at the exit of the machine, which will give scouts an impulse in the right direction. Players have to place another impulse robot in the level, which will give an equally powerful hit downward. Most students will at this point place the impulse robot directly over the second star, expecting the scout to move in the Y axis only, as shown in Figure 1. This is a misconception that Hestenes (2006) identified as "CI3 - last force to act determines motion". Players will eventually realize that both impulses have an impact on the scout's direction, and place the punching robot over the first star to reach the second one (see Figure 2).

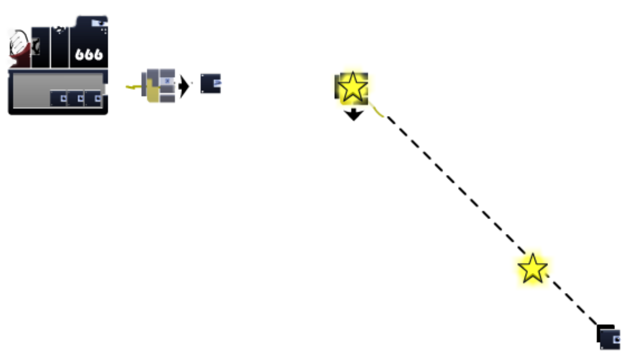


***Figure 2*. The solution to level B1**

Mecanika features 50 levels, each focusing on misconceptions identified by Hestenes (2006). Players place robots that generate impulses, continuous force areas, circular movement, or even toggle gravity. Since the game is designed to be played as homework, considerable effort was spent on the production value of the game to make it a compelling activity for students at home. The game was developed by researchers at the University of Quebec in Montreal and the Creo Montreal game studio over the last two years. It contains 3 to 4 hours of gameplay, and is available for free at www.gameforscience.ca/physica.

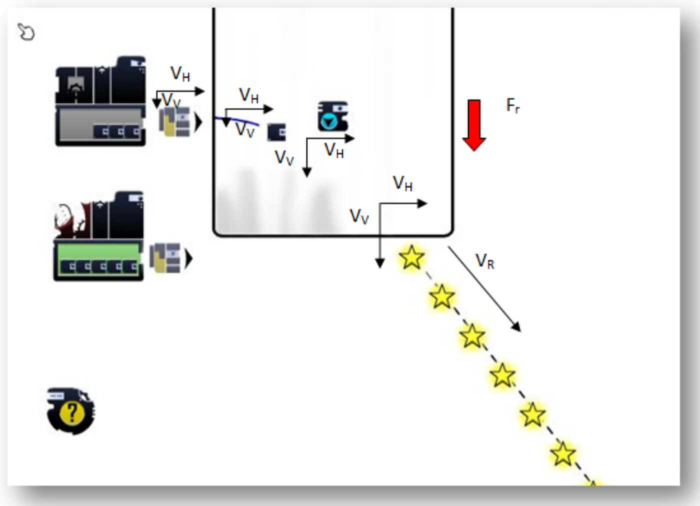


***Figure 3*. A sample illustration from the teacher's guidebook**

Formal understanding of the mechanics concepts happens in the classroom, where teachers use detailed pedagogical guidebooks (100+ pages, see Figure 3) to explain what students intuitively learned in the game. Students also have to describe why they think their own puzzle solutions worked. These guidebooks are available to teachers and researchers, along with videos that explain the material behind each level, on a teacher's portal. Access to this portal is restricted, but will be granted if you email francoisbg@gmail.com from a school/university email. An English version of the guidebooks will be available by the end of summer 2011.

Research methodology

The game was studied in real classroom environments, in order to benefit from any instructional support that could occur there (O'Neil, Wainess, & Baker, 2005). The research methodology can be seen in Figure 4. Two teachers, each with four classrooms, participated in the study. The first part of the experiment is a typical experimental/control group setup with post and pretests. Each teacher first had their students take the Force Concept Inventory test, and taught as they would regularly for two of their classes. The two other classes got the same instruction, from the same teacher, but also played *Mecanika* as homework. They then filled out their student's guidebooks, and teachers debriefed them in the classroom about their game experience. Finally students from all groups took the FCI test again as a posttest.

One teacher used the game over one month; the other used the game sporadically throughout the term over a three months period. The overall time spent on the game, guidebooks, and classroom debriefings is about the same for both teachers, and they both used about the first two thirds of the game's levels.

***Figure 4*. The research procedure used to study *Mecanika*. Two different ways to use the game in the classroom were studied, each time comparing to a control group.**

In the second part of the experiment, students that played the game stopped using it, and continued with regular instruction. The players that did not yet play the game played it as homework, but did not receive paper guidebooks to fill, and did not benefit from classroom debriefing. They were only told to play the game as homework over a one month period. Every student then took the FCI test again.

Results and discussion

Impact with classroom debriefings

In the first part of the experiment, the control group did not see a significant increase in their overall FCI score ($p=0.08$, +1.9%, effect size $d=0.19$, $N=82$), but the experimental group had a significantly different gain ($p<0.001$, +9.2%, effect size $d=0.95$, $N=51$). The changing variables between the experimental and the control groups are the inclusion of *Mecanika* and guidebooks as homework, and the game discussions that happened in the classroom. This is an important result, since most game studies using a control group end up with similar results between the two groups (Hays, 2005).

The effect size is measured using Cohen's d, and can be considered to be a "large" effect (over the 0.8 threshold). But a perhaps more telling way to assess if the game caused a significant gain would be to look at other instruction methods that were studied using the same FCI test. One such study was conducted by the authors of the Force Concept Inventory in a nation-wide experiment called the Modeling Instruction Project. The researchers designed "an intensive 3-week Modeling Workshop that immerses [teachers] in modeling pedagogy and acquaints them with curriculum materials designed expressly to support it" (Hestenes, 2006). 66 teachers participated in this experiment (N=3394), which was conducted over a full term. As illustrated by Figure 5, the teachers which participated in the modeling workshop registered an important gain over the term, a gain which was 10% higher than the control groups.

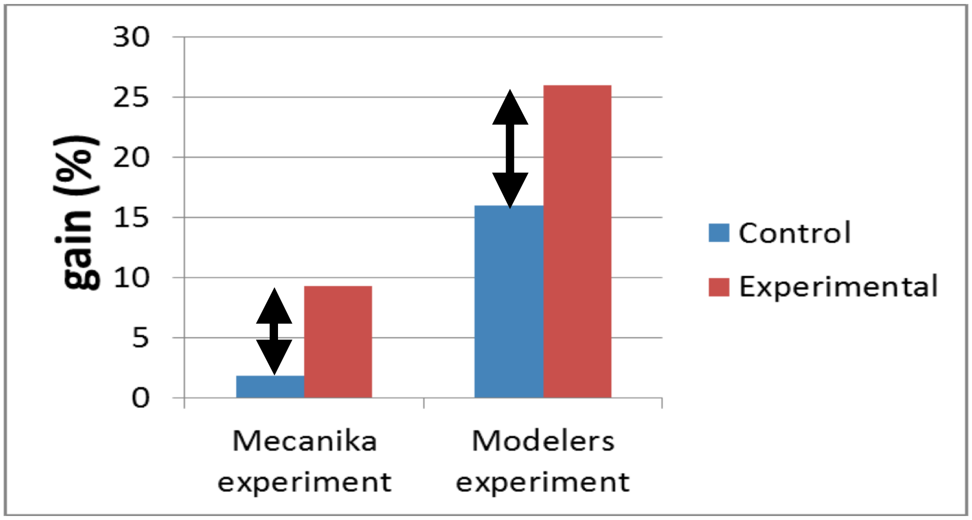


***Figure 5*. Gains for the *Mecanika* and Modelers Instruction Project experiments. Both gains, when compared to their control groups, are of comparable size.**

The *Mecanika* experiment was in comparison much shorter, but still produced a difference in gain between the experimental and control group of 7.4%. What is further interesting is that very limited training was given to the teachers: no more than 30 minutes was spent talking about the game in person. The results by no mean indicate that we should give the game to teachers instead of training them properly, but they do point to the possibility of rapidly enhancing students' Newtonian conceptions just by giving the game and pedagogical guidebooks to teachers across the country.

We were able to gather how much each student has played through *Mecanika*, and could thus observe which portion of the game seemed to cause a more important FCI gain (see Figure 6). The first ten levels were used to teach game mechanics, which would explain why no significant increase was found between groups. Levels 20 to 30 also did not seem to have much of an influence on FCI items. A potential explanation could be that although these levels contained situations similar to the ones seen in the FCI, the game and the test contexts were different.

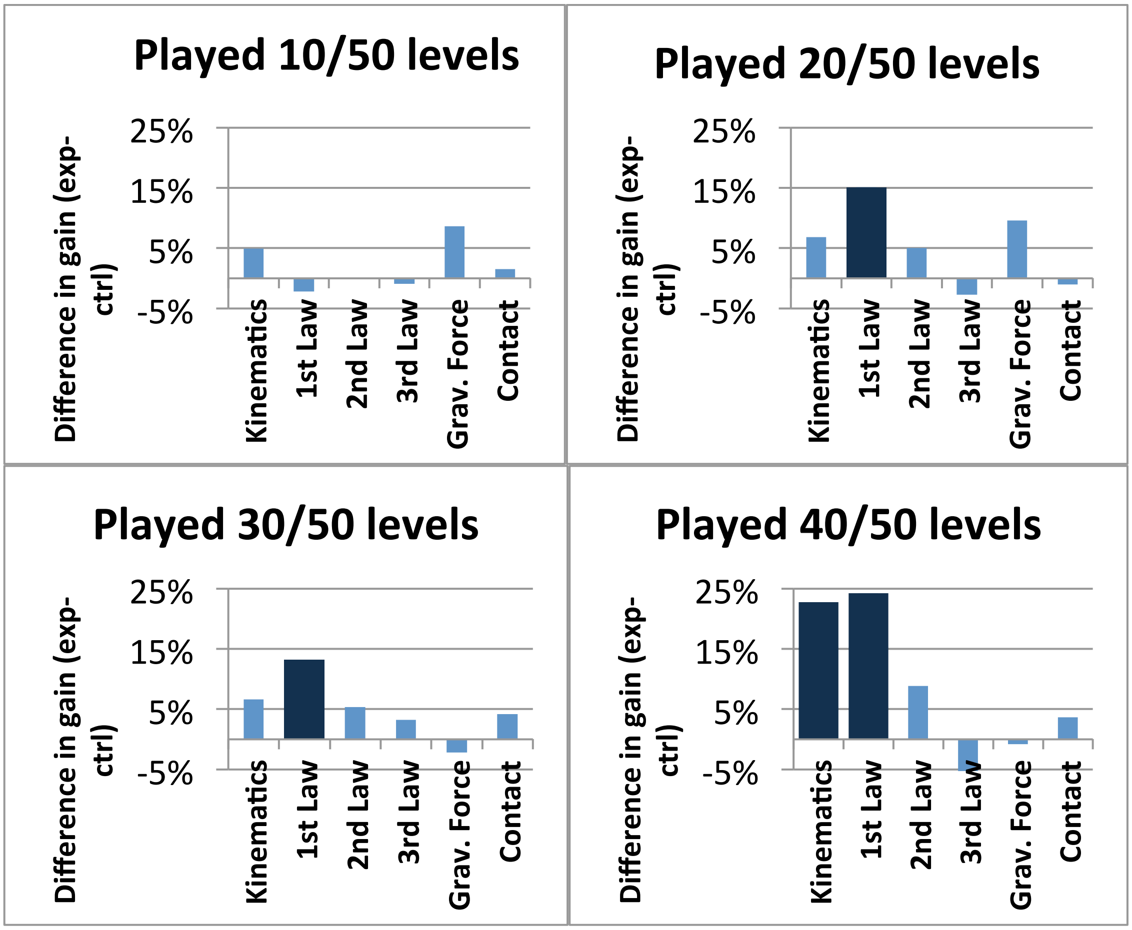


***Figure 6*. Difference between the experimental and the control group gains, categorized by concept. Students have been separated by their progression in the game. Larger and darker columns represent a difference in gain, which was significantly different (p<0.05).**

By dividing the FCI items in categories, the game's impact can also be studied more closely (Savinainen & Scott, 2002). Most of the overall test gain can be attributed to increases on Newton's First Law and on Kinematics FCI items. The game should thus be used when talking about these principles in the classroom. The focused impact was to be expected, since the game design didn't target all concepts covered by the FCI; the game's scope had to be limited in order to keep a consistent game design throughout all levels. The remaining levels at the end of the game were designed to focus on other concepts, but were not tested.

Impact without classroom debriefings

By looking at the experimental setup, one could wonder if the gain really happened because students played the game, or because they had guidebooks and classroom debriefings about it. The second part of the experiment can shed some light on this matter, since students that didn't play the game yet played it later as homework only. Teachers had explicit instructions not to talk about *Mecanika* in their classrooms. Since the game never explains concepts clearly, or even names the observed situations, the hypothesis was that the game by itself would have a much smaller effect than if the guidebooks and classroom debriefings were used as well. Not having debriefings also meant that the students would play for about 1.5 hours at some point in the month. We further thought that measuring an increase in gain for such a short activity over a full month would be much harder. We were surprised to see that the students got a gain (p=0.02, +7.3%, effect size d=0.59, N=26) which is not significantly different from the students which had guidebooks and classroom debriefings. The lower number of participant is explained in the limitations section.

One could look at these results and make the hypothesis that the gain is due to the teachers changing their instructions methods. If that was the case though, we would argue that we would also see an increase in the control groups, which was not the case. We are left to guess that either or both of these following hypotheses can explain the relatively high gains: 1 – the guidebooks were poorly designed, or the classroom debriefings could have been done better, or 2 – most of *Mecanika*'s potential comes from just playing with it.

Additional findings

Girls and boys did not get a significant gain difference, but when asked, boys did think that the game and the guidebooks were more useful, and that the game was more fun ($p<0.05$, effect size ranges from d=0.43 to d=0.49). It is also interesting to note that the gain registered by the experimental group in the first part of the study was left virtually intact one month after. The concepts were retained and no significant difference was observed during the last month of traditional instruction (p=1.00, +0.0%, effect size d=0.00, N=55).

Limitations

The previous statistics had a low amount of students in experimental groups. The reasons are twofold. First, some students were not able to play since the game was at times lagging too much. *Mecanika* is integrated in a larger flash MMO-like world, http://www.gameforscience.ca, which at the time slowed down considerably when more than twenty people joined in simultaneously. This bug, combined with the fact that *Mecanika* is a pretty heavy flash game, made it not playable for many: 48% of students said they had technical problems that prevented them from playing at some point. The second reason that could explain a lower-than-expected participation rate is that play was made mandatory by teachers, but wasn't reinforced by making the results count on their class score for example.

Another important limitation to this study lies in that only two teachers participated to the study, despite the relatively large number of students. More teachers would have allowed us to see if other ways of debriefing on the game in the classrooms could have result in higher gains. The two teachers we had were also not randomly selected – they were recruited for their interest in the project. We should add though that one of them was not acquainted with technology, and obtained similar gains to the second teacher, which played games regularly.

Conclusion

Multiple interesting research avenues remain, such as investigating if we could train teachers to make a better use of the game, or doing A/B testing to investigate the impact of some game mechanics on learning. These research questions can be easily answered, since we now know that the game will most likely have a measurable impact. The research team is open to share the game and resources with other teams in order to investigate these questions, and can be reached by using the contact information on this paper.

Mecanika will be publicly launched in the Fall of 2011, and is mostly finished at this point. Much design insight was gained from studying the learning results from the game, and the company behind the game's graphics and story, Creo, is now looking for funding on the second iteration of the game.

The findings presented in this paper make it clear that even a low involvement on the part of teachers, by giving the game to play as homework, helps transform the students' conceptions into Newtonians conceptions. Whether or not other means of using the game in classrooms, computer laboratories or at home could wield higher results is still an open question.

References

Clark, D., Nelson, B., D'Angelo, C., Slack, K., & Garza, M. (2010). SURGE: integrating Vygotsky's spontaneous and instructed concepts in a digital game? In *Proceedings of the 9th International Conference of the Learning Sciences - Volume 2* (pp. 384-385). Chicago, Illinois: International Society of the Learning Sciences. Retrieved from http://portal.acm.org/citation.cfm?id=1854509.1854709

diSessa, A. (2001). *Changing Minds: Computers, Learning, and Literacy*. Cambridge: The MIT Press.

Hake, R. R. (1998). Interactive-engagement vs Traditional Methods in Mechanics Instruction. *American Journal of Physics*, *66*(1), 64-74.

Hays, R. T. (2005). *The Effectiveness of Instructional Games: A Literature Review and Discussion*. Retrieved from http://stinet.dtic.mil/oai/oai?&verb=getRecord&metadataPrefix=html&identifier=ADA441935

Heller, P., & Huffman, D. (1995). Interpreting the force concept inventory: A reply to Hestenes and Halloun. *The Physics Teacher*, *33*(8), 503.

Hestenes, D. (2006). Notes for a Modeling Theory of Science, Cognition and Instruction. Presented at the GIREP conference: Modelling in Physics and Physics Education.

Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force Concept Inventory. *The Physics Teacher*, *30*, 141-158.

OECD. (2008). *Encouraging student interest in science and technology studies*. OECD Publishing.

O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of Learning Outcomes: Evidence from the Computer Games Literature. *Curriculum Journal*, *16*(4), 455-474.

Potvin, P., Riopel, M., Charland, P., Ayotte, A., & Boucher-Genesse, F. (2010, October). *Enhancing performance in the "Force Concept Inventory" test using homework gameplay while involving physics teachers in the level design process : SpaceFart*. Presented at the Meaningfulplay 2010, East Lansing, MI.

Rieber, L., & Noah, D. (1997). Effect of Gaming and Visual Metaphors on Reflective Cognition Within Computer-Based Simulations. Presented at the AERA conference, Chicago, IL. Retrieved from http://it.coe.uga.edu/~lrieber/gaming-simulation/

Savinainen, A., & Scott, P. (2002). Using the Force Concept Inventory to monitor student learning and to plan teaching. *Physics Education*, *37*(1), 53-58.

White, B. Y. (1984). Designing Computer Games to Help Physics Students Understand Newton's Laws of Motion. *Cognition and Instruction*, *1*(1), 69-108.

Acknowledgments

The researchers would like to extend their special thanks to Creo, without which *Mecanika* would have never reached the esthetical level, production value and users it currently has. They would also like to extend their thanks to the Inukshuk organization, which funded the first iteration of the game, allowing it to be available online for free in both French and English.

Reframing Interaction: Designing for Disciplinary Participation

Lisa Brahms, University of Pittsburgh Center for Learning in Out of School Environments, Learning Research and Development Center, 3939 O'Hara Street, Pittsburgh, PA 15260, Email: ljb37@pitt.edu

Abstract

A central issue of designing informal learning environments is balancing highly engaging experiences with deep disciplinary content. This study uses the construct of *framing* to examine one approach to balancing this inherent tension through a collaborative design process between a group of contemporary artists and a children's museum. By focusing on the ways in which participants frame and negotiate the shared experience of design, this study provides insight into designing interactive learning spaces that enable meaningful participation for all involved in their creation and use.

Introduction

A central issue of designing interactive learning environments is balancing highly engaging experiences with deep disciplinary content. In this study, we examine one approach to balancing this tension through a collaborative design process between a group of contemporary artists and a children's museum.

Similar to the ongoing debate and industry-wide struggle for videogames to be considered spaces and mechanisms for authentic disciplinary learning (Barab et al., 2010), the notion of museums as places of learning is a very new concept in the long institutional history of museums.

As physical venues designed to offer their users first-hand, self-directed experiences with authentic disciplinary objects and practices, museums face an identity conflict: Do they exist as keepers and stewards of the world's material heritage and authoritative scholars of cultural history; or do they exist as interpreters of culture for a diverse visiting public? Of course, museums do both. But, as a result of this historical identity conflict, museums, by and large, are still wrestling with the question of how to support learning in meaningful ways. Such discontinuity presents challenges to the learning context, as the disciplinary objects and concepts on display become caught in a kind of tug-of-war between the professional desires of a field of experts, and the learning needs of a novice public. So, how do museums balance these competing tensions to design a meaningful learning experience? This study explores the work one museum is doing in their effort to find this balance.

The Children's Museum of Pittsburgh is committed to providing families a comfortable and safe space to experience creativity and curiosity through play, as well as to inspiring their community to think differently and innovatively about their world. This is done in two notable ways: through the in-house exhibit design philosophy, "play with real stuff," which promotes an organizational dedication to original contemporary design and material familiarity for visitors, and through commissioning, exhibiting, and cultivating established and emerging contemporary interactive artwork.

One avenue of cultivation is the Museum's annual *Tough Art* residency. Each summer, four emerging artists are invited to develop a work of art that preserves the artist's intention, while becoming responsive to, and able to withstand the hands-on environment and audience of the Children's Museum. Artists do this through observation of visitors, critical dialogue with each other and museum professionals, prototyping their artworks on the Museum floor, and modifying their work in response to these experiences.

Study Design and Theoretical Foundation

In this process, the question of meaningful participation emerges within the principal design tension, or tug of war, between the Museum's commitment to providing powerful interactive experiences though designed exhibits, and the artists' intention to make a personal contribution to the discipline of art.

This ethnographic case study included the participant groups of artists, museum staff, and visitors. Qualitative data, gathered through participant observation includes transcribed interviews with participants throughout the design process, as well as collected artifacts, naturalistic observations, field notes, and audio recordings of participants' activities.

We use the theoretical construct of *framing* to analyze this collaborative process. Framing is the theoretical construct used to determine how an individual or group begins to answer the often tacit question: What is it that's going on here? Framing has primarily been used within the context of science classrooms as a tool for understanding the ways in which students frame their activity with respect to knowledge and learning and how these framings can be more or less productive for advancing instructional goals (Hammer, et al., 2005; Hutchison & Hammer, 2009). In this case, we map this approach onto an artist's trajectory of experience through the Museum's residency as a way to help explain the inherent tension in designing interactive disciplinary learning experiences.

Framing is a dynamic cognitive process of aligning events and objects of prior experience into relationship in present experience (Tannen, 1993; Hammer, et al, 2005; Hutchison & Hammer, 2009, Scherr & Hammer, 2009). When learners approach any context of activity, they bring to that context bits of knowledge, or cognitive resources, and histories of participation in past experiences that combine to compose a "structure of expectations" (Tannen, 1993). As individuals and groups work to frame an experience, they may attend to different environmental affordances (Gibson, 1918/1979)—signals, signs and triggers of expectation—which activate certain cognitive resources and indicate the type of activity in which they are engaging. As a result, participants may alter the framing when it appears appropriate. In this way, aspects of framing may shift, while others remain rather "sticky" or impervious to change (Hammer, et al, 2005; Hutchison & Hammer, 2009). Over time, participants may progressively refine and reorganize their activated resources, accommodating new resources, and building up a more coherent or meaningful pattern of activations for use in the specific context of activity (Scherr & Close, 2010).

Analysis of artists' participation over the course of the residency revealed that artists were using two dominant framings to make sense of their practice-in-context, those of art and exhibit. These framings become explanatory lenses for the tension, or tug-of-war, between disciplinary content and learner engagement.

To locate these shifts in framing, segments of artists' interviews that related to the artists' process and pieces were lifted. Each segment was then coded and charted using a five-point scale on both art and exhibition. Degree of "artness" ratings were based on artists' self-defined notions of art and their artistic process. A rating of 5 means that the artist's statement reflected a high degree of commitment to their concept of art and artistic practice, whereas a rating of 1 means that their statement did not. Degree of "exhibitness" ratings were based on the Museum's notions of successful exhibits and site-specific design. A high score on this dimension includes consideration of visitor perspective, simple intuitive visitor use, length of time visitors spend with a piece, methods of engagement for diverse audiences, the iterative process of design, and the robustness and reliability of a piece. Graphs were made for artists at each major interview time-point, allowing us to see artists' shifts in framing over time. The figure you see reflects the proportionate values of one artist's statements at each time-point across his trajectory of participation in the tough art residency (Figure 1). Here, we tell the story of an artist whose experience in the residency exemplifies this dominant tension between framings of art and exhibit.

Blaine's Concept:

In anticipation of the Tough Art residency, Blaine proposed projects that would evolve a specific area of his recent practice that he termed "performative installations." These are inflatable sculptures made of found and recycled materials such as cardboard boxes and household plastic bags. The sculptures inflate in response to motion sensor signals from the movement of the sculpture's adjacent viewers. As such, his work is intentionally interactive in that it depends on visitor movement to inflate and animate the pieces. Yet once the works are inflated, Blaine explains that the viewer becomes "nothing more than the viewer, you know, just bringing a lens to the piece that already exists." In line with this comment, Blaine makes it clear that his work is never created for an intended audience. Rather, Blaine creates art for himself. However, he hopes that his art, like all good art, removes the viewer from their everyday experience: "…makes you see the world differently."

Through his initial interview, Blaine identified two salient interrelated practice-based resources that he brings to the creation of his work: material choices and relational aesthetics. Blaine's choice and use of materials are integral to the conveyance of his artistic intention. Through his previous use of familiar materials such as cardboard boxes and recycled plastic grocery bags, Blaine makes comments about the socioeconomic consequences of humanity's actions. Blaine sees his pieces as somewhat fragile "creatures" that, as a result of his material choices, "have a life span" in that they grow, through the inflation of air, and over the course of a few months, expire.

Blaine's resource of relational aesthetics is the practice of allowing the environment in which a work is exhibited to influence the creation of the work itself: "so I come in with a bunch of ideas…but until I find a room and how that room works, and for lack of a better term, the energy in that room…my piece is going to be pretty malleable to different things."

Blaine incorporated these practice-based resources into the structure of expectations with which he approached the residency. Before the residency began, Blaine saw the Tough Art experience as an opportunity to develop his practice in a new direction:

> For like two or three years I've been working on inflatable installation and I have it down, pretty much. To the point where I'm kind of, well it just needs to evolve into something else. Because I've mastered what I can do with it, but now it's like okay we're going to make them extra durable and they're

> going to change and [through] their durability their meaning is somewhat going to change (Figure 1, Concept, 4, 5).

In accordance with his practice of conveying meaning through material choices, Blaine recognized that in order for his work to become durable, the materials he chooses to use will have to change, and with this, the intention and conveyed message of his work will necessarily change. At this point in the process, Blaine welcomes and is encouraged by this possibility for change-in-practice. Since he is speaking about intentional changes in his art practice, this statement was given a *five* on the art dimension. And since robustness is a clear component of a successful exhibit, it was given a *four* on the exhibit dimension.

Similarly, he looks forward to the ways in which the context of the residency, which includes the affordances of the physical space of the Museum, as well as the people with whom he will interact, will influence the creation of his piece as he activates his resource of relational aesthetics:

> It's [artwork's concept] just going to keep going through permutations in my mind until I actually get into the space and start working. Once I'm in the space and once I'm talking to people from the museum...that's going to get up the ability for me to make choices about things, limitations are going to occur, and the piece is going to be able to form naturally that way (Figure 1, Concept, 5, 5).

Blaine's structure of expectations includes the affordances of a dynamic, collegial environment for evolving an existing line of practice in a productive direction when combined with his own practice-based resources. At this point, before the residency begins, Blaine is clearly framing his experience as art making. The context in which he creates will influence his work in a similar manner to previous contexts of his creation. Rather than presenting a challenge to his practice, this influence is an opportunity for artistic growth.

Blaine's Plan:

The week-long orientation to the Museum and residency introduced, what for Blaine, became the dominant practice-based tension of *designing exhibits* for *others* versus *creating* art for *oneself*.

> "It's an ongoing conversation back and forth in my mind and it all kind of came out of orientation. I started off feeling like I needed to compromise what I wanted to do, and that I needed to make it this design element, tough thing. Do something that wasn't what I do, to make it fit into the museum." (Figure 1, Plan, 4, 1)

Consequently, Blaine began to notice unanticipated affordances of the Museum, and to draw upon a different set of practice-based resources to negotiate his framing of his own practice-in-context.

For example, Blaine recognized that the context of the Museum demanded that his work be made for the explicit audience of children. Being immersed in the Museum, prompted Blaine to reconsider his understanding of children; their view of the world, and their use of materials through play:

> I was reminded of how children if you give them one thing with it's intended use and they will find five other uses for it. So the way they look at the world- the open-mindedness and the latitude with which they look at the world. I was reminded of that. And also reminded, you know, literally, how tough children can be on things. How destructive. But also at the time same, very creative. (Figure 1, Plan, 5, 2)

Initially, this realization presented a conflict between Blaine's traditional practice of making for himself, rather than for the viewer, and with that, his choice of materials:

> "You know, I build—I make my work, and people experience it. But it's just having to have these other considerations, you know? Like it needs to be durable—especially with what I do. The thing that is difficult is the context with which children see inflatable things. It's bouncing jungle gyms…[but] if I use more durable materials, then it's not really my work, I'm changing too much. Um… and I want to stay true to the conceptual basis of how I work. (Figure 1, Plan, 4, 2)

Upon reflection, Blaine was able to use these perceived affordances as tools when viewing them in light of his own practice-based resources.

> I'm coming to a nice compromise where I'm like okay, I can cater to kids somewhat, because I do think they have the best imaginations and through orientation I started watching how children interact here, I'm thinking how they've interacted with my pieces in my past. And so there's nothing wrong with creating specifically for them, and I can still do it in my manner. It's a realization of the line between what I do and working for someone else and how to make that balance. And orientation presented that issue and then helped me figure that out. (Figure 1, Plan, 3, 4)

Establishing this tension, Blaine has begun to call upon his own practice-based resources and histories of participation to help him negotiate his framing of experience-in-context.

Blaine's Prototyping:

Mid-way through the residency, Blaine's conception of his work in thought and form had changed dramatically, due in large part to his commitment to finding the "balance," or what could be called *frame alignment* he had spoken of months earlier.

> This fine line that you're walking. Being true to yourself as an artist and being able to satisfy the requirements of this program, um for an interactive art piece that has properties of being an exhibition…So that's been both a struggle and something that's very interesting and a unique challenge. It's a very different beast than just creating a piece. So that's kind of dominated my thinking. (Figure 1, Prototype, 3, 3)

In order to maintain the identity of his piece as a work of art, as opposed to exhibitory, Blaine further called his practice-based resources of relational aesthetics and material choices into action in ways both consistent with his traditional practice, as well as in ways highly influenced by the immediate affordances of the context.

Artists were allowed to choose any physical space within the Museum to position their work. This site-specificity enabled Blaine to employ his practice of relational aesthetics, or creating work in response to its physical environment. Blaine chose to create his piece in the Museum's art studio. This is a light and airy, historic room with a large dome ceiling. In response to the architecture and aesthetic of the room, Blaine altered the materials he chose to use in its composition, and with it, the appearance and intention of his piece.

> It's become much more streamlined in the use of materials. What I originally really wanted to do, it wouldn't match the room that I'm responding to so something that was more amorphous and very weighty has become something that's much more linear and lighter to match what happens with the room. So there's been a big change. But that's not uncommon when I work. You start with one idea and you just have to stay receptive to the work speaking back to you. And in this case there's a lot of things you need to pay attention to speaking back to you. The space, the work, again the nature of making this thing that children can interact with but still realize is a work of art…(Figure 1, Prototype, 4, 5)

Rather than continuing to think of the charge of creating explicitly for children as a discordant constraint, Blaine began to see this affordance through his resource-based lens of relational aesthetics—the physical environment expanded to include the relational context.

The program-based requirement of prototyping was very influential to Blaine's overall process of creating. As the physical space initially guided Blaine's understanding of the form his work should take, prototyping aspects of his work on the Museum floor with visitors furthered this line of thinking as it informed the kinds of visitor interactions his piece would elicit.

> The first prototype, the kids took the hose and started blowing it around, so I thought about how wonderful and how beautiful it was…so it influenced the interaction, but it also started to influence the form the piece is going to take because then I started thinking about *moving* upward into the space, as opposed to just *looking* upward *at something*… (Figure 1, Prototype, 5, 5)

Visitor use of his prototypes helped Blaine to notice features of the context differently than he had previously, and allowed him to recognize how such features could become usable affordances when combined with his practice-based resources. Whereas before prototyping, he looked solely at the physical features of the space, now he was able to see how visitors' intuitive and unexpected use of environmental features, such as a child's natural inclination to put a tube in a hole, and the joy of blowing air in the face of a friend, could be purposefully utilized in the intention and animation of his art.

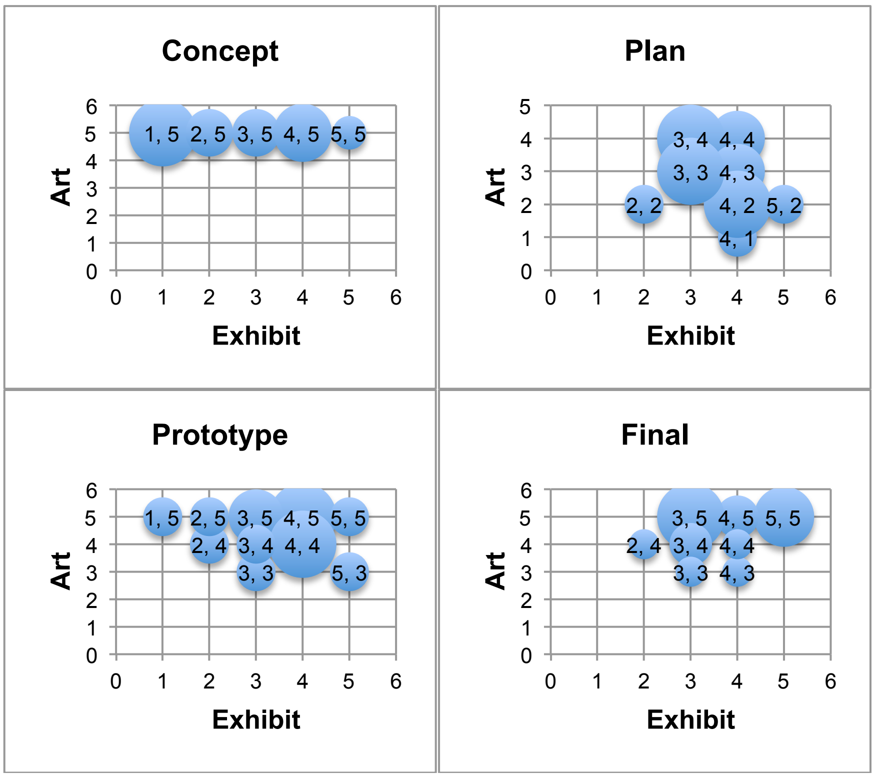


Figure 1. **Blaine's Trajectory of Participation, Framing Analysis**

Concept: 1 week before residency begins
Plan: 8 days into the residency
Prototype: approximately 50 days in the residency
Final: approximately 90 days in the residency

Blaine's Final

Between Blaine's prototype interview and the opening of the tough art show, his piece further changed in numerous ways. What began as a primarily inflatable form became an installation of winding tubes and pipes through which air passed, filling the art studio with whistling sounds. Tubes, affixed with handles, encouraged visitors to experiment with connecting the loose ends of streaming air to different holes in the body of the structure, thus producing various tones, depending on the combination of tube, pipe, and hole. Blaine chose to include relics of his former practice, by capping the tops of some pipelines with a Mylar or plastic grocery bag.

Through his resource-based practice of responding to his context, Blaine was able to make material choices that were both satisfying to his art practice, as well as robust enough to withstand constant family use. Rather than sticking with his traditional, fairly fragile materials of cardboard boxes and reused plastic grocery bags, Blaine instead turned to other, more robust materials—plumbing and air duct tubing—that were familiar to visitors, and for Blaine communicated an intention consistent with his art practice.

Negotiating this shift in framing, Blaine activated and combined his most resonant cognitive resources of relational aesthetics and material choices in new ways, enabling the context to feed, rather than restrict his process. This progression, led Blaine to mine and discover a useable combination of affordance and resource that allowed him to fulfill his personal expectation of growing his art practice:

> An intentional device to create sound, I've never done. So that was a good one for me. And honestly that was just through listening to materials, which I always try to do. Like what is it's basic nature? What is it used for? How can that be altered? So realizing that piping is more or less just a vehicle for air passing through, all of a sudden it's like, "oh that's exactly what a pipe organ is, or a recorder" so I was like, "okay, can I work with that?" So that was new, and that was fun (Figure 1, Final, 3, 5).

Although Blaine openly resisted the framing of exhibit to interpret his process and piece, in the end, he found true value in his audience's experience of his work. When asked what aspects of his piece were most successful, Blaine immediately replied:

> Watching the kids, watching them put it together. I give them enough of an idea about the language of how to operate it that they see the holes, they see the pipes, and they kind of figure it out. So watching them do that, and then watching with their parents help, discover the rewards for their actions (Figure 1, Final, 4, 3).

This shift in framing, which recognized the exhibit-minded considerations of simple intuitive, collaborative visitor use, and diverse methods of engagement for different audience demographics, were balanced by Blaine's unwavering fidelity to his practice-based resources, as well as his commitment to conveying his artistic intention:

> I liked that I was able to use everyday materials for a different purpose, that's big with what I do, and that was pretty successful. Sometimes you can use new materials and you're not using them in a very innovative way…But it was transformed enough because I used plumbing supplies to make music and to make inflatable sculpture…So more than anything I was just happy it did its job to change peoples mindset about the everyday. (Figure 1, Final, 5, 5)

Through the ongoing and, for him, rather explicit negotiation of framings of art and exhibit, Blaine was able to find a comfortable place of overlay. By progressively attending to the diverse and unexpected affordances of the context, and purposefully activating his own practice-based resources, Blaine participated in personally meaningful participation-in-context.

Conclusion

I have used the theoretical construct of framing as a tool to unpack the inherent tension between audience engagement and disciplinary content when designing interactive learning experiences for children and families. The tension at play in this case is emblematic of those inherent to any disciplinary design: when intentions of the artist or designer mingle with the objectives and learning goals of the client or user. Shifting and aligning framings is no easy task, and the process of frame negotiation may be different for diverse participants depending on the resources they choose to activate and the affordances to which they attend. Locating these points of difference and tension, as well as those of overlap and balance between participants' framings of experience, we may better understand notions of meaningful disciplinary participation in spaces of informal learning, and ultimately design experiences that enable meaningful participation-in-context for all.

References

Barab, S. A., Gresalfi, M., Dodge, T., Ingram-Goble, A. (2010). Narratizing disciplines and disciplinizing narratives: Games as 21st century curriculum. *International Journal of Gaming and Computer-Mediated Simulation, 2*(1), 17-30.

Gibson, J. J. (1986). *The ecological approach to visual perception*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc. (Original work published 1979).

Hammer, D., Elby, A., Scherr, R. E., & Redish, E. F. (2005). Resources, framing and transfer. In J. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (pp. 89-120). Greenwich, CT: Information Age Publishing.

Hutchison, P., & Hammer, D. (2009). Attending to student epistemological framing in a science classroom. *Science Education*. Wiley Periodicals.

Scherr, R. & Close, H. (2010). Transformative professional development: Cultivating concern with others' thinking as the root of teacher identity. Proceedings from the *9th International Conference of the Learning Sciences,* Chicago, IL.

Scherr, R. E., & Hammer, D. (2009). Student behavior and epistemological framing: Examples from collaborative active-learning activities in physics. *Cognition and Instruction, 27(2), 147-174.*

Tannen, D. (1993). *Framing in discourse*. New York: Oxford University Press.

A Path of Deploying Game-Based Learning into Classroom: An Empirical Study on Multiple Mice Supported One-Digit Addition Exercises Minigame

Ben Chang, National Chiayi University, 85 Wenlong, Mingsuin, Chiayi Hsien, Taiwan 62103,
Email: ben@ncyu.edu.tw
Nian-Shing Chen, National Sun-Yat-Sen University, No. 70, Lienhai Rd., Kaohsiung 80424 Taiwan, Email: nschen@mis.nsysu.edu.tw
Ming-Puu Chen, National Taiwan Normal University, 162, HePing East Road Section 1, Taipei, Taiwan, Email: mpchen@ntnu.edu.tw
Hao-Jan Howard Chen, National Taiwan Normal University, 162, HePing East Road Section 1, Taipei, Taiwan, Email: ntnuhjchen@yahoo.com.tw

Abstract

Game-based learning has emerged, and it is hopeful in having a radically transformative effect on schooling. However, in many ways, the resulting scope of the schooling transformation is not so much as that we had hoped for. Videogames have demonstrated the potential in engaging the kids, but, in general, schools are not ready for applying videogames. Using videogames in school is not only a technical problem, but also a set of problems covering content designs, students' learning achievement evaluations, parents' opinions, and the social culture values. In addition, deploying game-based learning into classroom is not like applying traditional software in school. In this study, we will discuss the potential obstacles of applying game-based learning in the classroom, and describe several concerns on applying game-based learning in school from teachers, students, and social culture perspectives. An empirical study applying multiple mice technology in face-to-face one-digit addition exercise minigame is reported.

Introduction

Game-based learning has emerged, and it is hopeful that it can cause radically transformative effects on schooling. However, in many ways, the resulting scope of the schooling transformations are not so much as we had hoped for. Videogames have demonstrated the potential in engaging the kids as well as in learning purposes, but classrooms are not ready for adopting videogames. Adopting videogames in classroom is not only a technical problem, but also a cluster of problems including pedagogical designs (Cheng, Wu, Liao & Chan, 2009), content designs (Chang et al., 2009), teachers' roles, learning assessments, parents' opinions, and the social expectations. The students of this generation are digital natives and they have very high interests in using videogames in classroom; so adopting learning games in the classroom for them is not a problem at all. However, the classroom is not only a place where learning takes place; therefore, the game-based learning designers should also be concerned about the teachers, the parents and the society expectations.

In this study, several obstacles and concerns on applying game-based learning in the classroom are described from teacher, student, parent and social expectation perspectives. Besides, an empirical study of applying multiple mice supported one-digit addition exercises minigame is elaborated. The goals of the minigame are to facilitate the kindergarten teachers to enrich face-to-face interactions in the classroom, and to enhance the kids' one-digit addition number sense. Two game modes are designed. One is one-digit addition practice and the other is one-digit addition practice with game competition activity. The multiple mice technology is applied in the system, which means a computer can connect with more than one mouse. In this study, four mice were connected to a computer, and four kids could use the four mice simultaneously. Twelve kindergarten kids were involved in this study. The preliminary results indicate that the usability of the multiple mice supported one-digit addition minigame system was acceptable; the kids could use the system very well without any pre-training. The kids' attentions were improved a lot compared to the traditional arithmetic exercises. Some of the kids could answer more than thirty one-digit addition questions in seven minutes.

Concerns of Applying Game in Schooling

Games are a rich medium which provide a lot of benefits for learning. Many scholars advocate that the videogames are good for learning (Gee, 2003; Shaffer, 2007). As the information technology enhanced learning researchers, we all hope that the game-based learning, which is an effective and more engaged learning method, can be applied in the classroom. However, a school is a complex system which involves a lot of different groups of people, such as students, teachers, parents, principals, officers, and volunteers, and a place where there are a lot of social expectations. When talking about deploying game-based learning activities in schools, we not only focus on the students but other groups of people at school. No all of the groups of people can totally accept game-based learning approaches as the students do at school. Below, we will discuss the game design concerns, the teachers' options, and the culture issues in applying the game-based learning in the classroom.

Designing a Continuous Innovation Game in Classroom

Classroom is a place where equipped with a lot of affordances, such as desks, text books, resource materials and teaching aids. These affordances can be modified with the evolution of technology. The process of modifying these affordances needs a lot of complex and innovative designs which can much improve the classroom environment. The innovative evolutions can roughly be cataloged into continuous innovation (Boer & Gertsen, 2003) and discontinuous innovation. For example, electronic toothbrush is a kind of continuous innovation design comparing to the traditional toothbrush. A typical continuous innovation example in the classroom is the evolution of the blackboard. In the past, blackboards had occupied the classroom for several decades. Whiteboards, similar design to blackboard but with the character of being easy to erase and without chalk dust, have much improved the teachers' writing quality and take over the blackboard's role in the classroom. With the technology evolution, the single gun projector soon replaced the whiteboard in this decade. Recently, the electronic whiteboard makes the teaching and learning progress more active and more innovative to attract students and enhance the interactive chances. The evolution progress from blackboard to electronic whiteboard is a typical example of continuous innovation inventions affecting classroom settings. For teachers, a continuous innovation invention is much easier for them to adopt in the classroom rather than a discontinuous innovation invention. An extremely innovative tool for the teachers, and much different from the traditional classroom settings are the merits of the game, though it might cause the teachers to have much extra burdens. It will be much easier for the teachers to adopt a continuous innovation design approach as the game-based learning in the classroom.

Involving the Low Information Ability but Innovative Teachers in Game Design

School is a complex system that includes officers, principals, teachers, parents, students, and volunteers. Among them, teachers play a very important role if adopting game-based learning in classroom. They can decide whether the game can be applied in the classroom or not. In the case of applying information technology in the classroom like game-based learning software, the school teachers can roughly be divided into three categories. They are: 1) innovators, 2) followers, and 3) conservators (Chang, Chou, Chen & Chan, 2004). Innovative teachers willingly adopt new teaching strategies, software and technologies. These innovative teachers themselves can be further divided into two sub-groups of which one is the teachers with high information technology ability and the other one is the teachers with low information technology ability. High information technology innovative teachers generally can independently use information technology in learning effectively, but unfortunately only few percentage of teachers are innovators with high information technology ability. In general, most teachers are "followers." Followers imitate innovators once they see them applying game-based learning software effectively, and are particularly encouraged by the success of innovators with low information technology ability. Ideally, an event called the "migratory effectiveness of game-based learning" will occur once the percentage of followers applying game-based learning exceeds a certain threshold. Every school also contains a group of conservators. These teachers have become accustomed to their current existing teaching styles and are unable to easily adopt new teaching approaches. Based on the simplified scenario described above, the authors believe that the key to achieve the migratory effectiveness of game-based learning is to collaborate with the teachers who are innovators but with low information technology abilities.

Culture Issue

The term of game-based learning in Taiwan has been modified to a special name called joyful learning. The reason of using the term joyful learning instead of game-based learning is the culture issue in Taiwan as well as in the Asia-Pacific region. In the Asia-Pacific region with the Confucianism culture, the people used to have the belief that recognizing one's success is by his or her hard work rather than recreation. With this kind of belief, in general, the parents and adult citizens can't totally accept the pedagogies applying videogames in classroom. From this perspective, applying videogame in the classroom is not only a technological issue but a culture issue. When designing game-based learning software, the designers should be concerned with not only the functions of the software and the attractions for the students, but also the impressions from the society of the game.

An Empirical Study: Multiple Mice Supported One-Digit Addition Minigame

Human-computer interaction researchers have been trying and much supporting for the development of multiple mice design of which a computer can be equipped with many mice, and the users can use the mice on the computer simultaneously (Infante, Weitz, Reyes, Nussbaum, Gomez & Radovic, 2011). In this study, by using the multiple mice technology, a multiple mice supported competitive learning environment named K-MUSCLE was designed which represents the kids' version of the multiple mice supported classroom learning environment. K-MUSCLE is a system which has many previous versions covering on different domains (Chang, Yang, Yu & Chan, 2003; Lin & Chang, 2008; Chang & Chen, 2010). The K-MUSCLE is a version focusing on the design for the kindergarten students. Figure 1 displays the scenario of K-MUSCLE. In the scenario, the group of kids is equipped with a notebook which can connect with more than ten wireless mice. All the students of the group can share the notebook by using the K-MUSCLE system. Each one of the group is equipped with one wireless mouse in hand, and he/she can interact with each other in front of the computer simultaneously.

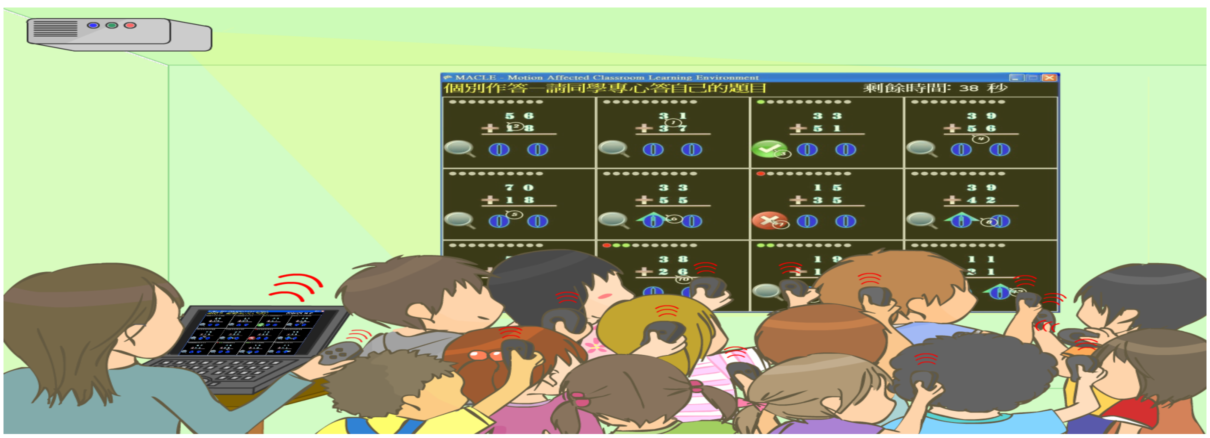


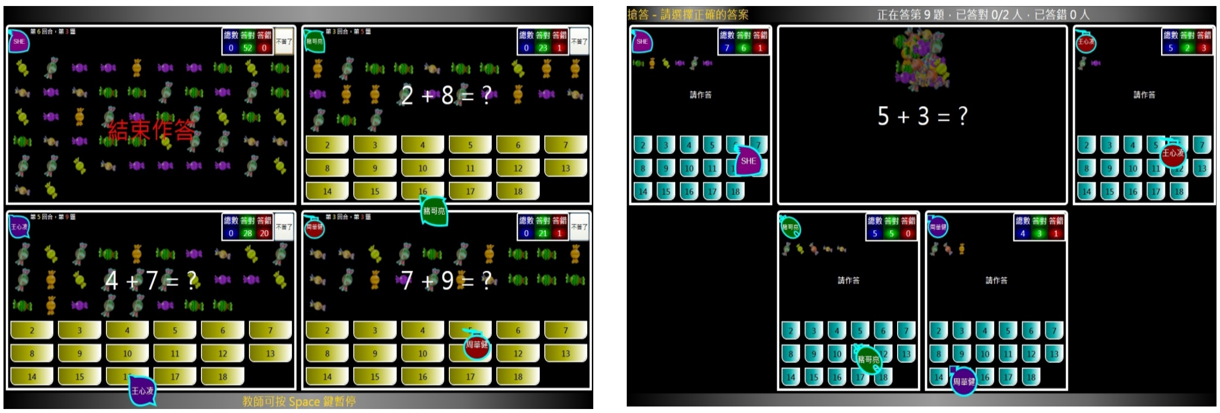
***Figure 1*. Concept of Multiple Mice Supported Arithmetic Minigame.**

Functions Description

Solely providing a multiple mice environment for teachers and students is insufficient for practicing the K-MUSCLE. To facilitate the students in performing the K-MUSCLE, in this study, minigames designed for kindergarten kids are illustrated.

In the K-MUSCLE environment, all the mice cursors can be displayed on a shared notebook, and each student can move the mouse to identify the cursor. Once the student recognized the cursor, the student can click on his or her name to match the cursor. After completing the name assignment, the teacher can enter the next stage to assign the groups. The teacher can have all students in one group or divide the students into several different groups depending on the need of the modes.

The purpose of the K-MUSCLE system is to facilitate the kids to have a much better number sense in doing one-digit addition exercises. Via a lot of one-digit addition exercises, the kids can manipulate the one-digit number addition easily. As shown in Figure 2, there are two modes of the minigame of which one is an individual one-digit addition practice, and the other one is a one-digit addition practice with game competition. In the individual one-digit addition practice mode, the shared screen is divided into several zones equivalent to the participants. The kids can do the one-digit addition exercise individually with their own cursors in their personal zone at their own speeds. The whole exercise ends only when all the students finish their tasks. A virtual candy is awarded to the kid who has the right answer. In the one-digit addition practice with game competition mode, all the kindergarten kids have the same one-digit addition exercise in the central area, but answer by their own mouse in their personal area. The mode is set as the three-chance mode. Only the fastest three students can win the virtual candies in each round. From game design perspective, the one-digit addition practice with game competition mode has higher competition intensity than the individual one-digit addition practice mode because the kids have to compete with others to give the right answers.



(a) Individual One-Digit Addition Practice (b) One-Digit Addition Practice with Game Competition

***Figure 2*. Screenshots of the Multiple Mice Supported One-Digit Addition Practice Minigames.**

Discussion and Conclusions

How to apply the videogame in the classroom is a new trend for technology enhanced learning, and game-based learning researchers have demonstrated the potential of applying videogames in the classroom. However, considering the game-based learning deployment, there are still a lot of obstacles to overcome. In this study, we explore some videogame approaches that contain the strategies of continuous innovation and for the main purpose of having the teachers with innovation but with low information technology ability get involved and participate in. Besides, we should also pay more attention to the culture issues concerned with the game-based learning.

K-MUSCLE, the system introduced above, is still a prototype of the game-based learning. As the matter of fact, the multiple mice design is a kind of continuous innovation one for most teachers and students. The teachers who are willing to use the system can be the moderator in the classroom to interact with the kids. Although K-MUSCLE is still a prototype, a preliminary study has been applied in a kindergarten in Taiwan as a preliminary study. This is an informal preliminary study with twelve six-year-old kindergarten kids involved, and its purpose is to explore the usability and the adaptivity of the system. The result indicates that all the kids could control the mice smoothly and some of the kids could even answer more than thirty one-digit addition questions in seven minutes.

According to the previous experiences of deploying the minigame into the classroom, this study suggests that: 1) The teachers' roles in a game-based learning environment are critical. The game designers should consider how teachers could be involved in the minigame activities. 2) To ensure every student participating in the game activity is very important, therefore, by using the multiple mice technology, every student can have the chance to use a mouse to interact with the peers. 3) The minigame design is a good approach because it can be integrated into the classroom activities as a supplementary material. Innovative game-based learning diffusion itself is an innovative process. In this study, we just mention some concerns of applying game-based learning in classroom. More approaches and opportunities might be ignored in this discussion, and further explorations are needed.

K-MUSCLE system demonstrates the potential of using multiple mice technology in the classroom, and the design of K-MUSCLE system also indicates that the system can provide affordable information technology accessibility in the classroom. By using the multiple mice technology, all the students can have the basic information technology accessibility and the cost is acceptable by the teachers. It also indicates the possibility of using non-PC-like human-interaction technology, such as gesture, wireless sensor and multiple-touch technology in the classroom. Obviously, the K-MUSCLE is still in its prototyping stage, both system implementations and well-designed evaluations are needed for the further pedagogical designs.

References

Boer, H., & Gertsen (2003). From continuous improvement to continuous innovation: A (retro)(per)spective. *International Journal of Technology Management, 26*(8), 805-827.

Chang, B., & Chen, C. W. (2010). *Students' competitive preferences on multiuser wireless sensor classroom interactive environment*. Proceedings of the 10th IEEE International Conference on Advanced Learning Technologies. 570-572. Sousse, Tunisia.

Chang, S. B., Lin, C. J., Ching, E., Cheng, H. N. H., Chang, B., Chen, F. C., Wu, D., & Chan, T. W. (2009). EduBingo: Developing a content sample for the one-to-one classroom by the content-first design approach. *Educational Technology & Society*, *12*(3), 343-353.

Chang, L. J., Chou, C. Y., Chen, Z. H., & Chan, T. W. (2004). An approach to assisting teachers in building physical and network hybrid community-based learning environments: The Taiwanese experience. *Journal of Educational Development*, *24*(4), 361-381.

Chang, L. J., Yang, J. C., Yu, F. Y., & Chan, T. W. (2003). Development and evaluation of multiple competitive activities in a synchronous quiz game system. *Journal of Innovations in Education and Training International*, *40*(1), 16-26.

Cheng, H. N. H., Wu, W. M. C., Liao, C. C. Y., & Chan, T. W. (2009). Equal opportunity tactic: Lessening negative effect in competition games in classrooms. *Computers & Education*, *53*(3), 866-876.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy?* New York: Palgrave.

Infante, C., Weitz, J., Reyes, T., Nussbaum, M., Gomez, F., & Radovic, D. (2011). Co-located collaborative learning video game with single display groupware. *Interactive Learning Environments*, *18*(2) 177-195.

Lin, Y. S., & Chang, B. (2008). Wireless sensor network to support a multiple-student group learning game with one PC in the classroom. ACM SIGGRAPH ASIA 2008 Conference Educator Paper, F228, Singapore, 2008.

Shaffer, D. W. (2007). *How computer games help children learn*. New York: Palgrave Macmillan.

Modeling but NOT Measuring Engagement in Computer Games

Mark Chen, College of Education, University of Washington, 1100 NE 45th St, Suite 200, Seattle, WA 98105, Email: markchen@uw.edu
Beth E. Kolko, Human Centered Design & Engineering, University of Washington, Box 352315, Seattle, WA 98195, Email: bkolko@uw.edu
Elisabeth Cuddihy, Human Centered Design & Engineering, University of Washington, Box 352315, Seattle, WA 98195, Email: ecuddihy@uw.edu
Eliana Medina, Fred Hutchinson Cancer Research Center, 1100 Fairview Ave N, Seattle, WA 98109, Email: emedina@gmail.com

Abstract

This paper describes a study that was performed to define a model of engagement in digital games and the problems encountered with our testing methods. Drawing upon multiple disciplines, our working model of engagement was meant to help describe, predict, and analyze the conditions that create a high level of engagement in players. To refine the model and develop a methodology for studying engagement, an exploratory prototype study was performed in which participants were observed playing a pair of games (*The Curse of Monkey Island* and *The Oregon Trail 5th Edition*). This study used common usability testing methods along with a pre- and post-test modeled after Witmer and Singer's Presence Questionnaire and a flow test at timed intervals. Unfortunately, it became clear that our testing methods needed refinement, though we believe the engagement model may still be useful as a common artifact informed from multiple disciplines.

Introduction

In 2005, the Digital Games Research Group (DGRG) at the University of Washington presented a model of engagement in games (Chen et al., 2005) that was informed by diverse disciplines including game design theory, presence literature from virtual reality (VR) and simulations research, narrative immersion from literary theory, and motivation literature from psychology and cognitive science. Our theoretical model was comprehensive at the time, and we believe it is still a very useful model to think about how to measure engagement with games as a product of user interface, realistic or consistent simulation and systems modeling, and narrative and role-play.

To measure engagement using our model, we created a data collection toolkit for use in a lab setting. These included a pre- and post-game series of questions based on Witmer and Singer's presence questionnaire (1998), a mini-survey based on flow theory (Csikszentmihalyi, 1990), detailed forms for researchers to fill out while observing participants playing, and post-game interview questions. To validate the model, we conducted a few initial pilot tests where participants played a commercial game (*The Curse of Monkey Island, i.e. Curse*) that we knew was "good" via its average meta-review score on gamerankings.com. We compared this with an educational game (*The Oregon Trail 5th Edition, i.e. The Oregon Trail*), hypothesizing that the commercial game would score higher than the educational one and that our measurements for *Curse* would reflect its aggregate gamerankings score.

Unfortunately, the results of our pilot tests failed to give us measures that reflected the metascore for *Curse*, and, what's more, *The Oregon Trail* scored higher for our participants! Possible reasons for this include the fact that many game reviews are not written until the reviewer has finished the game, that many memorable and immersive elements to a game's story do not occur until hours into a game, and that we did not run enough participants in our initial tests to have anything statistically reliable. While our testing toolkit was well suited to uncover issues with usability, it was ill equipped to shed light on the affective measures of engagement with a game's full experience. We shared our model that year (Chen et al., 2005) but did not move forward with validating it and never produced a final research paper.

This paper will cover our model and its theoretical underpinnings, which we believe to be extremely timely and important, as evidenced by other scholars from around the world continuing to cite our work from 2005. Sharing our model and how we failed to measure it is also important because there seems to be a new push in games for learning research on measuring engagement that may be following in our footsteps by not including methods that are ecologically valid. Thus, this paper presents a case where data collection methods failed to provide a good way to validate a model of engagement. We will also discuss how this helped shape our early careers as games scholars (e.g., pushing Chen into ethnography) and our current thoughts on how new research methods could be used to finally validate our model of engagement.

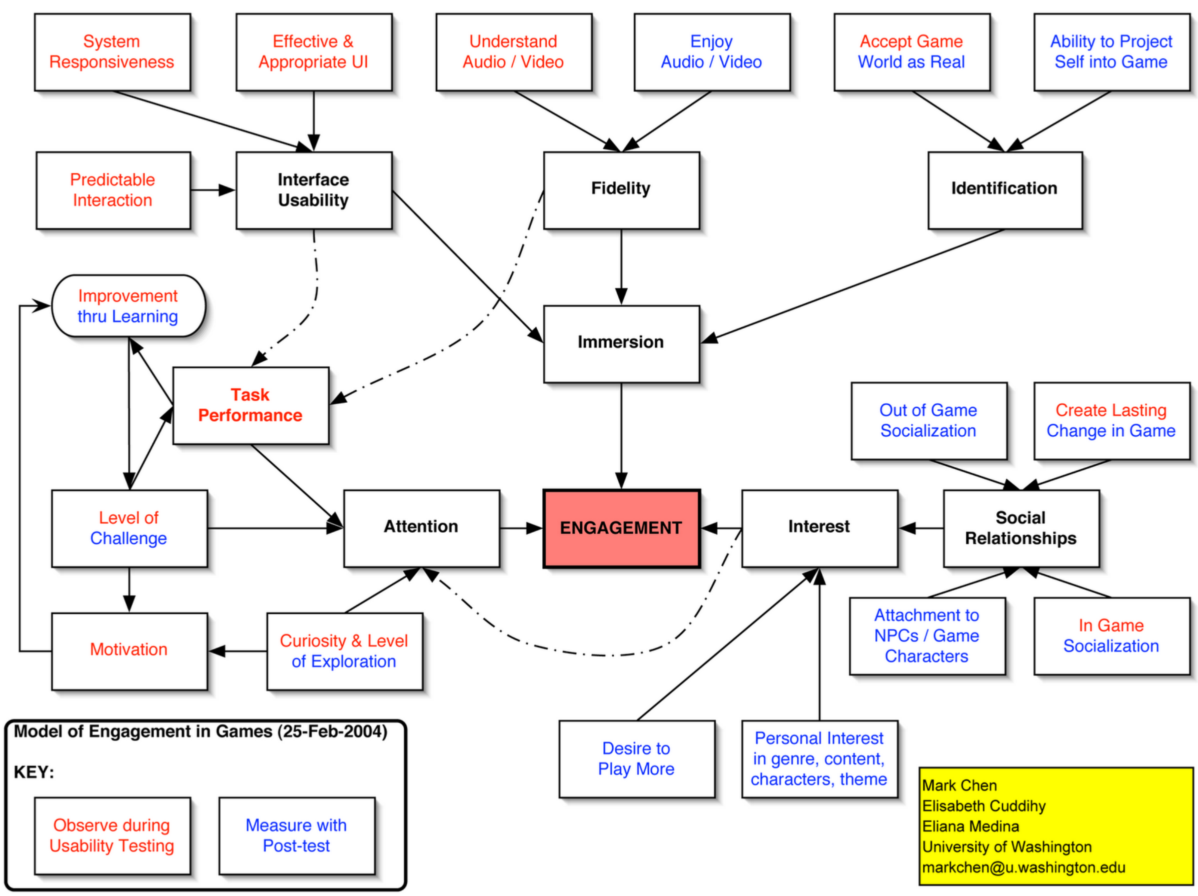


Figure 1. **Digital Games Research Group's model of engagement in games circa 2004/2005**

Modeling Engagement

When DGRG first started this project, a number of us were just starting our graduate school careers, and we were taking a multidisciplinary approach to our studies. This let us see that different disciplines over the years have taken different strategies to measure how people interact with computers and software. We saw, for example, that while VR literature had been focusing on *presence* (Zeltzer, 1992; Heeter, 1992; Bystrom et al., 1999; Witmer & Singer, 1998), games people from communications and information studies were also trying to define "fun" (Heeter et al., 2003). While cognitive psychologists and educational technologists were focusing on (intrinsic and extrinsic) motivation (Malone, 1980; 1982; Malone & Lepper, 1987; Keller & Suziki, 1988; Alessi & Trollip, 2001), scholars from education thought about character identification and role-playing (Gee, 2003). The games industry was (and still is) interested in generating emotion (Lazzaro, 2004) and feedback loops (Prensky, 2000; Crawford, 1982), while Csikszentmihalyi (1990) came up with flow theory.

All of these literatures seemed to be attempting to define (immersion, presence, engagement, affect, motivation) in some sort of functional way that allowed future researchers to measure and compare different experiences, working on the assumption that higher engagement led to deeper learning, more meaningful experiences, longer sustained interaction, etc. We took what we could find that focused on digital games or educational software (without claiming it was an exhaustive list) and iterated through a couple of conceptual models for engagement; the last version can be found in Figure 1.

Mayes and Cotton (2001) define engagement with respect to computer games as how fun, involving, and motivating a task is. Regarding computer-based learning environments, Jones (1998) defines engagement as a combination of the knowledge, interest, and stimuli that promote initial interest and continued use of an environment. Building upon these definitions, we define engagement as a sustained level of involvement caused by capturing a person's interest, holding the majority of a person's attentional resources, and placing the person in an immersive state. These three factors are covered (in brief) next.

Interest

The first prerequisite for engagement is the level of interest that a person has in a game's content, presentation, characters, theme, and genre. Additionally, interest is reflected in a person's desire to continue playing a game. For multiplayer games and games that have out-of-game dedicated online communities, interest can also be measured by the level of interaction that a player has in communities devoted to game discussion or modification, design of game tutorials, provision of game tips, seeking out or creating game mods, and seeking out or creating fan art and fan fiction. These out-of-game experiences enhance the level of interest that a player already experiences in-game.

In a lab, interest can be investigated by inquiring about a player's level of personal interest in a particular kind of game, genre, and theme. During game-play, a player's desire to continue playing can be sampled at regular frequencies. If appropriate, a player can be asked about their involvement in out-of-game community activities, and within longitudinal multiplayer studies, the effects of social interaction on interest can be analyzed.

Attention

Holding the majority of a person's attentional resources is another requirement of engagement. When attending to a task, a person diminishes or blocks out stimuli that is outside of their locus of attention.

Attention can be observed during game-play to see how focused the player appears on the task at hand and how they focus their attention on in-game challenges. Overall decrease in task performance due to boredom or frustration from inappropriate challenge levels signals a lessening of attentional resources directed toward the game. Finally, a player's level of curiosity and desire to explore may reflect level of attention.

Immersions

Immersion has been defined both qualitatively and quantitatively. Witmer and Singer (1998) describe immersion as a psychological state "characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continual stream of stimuli and experience" (p. 227). Bystrom et al. (1999) and Slater (1999) describe immersion by the quantifiable features of a system, including its visual and audio fidelity and impact. For the purposes of this paper, we define engagement as 1) the psychological state of being enveloped by a system, which is mediated by the system's physical interface, logical interface, and output fidelity, and 2) the user's ability to identify themselves as being within the environment.

A user interface that produces unpredictable results, has sluggish response, is unnecessarily complex, or fails to provide appropriate levels of control will likely frustrate the player because the user interface will require a level of attention that detracts from game-play. In other words, there is too much cognitive load (Sweller, 1988) involved in understanding the interface rather than devoted to problem-solving the content of the game. If the user interface cannot be quickly learned, the player will be less immersed in the game and thus less engaged in the play of the game itself.

The fidelity and presentation of the game's graphics and audio can also affect the level of immersion and engagement one experiences while playing. If the player finds the graphics or audio difficult to understand, this will require greater attention for processing the meaning of the graphics or audio. Audio that is jittery, skips, or has poor sound quality, for example, is likely to distract the player.

The second aspect of immersion, strengthening or weakening the sense of immersion created by the interface and fidelity, is that players mentally project themselves into the game environment and accept the game world's rules as real. In a first-person shooter like *Quake*, this means that players think of themselves as the character holding the gun and the maze-like world that the character walks through as the world that they are in. For character-driven, narrative-based games, such as Square Soft's *Final Fantasy* series or *Xenogears*, identification means personally identifying with the lead character, with supporting characters, and with their surroundings.

Immersion can be measured indirectly through observation and interviewing focused on how the player experiences the game's physical and local interface, the player's reactions to the game's fidelity and presentation, and the player's level of accepting the game world as real and projecting him or herself into the game. Difficulties in using the physical interface, misunderstanding of the logical interface, repeated errors, and expressions of surprise or frustration after an unpredicted outcome regarding the interface can be observed during game-play. Acceptance of the game world as real can sometimes be observed, for example, when a player physically ducks or crouches their own body at the same time as their avatar. Other aspects such as enjoyment of the audio and video can be explored after a game-play session.

(Not) Measuring Engagement

Within a usability lab, as a pilot study, a handful of participants were recruited to play a pair of games, complete pre-play and post-play questionnaires, and answer interview questions. We selected *The Curse of Monkey Island* and *The Oregon Trail 5th Edition* because they are similar in genre and fidelity yet one was a commercial game while the other was an educational title. We wanted to test our model for engagement against common wisdom that entertainment titles were inherently better than educational ones. The games were played back-to-back during two 45-minute play sessions, but first participants completed a shorter variant of the Immersive Tendencies Questionnaire (ITQ) based on Witmer and Singer (1998) and modified slightly for gaming (see Table 1 for sample questins). Selection of the first game to be played was randomly assigned. The player was told to play the game as if they were playing at home. They were told to think aloud whenever they wished, but that it was not required. At fifteen-minute intervals, play was briefly stopped to administer a short questionnaire addressing the level of flow participants were experiencing. After playing for 45 minutes, play was stopped and the participant given a Gaming Engagement Questionnaire (GEQ), again, based on Witmer and Singer's (1998) Presence Questionnaire (see Table 2 for sample questions). Follow-up interview questions were asked. These included open-ended questions about their game-play experience, such as what they enjoyed most and least about the game and how the sound and graphics affected their experience. Directed questions that clarified observations were also included in the interview as needed. These steps, minus the initial ITQ, were repeated for the second game.[1]

Our basic hypothesis was that *Curse*'s metascore (89.9%) from gamerankings.com would correlate to our measured level of engagement and that *Curse*'s score would be higher than that of *The Oregon Trail*. Yet this did not happen as expected with our initial participants.

14. Do you ever become so involved in doing something that you lose all track of time?						
NEVER			OCCASIONALLY			OFTEN
1	2	3	4	5	6	7
15. Do you easily become deeply involved in computer games or video games?						
NEVER			OCCASIONALLY			OFTEN
1	2	3	4	5	6	7

Table 1: **Immersive Tendencies Questionnaire sample questions**

14. Were you involved in the game to the extent that you lost track of time?						
NOT AT ALL			SOMEWHAT			COMPLETELY
1	2	3	4	5	6	7
15. How much did you feel like you were inside the game world?						
NOT AT ALL			SOMEWHAT			COMPLETELY
1	2	3	4	5	6	7

Table 2: **Gaming Engagement Questionnaire sample questions**

Failure and Reflection

Instead, the metascore for *Curse* did not match up with our test results. In fact, our participants were more engaged with the educational software, *The Oregon Trail*, than with the highly lauded adventure game! This shocked one researcher's sensibilities, having grown up on the point-and-click adventure gaming genre that *The Curse of Monkey Island* claims as its pedigree. This made clear that common wisdom could be wrong and that basing comparisons on its untested assumptions could lead to failure.

One reason for this mismatch was that the introductory puzzle in *The Curse of Monkey Island* could pose an immediate space for frustration as it included a genre cliché of "pixel hunting," where players had to move their mouse around the game screen, hoping to find a particular object or area of the screen that could be interacted with. Players with little or no familiarity with the genre did not know that they needed to move the mouse around to find hotspots; in fact, it seemed like they did not initially know that the mouse cursor would change when it was over hotspots and certainly didn't know that right-clicking the mouse would bring up an inventory and holding down left-mouse button would bring up a context-sensitive menu. In other words, the tests did in fact measure our participants' frustration with the game interface and thus gave us an accurate measure of lack of engagement, but, again, this was counter to what we had expected based on the metascore for *Curse*. It's possible that familiarity with a genre is needed for players to be fully immersed with later-generation iteration of that genre. If this is true, however, how does it affect ideas on how to accurately measure engagement? Perhaps our measurement instruments would be appropriate for certain purposes but not others. Usability testing or testing for the purposes of minimizing player frustration so player learning would increase, for example, may still find our testing methods useful.

Measuring engagement while recognizing gaming practice as part of a larger cultural ecology, however, would require different or supplemental testing methods. Games as memorable experiences often require hours upon hours of play time. This is due in part to their fundamental nature as exploration machines where players must perform a series of actions, navigating a path within a rule-based system with its own signs and signifiers and internally consistent meanings. Some consequences or results—and therefore opportunities for meaning making—can be predicted; others are unexpected. All are emergent out of the complex interaction between game and players, and these experiences are made more meaningful when a player is rooted in the cultural-historical community around the games' genre. Recognizing this, game reviews are typically written by professionals who are immersed in gaming culture, after many hours of play. Some reviewers will only review a game after completing it, either "winning" it or otherwise reaching some sort of final conclusion in the game's designed story. By contrast, our lab tests lasted 45 minutes. It's possible—very probable—that for the games we were testing as with many games, 45 minutes is not enough time for players to get a good sense of the underlying rule system of the game. It's not enough time to move out of disequilibrium and into pattern recognition, and Koster (2005) argues that fun in videogames comes from the player's ability to recognize patterns to exploit.

Further Research

During the months following our pilot test results, one issue immediately jumped out at us: it seemed clear that something was off about our measurement instruments. While our model may still be useful in helping scholars think about engagement from an immersion and interface perspective, other testing methods need to be added to adequately account for its social and affective components. Further pushing this idea was the fact that we never confirmed that metascores have any correlation to engagement. Perhaps metascores reflected reviewers' greater sense of gaming culture and history and lasting impressions of game experiences, where engagement (as we modeled and measured it) over emphasized interface and immersion. It would seem, then, that a stronger, broader battery of ways to look at engagement should be devised and tested, especially methods that could account for the situatedness of gaming experiences. This thought helped push one of the researchers into focusing on ethnographic methods for dissertation research (Chen, 2009).

Meanwhile, our model and testing methods did seem useful for others who successfully took them and modified them to better suit their needs. These include some fantastic work on posture, movement, and embodiment and games from Bianchi-Berthouze and team who use a modified version of our concept-map model and questionnaires (cf. Bianchi-Berthouze et al., 2006; Bianchi-Berthouze, Kim, & Patel, 2007; Lindley, Le Couteur, & Bianchi-Berthouze, 2008; Mueller & Bianchi-Berthouze, 2010). Furthermore, there has been some good concurrent research on engagement and player experience in the last few years that an updated version of our model would need to consider. These include a closer look at player experience and immersion (Ermi & Mäyrä, 2005), an exhaustive synthesis of presence literature (Beck et al., 2011), and even a different research group's independent modification of Witmer and Singer's Presence Questionnaire (Brockmyer et al., 2009).

End Notes

(1) All of our test instruments can be downloaded from http://markdangerchen.net/pubs/engagement.tools.zip

References

Alessi, S., & Trollip, S. (2001) Multimedia for learning: Methods and development 3rd Edition. Boston, MA: Allyn & Bacon.

Bianchi-Berthouze, N., Cairns, P., Cox, A., Jennett, C., & Kim, W.W. (2006). On posture as a modality for expressing and recognizing emotions. Emotion and HCI workshop at BCS HCI London, September, 2006. Retrieved from http://www.uclic.ucl.ac.uk/people/c.jennett/BerthouzeHCI06.pdf

Bianchi-Berthouze, N., Kim, W.W., & Patel, D. (2007). Does body movement engage you more in digital game play? and why? In A. Paiva, R. Prada, & R.W. Picard (Eds.), Proceedings of the 2nd Annual international conference on Affective Computing and Intelligent Interaction (ACII) 2007 vol. 4738 (pp. 102-113). doi:10.1007/978-3-540-74889-2_10

Brockmyer, J. H., Fox, C. M., Curtiss, K. A., McBroom, E., Burkhart, K. M., & Pidruzny, J. N. (2009). The development of the game engagement questionnaire: A measure of engagement in video game-playing. Journal of Experimental Social Psychology, 45(4), 624-634. doi:10.1016/j.jesp.2009.02.016

Bystrom, K., Barfield, W., & Hendrix, C. (1999). A conceptual model of the sense of presence in virtual environments. Presence: Teleoperators and Virtual Environments, 8(2), 241-244. doi:10.1162/105474699566107

Crawford, C. (1982). The art of computer game design. MacGraw-Hill Osborne Media.

Chen, M. (2009). Communication, coordination, and camaraderie in World of Warcraft. Games and Culture, 4(1), 47-73. doi:10.1177/1555412008325478

Chen, M., Kolko, B., Cuddihy, E., & Medina, E. (June 2005). Modeling and measuring engagement in computer games. Presentation at the annual conference for the Digital Games Research Association (DiGRA), Vancouver, Canada.

Csikszentmihalyi, M. (1990). Flow: The psychology of optimal experience. New York: HarperCollins Publisher.

Ermi, L., & Mäyrä, F. (2005). Fundamental components of the gameplay experience: Analysing immersion. Proceedings of DiGRA 2005 Conference: Changing Views – Worlds in Play. Retrieved from http://www.digra.org/dl/db/06276.41516.pdf

Gee, J.P. (2003). What video games have to teach us about learning and literacy. New York: Palgrave Macmillan.

Heeter, C. (1992). Being there: The subjective experience of presence. Presence: Teleoperators and Virtual Environments, 1(2), 262-271.

Heeter, C., Chu, K., Maniar, A., Mishra, P., & Egidio, R. (2003). Comparing 14 forms of fun (and learning and gender issues) in commercial versus educational space exploration digital games. Proceedings of the International Conference on Digital Games Research.

Jones, M. G. (1998). Creating electronic learning environments: Games, flow, and the user interface. Proceedings of Selected Research and Development Presentations at the National Convention of the Association for Educational Communications and Technology (AECT) (pp. 205-214). Retrieved from http://eric.ed.gov/ERICWebPortal/detail?accno=ED423842

Keller, J. M., & Suzuki, K. (1988). Use of the ARCS motivation model in courseware design. In D.H. Jonassen (Ed.), Instructional designs for microcumputer courseware (pp. 401-434). Mahwah, NJ: Lawrence Erlbaum.

Koster, R. (2005). A theory of fun for game design. Scottsdale, AZ: Paraglyph Press.

Lazzaro, N. (2004). Why we play games: Four keys to more emotion in player experiences. Proceedings from the Game Developers Conference. Retrieved from http://www.gamasutra.com/gdc2004/features/20040326/postcard-kane_04.shtml

Lindley, S., Le Couteur, J., & Bianchi-Berthouze, N. (2008). Stirring up experience through movement in game play: Effects on engagement and social behaviour. Proceedings of the 2008 SIGCHI conference on Human Factors in computing systems (CHI 2008) (pp. 511-514). doi:10.1145/1357054.1357136

Malone, T. W. (1980). What makes things fun to learn? A study of intrinsically motivating computer games (Xerox Palo Alto Research Center Technical Report No. CIS-7). Retrieved from http://cci.mit.edu/malone/tm%20study%20144.html

Malone, T. W. (1982). Heuristics for designing enjoyable user interfaces: Lessons from computer games. Proceedings of the 1982 conference on Human Factors in Computing Systems. doi:10.1145/800049.801756

Malone, T. W., & Lepper, M. (1987). Making learning fun: A taxonomy of intrinsic motivation for learning. In R. E. Snow & M. J. Farr (Eds.), Aptitude, learning, and instruction, vol. 3: Cognitive and affective process analysis (pp. 223-253). Mahwah, NJ: Lawrence Erlbaum.

Mayes, D.K., & Cotton, J.E. (2001). Measuring engagement in video games: A questionnaire. Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting (pp. 692-696).

Mueller, F., & Bianchi-Berthouze, N. (2010). Evaluating exertion games: Experiences from investigating movement-based games. In R. Bernhaupt (Ed.), Evaluating user experiences in games (pp. 187-207). Springer. doi:10.1007/978-1-84882-963-3_11

Prensky, M. (2000). Digital game-based learning. New York: McGraw-Hill.

Slater, M. (1999). Measuring presence: A response to the Witmer and Singer Presence Questionnaire. Presence: Teleoperators and Virtual Environments, 8(5), 560-565. doi:10.1162/105474699566477

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12, 257-285. doi:10.1016/0364-0213(88)90023-7

Witmer, B. & Singer, M. (1998). Measuring presence in virtual environments: A Presence Questionnaire. Presence: Teleoperators and Virtual Environments, 7(3), 225-240. doi:10.1162/105474698565686

Zeltzer, D. (1992). Autonomy, interaction, and presence. Presence: Teleoperators and Virtual Environments, 1(1), 127-132.

Bio-Gaming: Videogames as Tool to Teach Cell Biology

Javier A. Corredor, Universidad Nacional de Colombia, Email: jacorredora@unal.edu.co

Abstract

This study describes the cognitive and social differences between students working with *Virulent!*, a videogame devoted to cell biology, and students working in a traditional class activity involving reading text and graphs. Specifically, this study analyzes the conversations and cognitive processes that arise when kids play and talk about *Virulent!*, a game that requires players to control the behavior of a virus and interact with cell structures in a way that resembles the actual behavior of biological agents. Results show that using the videogame creates more social interaction focused on content during the study time, and produces higher levels of understanding regarding the temporal relationships and the biological mechanisms involved in the viral replication process.

Learning Advantages of Videogames

This study explores the role of videogames in the learning of cell biology, particularly in the integration of information coming from a text that describes viral reproduction. Differences between learning in videogames and learning in traditional class activities can be explained by three factors: the representational, social and pedagogical advantages of videogames.

Moving Parts: The Representational Edge of Videogames

Different forms of content presentation imply different cognitive constraints. Larkin & Simon (1987), for example, point out that graphs are more efficient than text to present certain types of content because they make explicit information that is hidden in text-based representations. In the same way, videogames and simulations have representational advantages over graphs because they can present temporal relationships that are not visible in graphs. Additionally, videogames and simulations can present emergent processes in a way that makes clear how the micro and macro levels relate. This is important because research in cognitive psychology has shown that understanding emergent processes is difficult, creates misconceptions in several content domains and requires conceptual change and ontological reorganization to be achieved (Chi, 2005).

Playing Together: Social Interaction in Videogames

Social interaction around videogames is well-known. Videogames create communities of practice in which players develop skills and identities, share knowledge and conduct collaborative reasoning (Steinkuehler, 2008). This process of collaborative reasoning fosters scientific habits of mind, mathematical understanding and digital literacy (Black & Steinkuehler, 2009; Steinkuehler, & Duncan, 2008). Research shows that gaming communities use resources (e.g., online discussion boards) to build collective knowledge about the game, and to conduct modeling of game characteristics (Steinkuehler & Williams, 2009).

Teaching Each Other: Pedagogical Adequacy of Videogames

Videogames provide situated learning. In games, problem solving and learning are related to task goals in such a way that learners know the use and meaning of skills and contents within the context of the game (Gee, 2005). In the same way, learning activities within games are easily connectable to identities that are socially valued by the gaming community (Gee, 2008). Additionally, gamers engage in reciprocal teaching activities in which new members of the group are introduced to the practices, values and skills of the group. This process is facilitated by the fact that learning in videogames happens within the Zone of Proximal Development (Vygotsky, 1978).

Virulent! and the Understanding of Genetics

Virulent! presents the process of viral replication and the genetic mechanisms related to it. The understanding of genetics is challenging for many students. Students have problems to understand the origins of genetic disease, the nature of research in genetics and the characteristics of genetic explanation (Wood-Robinson, Lewis, & Leach, 2000). The challenge to understand genetics comes, in part, from the fact that genetics requires coordinating two ontologically different levels (Duncan & Reiser, 2007): The information and the physical level. Understanding the relationship between two different levels requires ontological reorganization and conceptual change (Chi, 2005). *Virulent!* presents the relationship between these levels by showing how both the cell and the virus genetic information are expressed using cell structures. In the process, students have the opportunity to observe the relationship between genetic material, proteins and organisms.

The game supports learning in two ways. First, it helps students to comprehend better the text by providing a representation to which participants can attach the incoming information. In this way the game facilitates the process of propositional integration. This process is fundamental for the construction of the mental models that support understanding and problem solving (Johnson-Laird, 1980). Second by showing how interactions at the micro level explain observable traits, the game helps students to understand the emergent nature of biological processes. Understanding the relationship between different levels of description has been considered core for the understanding of science in general, (Chi, 2005), and of genetics in particular (Duncan & Reiser, 2007). Research on genetics education has additionally shown that the comprehension of this relationship is challenging for students (Lewis & Kattman, 2004).

Game Design: Bringing Biological, Educational and Design Expertise Together

The game was designed by the Educational Research Challenge Area (ERCA) group at the Wisconsin Institute for Discovery-Morgridge Institute for Research (WID-MIR) with the collaboration of experts in the field of virology. For this reason, the game presents adequate disciplinary knowledge. More important, the game uses the educational advantages of videogames, such as interactivity, agency, collaborative reasoning and situated learning (Gee, 2005; Squire & Durga, 2009: Steinkuehler & Duncan, 2008), to illustrate the mechanisms that at the micro level explain viral reproduction and genetics. To achieve this goal, experts from the WID-MIR in the field of virology were brought together with experts in design, education, computer science and psychology during an iterative 16-months process. Initially content experts elaborated descriptions of the viral reproduction process (e.g., graphs) and explained them to the design group. These descriptions included a list of different types of viruses (e.g., positive-strand RNA viruses, DNA viruses), their specific paths during the viral reproduction process, and their use of cell structures. From that description, design experts produced paper prototypes of several possible games that represented the viral reproduction process using diverse game mechanics (e.g., role-playing game using dices / strategy game in a board). Then experts reviewed the prototypes to make them closer to disciplinary content. Several rounds of this process were conducted in the different stages of the design process (e.g., paper prototype/initial computer-based prototype). Also several play tests were conducted during the game design and development process. Using all the available information, the game was modified in order to present an adequate description of the viral reproduction process and to respond to user preferences regarding usability and game mechanics.

Method

In this study, participants were assigned randomly to two groups. In the control group (Traditional), students read a text on the polio virus, studied the graphs that explain the process, and solved collaboratively a questionnaire regarding the viral reproduction process. In the experimental group (*Virulent!*), students read the same text and played *Virulent!*. During the study period (about 1hr), students in both conditions were asked to think aloud (Ericsson & Simon, 1993) and to talk to each other in pairs. After a reasonable period of time, students were asked to explain the process of viral reproduction using a drawing and to think aloud.

Students' conversations were audio recorded and then coded in three levels: *Interaction*, *interaction focused on content*, and *multimodal interaction focused on content*. These categories were coded hierarchically, that is, a code was created for the deepest type of interaction presented in a segment of time. The reason for this decision was that *multimodal interaction* implies *interaction focused on content*, and *interaction focused on content implies interaction*. *Multimodal interaction* was coded when students talked about and referred to two different sources of information in different formats during the study period (e.g., computer screen, game instruction, graphs, or text). *Interaction focused on content* was coded when students talked about content knowledge, the activity and the documents. Finally, *interaction* was coded when students talked about a topic not related to the class activity.

As part of the evaluation, students were asked to draw a cell and explain the viral reproduction process, while thinking aloud. These explanations were coded according to the presence of expressions indicating temporal relationships and viral reproduction mechanisms. For temporal relationships, the coding criteria implied the presence of temporal organizers and the segmentation of the process in steps (e.g., the virus first has to find a receptor, then …). For viral reproduction mechanisms, the criteria required a description of an interaction that intervenes in the process of expression and copy of the virus genetic material (e.g., it has to make a copy of its RNA: it has to get energy from the mitochondria; it has to find a receptor similar to those in its membrane).

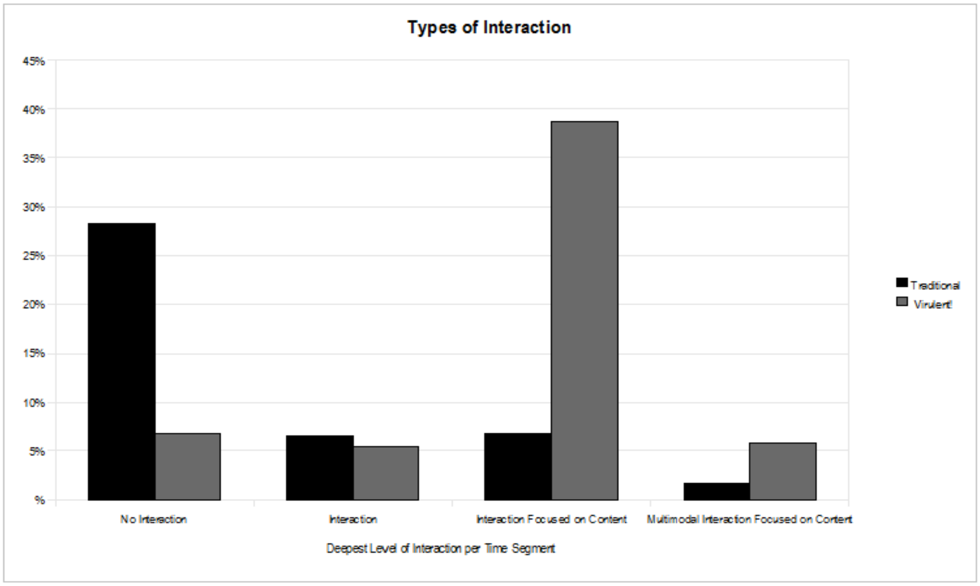


***Figure 1*. Levels of Interaction during Study Time.**

Results

Data suggest that the experimental condition produces higher levels of social interaction focused on content than the control condition (Figure 1). This difference is produced because *Virulent!* creates an environment where students informally talk about the game. The game is what Leinhardt and Crowley (2002) call an object of talk, a token around which disciplinary conversation arises in the context of family or peer interactions. In the traditional class activity, although students were encouraged to study the content together, they reviewed the content individually and had few questions about it. In the game condition, by contrast, questions on content and strategic decision making were more common. The experimental condition also produces higher levels of multimodal interaction focused on content. That is, students in the experimental condition went back and forth between text and game, while students in the control condition usually read the text first, and then looked shortly to the graphs, but they did not do it simultaneously. This difference might be a consequence of situated learning in games in which the text is presented in the context of the activity, and therefore linked to the goals of the task. By consequence, the text is used in relationship to all the other activity-related elements because they are linked to similar goals in the task structure (e.g., the game problem space).

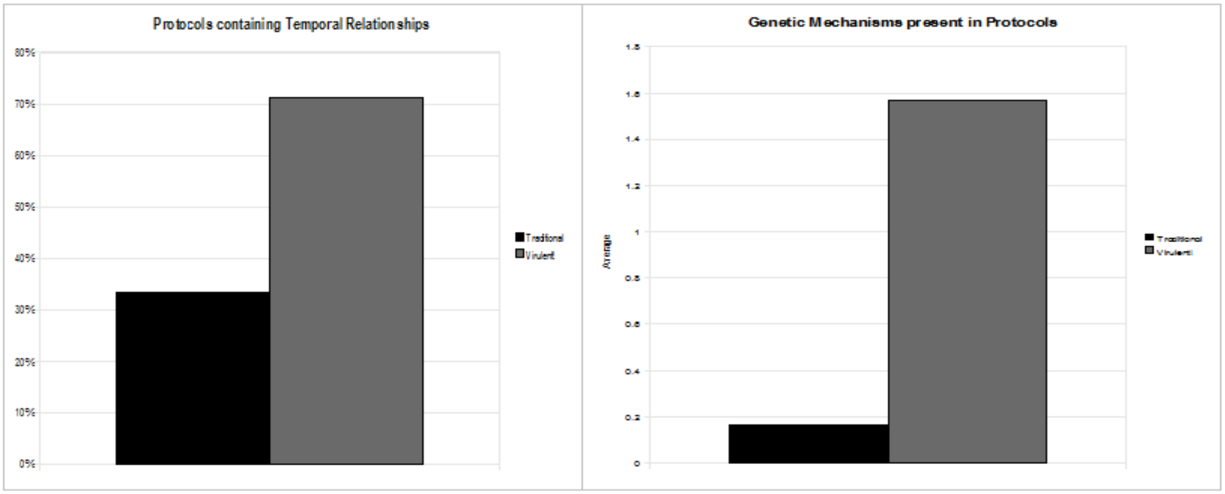


***Figure 2*. Temporal Relationships and Viral Reproduction Mechanisms in Protocols.**

Additionally, the game facilitates the understanding of temporal relationships that are hard to grasp for students in the control condition (Figure 2). This fact is evident in the protocols that show that students in the experimental condition are better than students in the control condition in establishing the order of events in the viral reproduction process. Table 1 shows two examples of typical answers from both groups. The student in the game condition has a dynamic representation of the viral reproduction process that includes different sub-goals and steps associated to them. In the traditional condition the student has a static representation of the process based on the parts of the cell, but without any mention of how virus and cell structures interact.

Virulent!	**Traditional**
"mmm… voy a dibujar el polio [virus](silencio y risas) acá voy a dibujar la célula… y… (risas)… el recep… si el receptor tiene que encontrar un…. Tiene que encontrar un receptor que sea igual [igual al de su membrana]...eee, después tiene que hacer una copia de su ARN… bueno por acá [señalando el ribosoma] saca su ARN… ee… Acá está el núcleo de la célula".	"Pues, yo me acuerdo que era el núcleo, la pared celular, los lisosomas, la vacuola, la pared celular, la pared nuclear, pero no me acuerdo de más".
"mmm. I´m going to draw the polio [virus] (silence and then laughs), here I´m going to draw the cell and (laugh) the receptor... it has to find a , it has to find a receptor equal [equal to the one in its membrane]... eee, and, after, it has to make a copy of its RNA... well here [pointing to ribosome] it gets its RNA... here is the nucleus of the cell..."	"Well, I remember that it was the nucleus, the cell wall, the lysosomes, the vacuoles, the cell wall, the nuclear wall, but I don´t remember anything else".

***Table 1*: Examples from protocols.**

A similar pattern was identified in the drawings of the viral reproduction process in which students in the game condition included arrows and numbers to describe the steps of the viral reproduction process (Figure 3). In a similar fashion, students in the game condition were better than students in the control condition in remembering the mechanisms participating in viral reproduction. When protocols of students´ drawings were coded, it was evident that students in the control condition remembered more of the interactions between virus and cell structures that participate in the viral reproduction process (e.g., find a receptor, make copies of RNA).

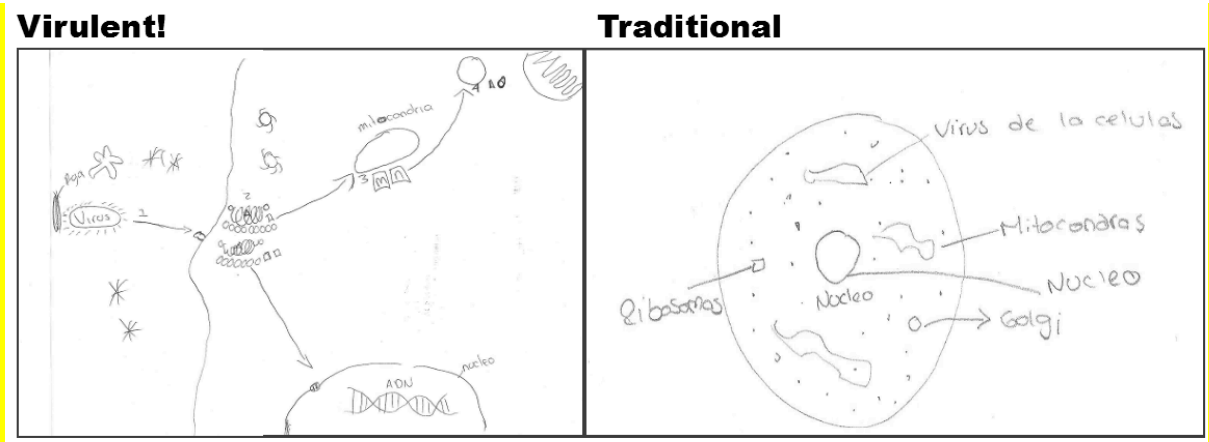


***Figure 3*. Examples of Drawings Made by the Two Groups.**

Conclusions and Further Developments

This study shows that videogames can be used to bring disciplinary content to school environments in a way that promotes interaction and helps students to better understand dynamic processes. In this sense, this study shows that videogames can be a powerful tool to transform schools in ways that are consistent with the cognitive and socio-cultural perspectives in the learning sciences. At a cognitive level, videogames provide students with a better representation of temporal relationships and emergent processes. At a socio-cultural level, videogames create an environment that fosters informal, non-directed, interaction focused on disciplinary content. The findings, however, need to be read with caution. The differences between the experimental and the control group are important, but small in absolute terms. This fact is especially evident when the differences in the number of viral reproduction mechanisms remembered by students are analyzed (Figure 2). The experimental group mentions 1.57 mechanisms, while the control group mentions less than .2 on average. The point is that the absolute number of mechanisms described in the text and necessary to succeed in the game is higher than 10. Students in the game condition remember more than students in the control group, but still their absolute scores were low. Part of this small effect comes from the fact that this study conducted a short intervention (1 hr approx.). It is necessary to conduct a proper design experiment with at least 8 hours of game play to allow students to finish all the game levels. A longer intervention will allow students to interact several times with the strategic actions involved in the game and to build a more robust cognitive representation of the game´s problem space. In the same sense, it is necessary to study how *Virulent!* fosters interaction in online environments, when deployed in out-of-school environments, for long periods of time (6 months). This type of study will provide information useful to evaluate whether *Virulent!* produces the same dynamics of collaborative reasoning observed in online environments related to *World of Warcraft* and other videogames (Black & Steinkuehler, 2009; Söbke & Corredor, 2011).

References

Black, R. W. & Steinkuehler, C. (2009). Literacy in virtual worlds. In L. Christenbury, R. Bomer, & P. Smagorinsky (Eds.), *Handbook of adolescent literacy research* (pp. 271-286). New York: Guilford.

Chi, M.T.H. (2005). Common sense conceptions of emergent processes: Why some misconceptions are robust. *Journal of the Learning Sciences*, 14: 161-199.

Duncan, R. G. & Reiser, B. (2007). Reasoning across ontologically distinct levels: Students´ understanding of molecular genetics. *Journal of Research in Science Teaching*, 44(7), 938-959.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis; Verbal reports as data*. Cambridge, MA: Bradford books/MIT Press.

Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-Learning*, 2(1), 5-16. Retrieved July 1st, 2011 from http://www.academiccolab.org/resources/documents/Game%20Paper.pdf

Gee, J. P. (2008). Learning and games. In K. Salen (Ed.) *The Ecology of games: Connecting youth, games and learning. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning.* Cambridge, MA: The MIT Press, 2008. 21-40.

Johnson-Laird, P. N. (1980). Mental models in cognitive science. *Cognitive Science*, 4, 71-115.

Larkin, J. H. & Simon, H. A. (1987). Why a diagram is (sometimes) worth ten thousand words. *Cognitive Science*, 11, 65-99.

Leinhardt, g. & Crowley, K. (2002). Objects of learning, objects of talk: Changing minds in museums. In S. G. Paris (Ed.), *Perspectives on object-centered learning in museums* (pp. 301-324). Mahwah, NJ: Lawrence Erlbaum Associates.

Lewis, J. & Kattman, U. (2004). Traits, genes, particles and information: Re-visiting students understanding of genetics. *International Journal of Science Education*, 26, 195-206.

Söbke, H. & Corredor, J. (2011). *Learning, reasoning and modeling in social gaming*. Paper presented at the ELBA Conference, Rostock, Germany.

Squire, K., & Durga, S. (2009). Productive gaming: The case for historiographic game play. In R. Ferdig (Ed.) *Handbook of research on effective electronic gaming in education.* Hershey, PA: Information Science Reference. Retrieved from http://website.education.wisc.edu/kdsquire/tenure-files/05-durga-squire-Final.pdf

Steinkuehler, C. A. (2008). Cognition and literacy in massively multiplayer online games. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of research on new literacies*, (pp. 611-634). Mahwah, NJ: Erlbaum.

Steinkuehler, C. A. & Duncan, S. (2008). Scientific habits of mind in virtual worlds. *Journal of Science Education and Technology*, 17(6), 530-543.

Steinkuehler, C. & Williams, C. (2009). Math as narrative in world of Warcraft forum discussions. *The International Journal of Learning and Media*, 1(3). Retrieved from http://ijlm.net/knowinganddoing/10.1162/ijlm_a_00028

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, Mass.: Harvard University Press.

Wood-Robinson, C., Lewis, J. and Leach, J. (2000). Young people's understanding of the nature of genetic information in the cells of an organism. *Journal of Biological Education*, 35(1), 29-36.

The Lost Binder:
Communicating Ethnographic Research With Games

Raphael D'Amico, IIT Institute of Design, 350 N LaSalle St, Chicago IL, 60654,
Email: rdamico@id.iit.edu

Abstract

With annual U.S. research and development spending amongst Booz & Company's Global Innovation 1000 at over $500 billion (Jaruzelski & Dehoff, 2010), companies are generating an overwhelming amount of ethnographic research data about how people clean, game, shop, learn, eat, and more. Buried in this data—they hope—is the insight that could inspire the next great innovation. And often it is. But, it usually ends up stranded on an executive's desk instead of entering the collective intelligence of the organization. This paper shows a method, based on experience modeling, for extracting an educational, inspirational, and viral system of games from a large qualitative data set of observations and interviews with 21 American women.

Introduction

Real Moms is a system of prototype games created to address a fundamental problem with design research in large institutions (e.g. corporates and government bodies): that it often fails to spread through the organization, falling short of its true potential because it doesn't reach those who might use it. It is often relegated to binders on out of the way shelves, ignored, and finally lost.

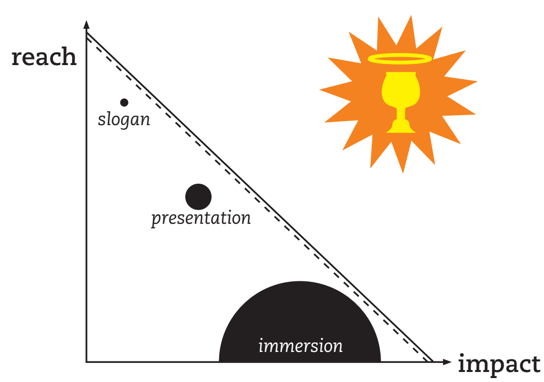


Figure 1. The Tradeoff

Design ethnographies can run to dozens or hundreds of hours of footage and tens of thousands of words of transcript, and current methods of communicating this research fall prey to a tradeoff between reach and impact. Immersive data experiences that foster true empathy are costly and time consuming, reducing their reach, while short presentations or pithy slogans have little impact because they lack the depth to generate that connection (see Figure 1). Games that build on strong models of experience may be a way to break this relationship and achieve both reach *and* impact.

Games Rooted in Physical Models

Games focused on physical authenticity (e.g. *Gran Turismo*, *Forza Motorsport*, *Flight Simulator*, *Operation Flashpoint*, and *Rock Band*) have mechanics that are deeply rooted in and require you to master underlying physical models (cars, planes, war-fighting, musical instruments). These games highlight several aspects that make the medium work as a delivery method for models.

Games *(1) sequence* hours of content into a series of bite-size experiences of increasing difficulty, making that content less overwhelming. This makes them an excellent potential structure to progressively disclose an ethnography. They allow players to *(2) explore* models and tease out the relationships themselves–without crashing a real car or plane. This may foster a deeper understanding. They are *(3) stand-alone;* they don't need to be put in context by a human presenter because they teach you how best to use them, which helps them to spread virally.

However, games have struggled to remain grounded as they move from gameplay based on objective physics to subjective experiences that deal with human emotions and society. Extreme examples like *Grand Theft Auto* show what happens when you throw out moral nuances in favor of gameplay, while even games that aim for an ethical element (*Star Wars: Knights Of The Old Republic*, *Fable*, *inFamous*) boil ethics down to a simplified arithmetic of 'good' versus 'evil' actions. On a larger scale, games like *Sim City* and *Civilization* replace the web of values that define culture with a standardized set of attributes that the player seeks to optimize. Other games use themes that in real life are emotionally charged, such as food preparation (*Diner Dash*, *Cooking Mama*, countless Flash games) or homemaking (*The Sims*)–as decoration for much simpler gameplay. These are great games but also caricatures, inspired but not rooted in reality.

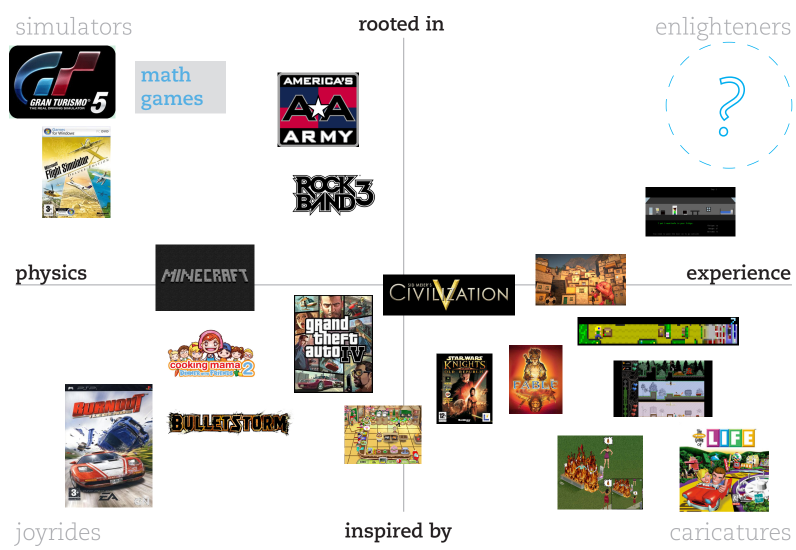


Figure 2. **Physical vs. Experience Models**

What might happen when gameplay is thoughtfully built around real experience?

Jason Rohrer's *Passage* invites the player to live a whole life in exactly five minutes, and its mechanics are abstractions of the author's own values, which he outlines in detail on his website (Rohrer, 2007). You are set in a narrow, pixelated landscape. You can walk to the right and see a variety of environments, or you can head down into an increasingly tight maze to find scattered chests. Some are empty. Some hold treasure, which increases your score. This is a crude model of the tradeoff between career and adventure. If you 'marry', you and your wife cannot physically fit as deep into the maze, but any treasure you do find yields double points; a model for relationship compromise. Inevitably you die, although your wife dies first, and when she is suddenly replaced by a little tombstone graphic, most players are reluctant to keep moving. That this tiny bereavement occurs is a sign of *Passage*'s success as a thinly decorated model of the experience of life and love.

A simpler example is Digital Dreams Light's *A Tale By Alex*, which eloquently inserts us into the mind of a child playing '*the floor is lava'*. The player simultaneously sees the world in three ways: the bottom as just a living room, the top as a fantasy world where tables become ledges, coat racks become trees, and the dog becomes a ferocious monster. In the middle is a mixed view, where the real and imaginary coexist. This could easily be a model of the way a child experiences play.

Finally, Jaime Fraina's *Is It Time*, a game where you inhabit the life of an elderly woman whose husband has passed. You are alone, frail, slow, and disoriented. Your daughter occasionally bursts in with some food, and leaves just as suddenly. Days are mundane, boring, with the simple task of keeping your fatigue, hunger and boredom at manageable levels. Managing those three variables is a model of the experience of being old.

These games show what happens when you embed a model of experience into the mechanics of the game. They are not necessarily fun, but they are impactful (the author and his roommate both called their grandmothers after playing *Is It Time*) precisely because they put you in touch with one another.

Real Moms: The Dinner Experience Model

Real Moms was an exploration of games' potential to communicate ethnographic data about women's experience of preparing dinner for their families, conducted in the context of a 14-week workshop class at Chicago's IIT Institute of Design and taught by adjunct professor Kim Erwin. The overall assignment was to explore more compelling ways to communicate large qualitative data sets for design, with each student developing their own angle. To simulate a real commercial environment, we each worked off fictional client briefs (in this case, Real Simple) and were given access to two different data sets drawn from commercial design ethnographies.

The data sets comprised:

- In-home interviews with 12 convenience focused moms, collected while they were preparing and eating dinner.
- Online self-documentation with 9 edge-of-mainstream women, focused on healthy living and eating. The platform was Revelation Software.
- Between those two sources, 12 in-home observations of dinner preparation, 4 video taped interviews, 10 days of meal documentation with pictures, 102 diary

pages capturing activities and thinking around healthy eating, 45 reflections on activities and attributes of living healthy.

The first step was to develop an experience model to clearly fix into inspectable form the behaviors and feelings of the participants as they prepare dinner for their families. Experience models are tools for thinking about people, much as Watson & Crick's model of DNA is a tool for understanding genetics (Robinson, 2001). A good experience model is a visual Rosetta stone that usefully organizes the behaviors of people involved in an experience so that an outsider can understand them from the insider's perspective. They are visual and concise, so they provide a more actionable interface with data than a long form text or other breakdown. Because they clearly capture key reasons why people behave and feel the way they do, experience models provide a solid base to build game mechanics from. (1)

The model is shown in Figure 3. On the left side are the *hope,* what she considers the perfect dinner, and *tactics,* contingencies that she has planned for (there will probably be a delay, and the kids will probably need something different to eat). On the right the *struggle* of reality, with the family scattered by (1) the husband's *delay* at work*,* (2) having to make a separate meal of peppers and hummus for the kids (because they won't eat salad) which then, (3) *expands* in scope because the kids won't eat just those vegetables (burgers are added to the menu) and then (4) *splits* again for the youngest when he throws a tantrum and refuses to eat anything that's been made. Finally (5), the meal *expands* once again when, just as she and her youngest finally sit down, he asks to be read to.

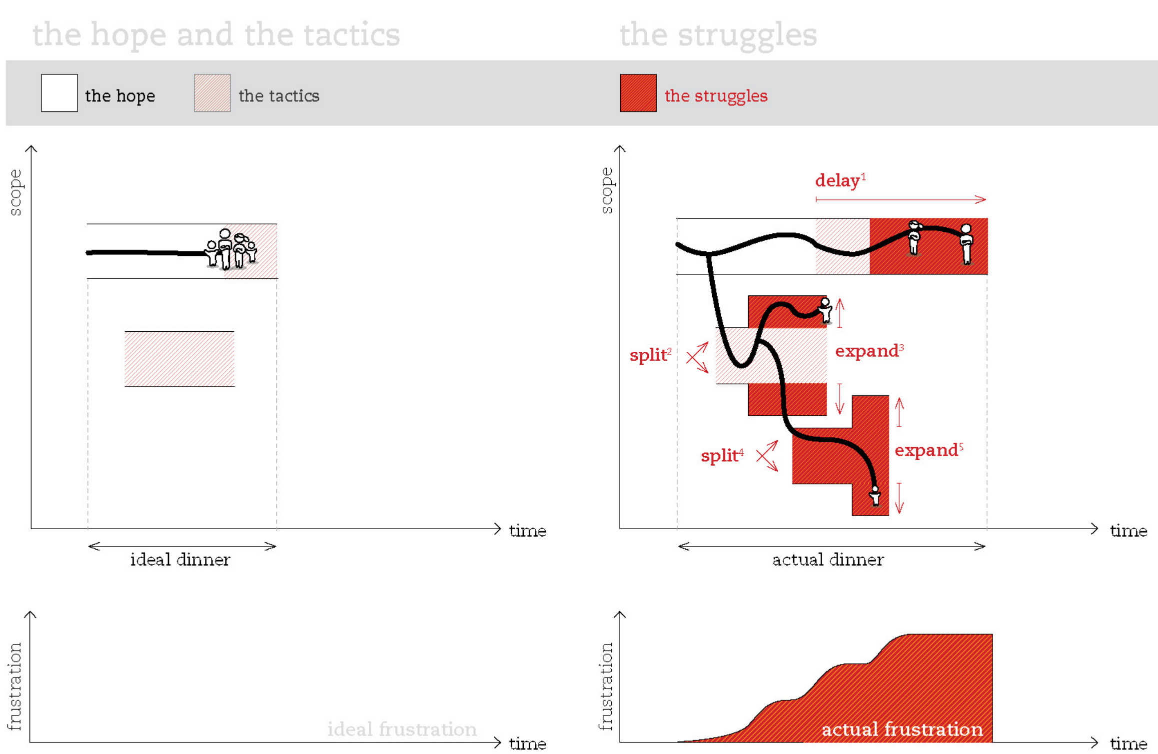
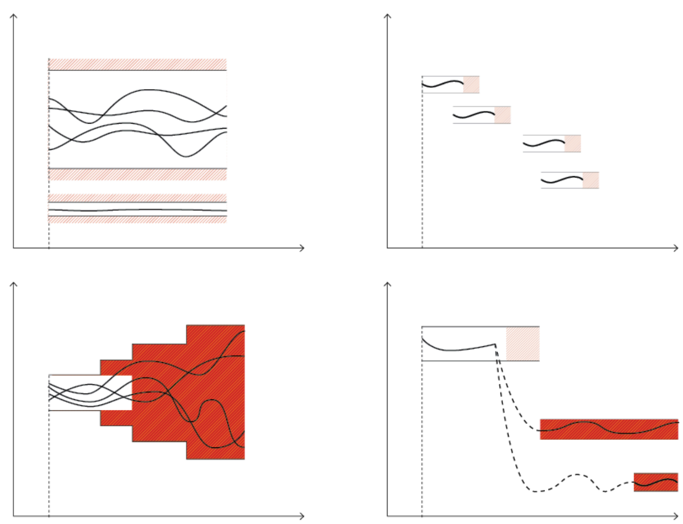


***Figure 3*. The Real Moms Experience Model.**

The core insight from the model was that *the struggle of dinner isn't about food: it's about wrangling the family*, and what defines her satisfaction at the end of the night is not how chaotic the evening was in absolute terms (*the reality*) but how far it strayed from her ideal (*the hope*) and the buffer she put in place to take care of contingencies (*the tactics*). (2)

To clarify further: each area in the diagram is an individual meal within the family dinner. The black lines are the individual paths that the family takes through this dinner space. The perfect path would go straight down the middle and would stay within the hope. In reality, they curve and stray to represent the negotiation between the eater's tastes and the developing dinner.

Actually eating dinner is just a small part of it (the horizontal axis, time). Dinner starts with preparation, and ends after the cleanup is complete. The scope (vertical axis) of the meal can vary widely—a very narrow scope might be a sandwich, while a fine gourmet meal with seven courses would be much broader. Scope isn't just about the food; setting up a romantic atmosphere, helping kids with homework, or coordinating dinner guests would also increase it.



-

***Figure 4*. Flexibility of the Model.**

The model therefore works for a wide range of situations (see Figure 4). Clockwise from top left: (1) the big, multi-course family dinner with a separate vegetarian option, (2) four small separate sandwiches, (3) too many cooks; a poorly planned dinner party that flies out of control, (4) catastrophically burning the Valentines Day dinner, resulting in two sad, separate meals.

So what is the difference between a meal that is perceived to have gone well and one that hasn't? The good dinner may not be what she had *hoped* for, but at least she had *tactics* planned to deal with the delays, expansions and splits of *reality*.

Games From Experience Models

This model was used to explore the communicative ability of games. Two games and a workshop were created. Also prototyped was a website to connect the games to the underlying data.

There were three major considerations (reinforced by the real constraints of the project):

1) Scope: With the compressed time horizons of design, the game would have to be built in just a few weeks (or sometimes days).

2) Style: To fit institutional environments the game would have to balance a personable style with the need for credibility as an information source.

3) Depth: As explored above, the beauty of games is their ability to sequence and progressively disclose information. The game designs would have to be portals into the data.

Exquisite Dinner

Exquisite Dinner takes the tactics and struggles that lie at the heart of the model and turns them into a card game. It is inspired by *Dominos*, the *Metagame*, *Exquisite Corpse*, and semi-structured storytelling games in general and is best played with three or more people.

Players shuffle the deck and are dealt seven cards each. The first player places a struggle card from their deck, and the next player has to find a tactic to match it (the examples in Figure 4 would work). The next player should then try to follow that tactic with a struggle that would negate it, to be followed by another tactic—and so on. The aim is to lose all your cards.

Here's the twist: these connections are judged by the players. If other players disagree, the person who put down the contentious last card must justify themselves to the group. If they lose the argument, they must take it back and pick another card off the deck.

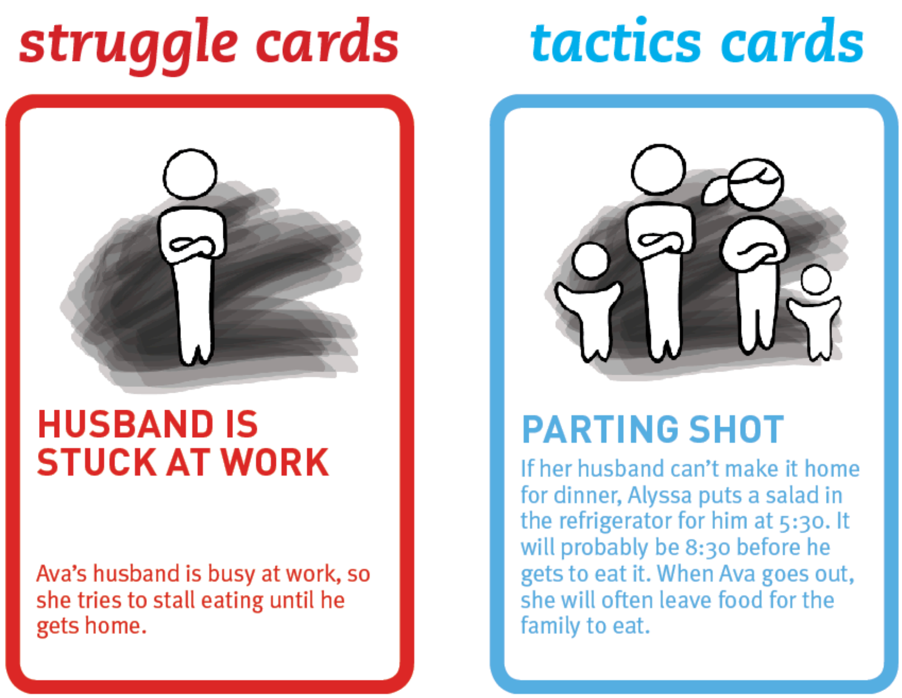


Figure 4. A Potential Match of Exquisite Dinner Cards

Every time the players have a disagreement (almost every hand if the group is mischievous enough) they end up unwittingly exploring the tactics and struggles and relating it to their own experience. By the end of a game, they will have interacted with a significant slice of the data.

Exquisite Dinner Workshop

A workshop was imagined to introduce the game (though not tested due to time constraints). For this activity the struggle cards would be split into four suits (tastes, time constraints, personal tensions, and surprise twists) and mounted on a large display. Groups of participants would select a few struggle cards from each suit to form the worst evening possible. The groups would then share their stories and together look for tactics that might help—from the cards, from their own experience, or by beginning to design new ones.

Wrangle

The final game was closer to a direct rendition of the model itself. Players play through a sequence of successively harder family dinners abstracted as a set of tracks, one for each potential meal within the dinner. Your job is to make enough food, keep it warm, serve it before your family gets there, and clean it up afterwards, all implemented through a mechanic similar to *Guitar Hero*. At each stage of cooking you keep the dinner going by clicking on colored circles that come flying across the screen at random intervals. Dinner gets off track when you miss too many.

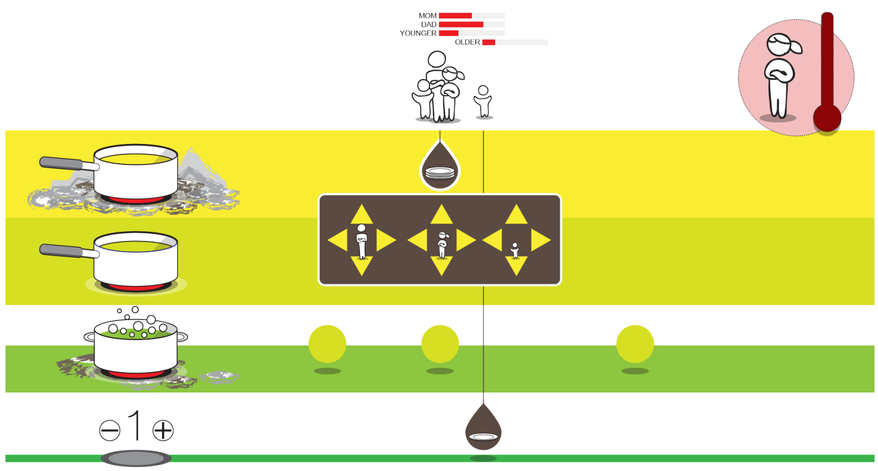


***Figure 5*. Mockup of *Wrangle* (a basic prototype was also built using Javascript/HTML/CSS)**

The struggles make their appearance, too, delaying a family member's path to the table (e.g. husband stuck at work) or forcing you to start another meal on a new track (e.g. kid's tantrum). After a few splits you are forced to make several meals at the same time and it becomes impossible to click on all the circles as they go by, mimicking the stress and split-second compromises of multitasking. Because these scenarios are drawn from the data, you can pause the game or click on the struggles when they appear and zoom all the way into the original footage.

The whole game should take just a few minutes to complete, but by the end of it players have a new access point to the data and a visceral sense of the underlying experience model.

The Pantry

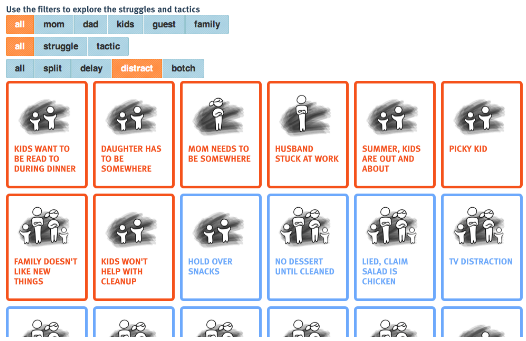


Figure 6. The Pantry

The final piece is the website to connect the games to the underlying data, called *The Pantry* (see Figure 6). This site hosts (1) *Wrangle* and instructions for *Exquisite Dinner*, (2) an animated intro to the experience model, (3) the full catalogue of struggles and tactics along with several views to browse the relationships between them, and (4) a detail view showing video, a transcript of the relevant data, and a list of related tactics and struggles.

This is the element that knits the rest together. The limited scope of the individual games makes it even more important to connect them to each other to channel the interest they spark.

Key Findings

These prototypes are little more than experiments at this point, and have yet to be tested on a significant scale. Nevertheless, they stimulate a number of useful questions and considerations:

Fun: When accurately modeling a painful experience, should the game be painful too? This will build empathy, as *Is It Time* did, but may dampen people's enthusiasm to play and pass it on. Simply making a good game is itself a fundamental challenge.

Size of games: The key insight from this project is that a system of smaller games connected to a robust platform is likely to be more attainable than a monolithic, all-encompassing experience. In particular, the experience models are natural candidates to bring to life as abstract games that don't require extensive art and programming resources.

Unit of play: Struggles and tactic were appropriate units of play because they mapped well to the parts of the experience and were in opposition to each other—fertile ground for a number of useful game mechanics. But were they the right way to introduce players to the data? Further work should be done to explore different categorizations of the data (e.g. different stages of the meal), and perhaps creating an array of games with multiple perspectives on the same data.

Subjectivity & Rigidity: The hardest thing about setting up game mechanics to mirror an inherently subjective model of experience is that some actions may be desirable for one party but not for others. For example, one family may view eating in front of the TV as a sign of failure. Another might perceive TV dinners as a wonderful way to be together. This may be addressed by manipulating the rigidity of the game.

Exquisite Dinner and *Wrangle* sit at opposite ends of a spectrum, the former representing a loose structure drawn from the model and the latter being rigidly bound to it. A loose structure is good for discussion. It's an effective way to respect life's essential messiness and the issue of subjectivity, but is less actionable because it's less connected to the insights of the model. However, it gives players more space to introduce their own thoughts. The more rigid structure is good for data delivery. It teaches the model much more effectively and the gameplay is less dependent on the creativity and argumentativeness of the players, or having other players at all. This makes it more self-contained. However, it may cut out too much of life's messiness.

Time constraints: Is it possible to design a compelling game within the very limited time constraints of the design process? Further investigation should be done of platforms and reusable elements, but perhaps the best solution is to frame these systems of games as persistent artifacts to be updated year-on-year as the data evolves.

Authoring tools: These games need to be paired with flexible authoring tools that don't lock researchers into an overly restrictive model of the world. They need to be able to insert data and mold it into gameplay scenarios, but also modify the game as their understanding of reality improves.

Security: Large institutions should be the perfect breeding ground for these models and games: a large group of people who need to be aligned around a specific goal, controlled computer systems, and plenty of colocation. But espionage and fears about intellectual property lead to restrictive policies on what can be seen by whom. A truly insightful model may be perceived as too important to be allowed to spread, even though that dissemination might increase the ability of the institution as a whole to serve its users. This tradeoff is ripe for further investigation. Perhaps games may actually allow for a more granular disclosure of this information than existing methods.

Conclusion

Games like *Passage*, *Alex's Story*, and *Is It Time* show how emotional content can be communicated by games rooted in simplified experience models, and the broader universe of games is ripe with examples of popular games encapsulating large domains of information, though mostly inspired by—not firmly rooted in—reality. It's hard to design good game mechanics for subjective experience without distorting or overly simplifying the messiness of real life.

The exploratory prototypes in this project suggest that an approach based on experience modeling may be a way to create a robust structure to keep game mechanics faithful, and raise a number of questions about the tradeoffs to navigate to create a successful system. It's also important to remember that games are one of many approaches to making data more engaging. The best solution may be a mix of approaches.

This research may also be relevant from the reverse perspective: creating games that are more rooted in reality. There is a clear business goal to increasing the reach and impact of ethnography within institutions, but there is perhaps an even broader target: embedding real human insight into the cores of games that we all play.

Endnotes

(1) Experience modeling was heavily used at E-Lab in the mid-90s and then Sapient, and parts of the methodology have been employed by a number of design firms since (Jones, 2006). Most likely due to the commercial nature of most modeling work, little of note is published and it is out of scope of this paper to provide a substantial introduction. The Real Moms case study should nevertheless provide a useful illustration, with a fuller overview to come.

(2) For those reacting to the exclusive use of *'she'* throughout this paper to describe preparing the family dinner, it is worth reiterating that the data we used unfortunately only covered women. In a world where gender roles are becoming increasingly fluid, it would be ideal to understand both genders.

References

Jaruzelski, B. & Dehoff, K. (2010). The global innovation 1000 - how the top innovators keep winning. (61), Retrieved from http://www.booz.com/global/home/what_we_think/featured_content/innovation_1000_2010

Rohrer, J. (Designer). (November 2007). *Passage*. [Web]. Retrieved from http://hcsoftware.sourceforge.net/passage/

Rohrer, J. (2007, November). *What I was trying to do with passage*. Retrieved from http://hcsoftware.sourceforge.net/passage/statement.html

Digital Dreams Light (Designer). (2011). *A Tale By Alex*. [Web]. Retrieved from http://www.digitaldreamsgames.com/games/a-tale-by-alex/

Fraina, J. (Designer). (2011). *Is it time?.* [Web]. Retrieved from http://jaimefraina.com/other-stuff/design-documents/is-it-time/

Robinson, R. E. (2001). Things to think with. Proceedings of *The Doors Of Perception*, http://museum.doorsofperception.com/doors6/doors6/transcripts/robinson.html

Jones, R. (2006). Experience models: where ethnography and design meet. Proceedings of *Ethnographic Praxis in Industry Conference (EPIC) 2006.* Retrieved from: http://pages.cpsc.ucalgary.ca/~saul/wiki/uploads/HCIPapers/jones-ethnog.pdf

Acknowledgments

I am indebted to John Cain and Kim Erwin for their teaching, insight, and for making this project possible, and to Elena O'Curry for setting me on this path (and helping me not to wander off it).

Urban Game Design as a Tool for Creativity, Collaboration, and Learning Among Youth

Ingrid Erickson, Joan Ganz, Cooney Center at Sesame Workshop, New York, NY, ierick@gmail.com
LeAnne Wagner, Hyperquake, Cincinnati, OH, Email: leannemwagner@gmail.com
Hillary Kolos, New Learning Institute, New York, NY, Email: hkolos@gmail.com
Kan Yang Li, Institute of Play/Parsons New School for Design, New York, NY, Email: kanyangli@gmail.com

Abstract

As part of a National Science Foundation grant entitled "Urban Game Design as a Tool for Creativity, Collaboration, and Learning Among Youth," we report on early findings from our first workshop with a group of young people, aged 9-14, at a branch of the New York Public Library. The focus of the workshop was to determine whether teaching kids the principles of game design had any impact on how they used mobile devices for creative ends. We report on early findings that suggest that game play does not necessarily prompt a desire to design games in youth, that the transition from two-dimensional to three-dimensional game spaces can be challenging, and that articulating game rules is one of the most difficult aspects of being a game designer.

Introduction

There is little contestation to the claim that living, learning, and working in the twenty-first century will require a combination of technological literacy, social acumen, and innovative problem solving. Recently, the Partnership for 21^{st} Century Skills (P21), a coalition of the U.S. Department of Education and several corporate partners, has produced a framework to guide institutions in providing the necessary skills and training to up and coming youth populations (Partnership for 21st Century Skills, 2008). This skills framework does not privilege traditional content areas such as history or geography, but rather emphasizes the cultivation of abilities such as creative thinking, applying technology effectively to a task, and working collaboratively to incorporate knowledge into a realistic context of use. Moreover, the Partnership contends, skills should be developed within supportive learning environments that provide learners equitable access to "relevant, real world 21st century contexts" and via situations that "support expanded community and international involvement in learning, both face-to-face and online" (Partnership for 21st Century Skills, 2008, p.9).

P21 defines creativity as a learning and innovation skill. They suggest that creative thinking is constituted by the ability "to use a wide range of idea creation techniques (such as brainstorming); to create new and worthwhile ideas (both incremental and radical concepts); and to elaborate, refine, analyze, and evaluate one's own ideas in order to improve and maximize creative efforts" (2008, p. 9). Alongside of this, individuals should be able to work creatively with others and know how to implement their innovations.

It has not always been the case that creativity has been defined as a necessary skill or competency. In his treatise on creativity, Csikszentmihalyi (1996) documents the lives of notable creative people, ultimately detailing their common practices and highlighting their unique attributes as a way of both celebrating yet demystifying what the author often refers to as a state of ‘flow’ (Csikszentmihalyi, 1990). In a paper on creativity and learning systems, Burleson (2005) acknowledges the various theories of creativity by such thinkers as Amabile, Faure, Kay and Papert, a few of whom speak of creative skills (e.g., Amabile, Kay). Yet on the whole, the approach Burleson takes as he considers building learning systems is one of motivating creative engagement for his potential users, not engineering it. Shneiderman (2007) echoes this approach is his work on creativity support tools, as does Resnick (2006) with his notion of the computer as paintbrush. Indeed, at the far end of the spectrum of creativity research, media scholars such as Ito and colleagues (Ito et al., 2008), Jenkins (2006, 2009), and Loveless (2002) suggest that IT-enabled creative engagement, beyond being a state that is motivated or supported, simply is the same as normal youth practice online. In this sense, participation and creative engagement are becoming blurred.

Thus we find ourselves at the apex of an important conversation regarding the relationship between creativity and technology. On the one hand, educators are embracing the need to teach creativity and hone creative skills to prepare their charges for the complexities to come. On the other hand, researchers of contemporary digital youth practices seem to have imploded the definition of creativity beyond its traditional associative anchors of ‘newness’ or ‘innovation’ to categorize the everyday as worthy of creative assessment. As researchers, we stand at this juncture equally influenced by the research streams of user-centered technology and youth-centered practices, but find appeasement by neither set of arguments. As such, we have designed a study to test the following research questions: (1) If creativity is a expandable skill, what is required to nurture it? (2) If creativity is a nascent quality of everyday youth practice, how is it expressed and identified? (3) What role does information and communication technology play in the development of creative skills, the expression of creative actions, or the engagement in creative practice? We interrogate these queries by placing them within the context of design.

Creativity in the Design Process

There are many types of design—iterative design, participatory design, collaborative design, etc. We focus our investigation of creativity within a set of collaborative design activities. Collaborative design, or co-design, is the area of design in which people come together with different ideas, perspectives, and skills and work towards one common goal of making the end-product better. Complex design problems require more knowledge than any single person possesses because the knowledge relevant to a problem is usually distributed among stakeholders. Bringing different and often controversial points of view together creates a shared understanding that can lead to new insights, new ideas, and new artifacts. According to design researcher, Don Norman, “Good learning requires that learners feel like active agents (producers), not just passive recipients (consumers). Co-design means ownership, buy in, and engaged participation. It is a key part of motivation. It also means learners must come to understand the design of the domain they are learning so that they can make good choices about how to affect that design” (1993).

Providing open systems is an essential part of supporting collaborative design. An open system provides opportunities for significant changes to the system at all levels of complexity. By creating opportunities to shape the system themselves, designers can be involved in the formulation and evolution of problems from multiple entry points. Games provide just such an open system for collaborative design.

Like design, there are different types of games. Our project makes use of the game type known as 'Big Games'—a new game genre that encourages players to step outside and explore physical reality as a three-dimensional game space. Big Games, often played in cities where they are known as 'Big Urban Games', are made possible because of mobile technology. Mobile devices like the iPhone allow *designers* to use things like QR codes (1) to tag aspects of the physical environment (e.g., walls, benches, etc.) as essential elements of the game. Mobile technology also allows for the possibility of using less discrete parts of the natural of historical environment, such as a city block or a building, in the design of a game. For example, a game set in lower Manhattan could avail itself of actual historical landmarks to build a historically accurate narrative in which players inhabited characters from history (2). Mobile devices give *players* the opportunity to move and explore an area in an entirely new way—hopefully a way that encourages new insight or experience because of being in a particular locale. Another way of stating this is to say that Big Games offer their players situated learning experiences. In addition to the learning affordances of videogames, which actively engage players' visual and auditory senses while fostering the imagination of virtual world, Big Games present a tactile and kinesthetic experience that allows players to piece together a larger meaning system within in a real, physical context.

Research Study

While the affordances of game design and mobile learning have been well documented regarding their various learning attributes (Gee, 2008; Salen, 2008; Soloway, et al., 2001), the relationship between game design and creative expression, as well as creativity and gameplay, have yet to be fully researched. In alignment with our research questions, we have begun to address this gap by creating a project that investigates how an urban mobile game might be used as a design tool to support and possibly enhance the creative output of youth. Our hypothesis, more precisely, is that by designing an urban mobile game, iteratively testing it, and playing it, youth will experience the game framework as a mechanism for both creative expression (game design) as well as creative engagement (interactive game play). We also believe that bringing the city to life via mobile game play will foster situated and social learning, geospatial understanding, and interest in community engagement.

The curriculum for this project was developed by LeAnne Wagner, a graphic artist and game designer, and Hillary Kolos, a media artist and educator. Together they created a staged set of experiences that take participants over the course of 32 hours (2 hours a day, twice a week, for 8 weeks) from game players to game designers. The logic of their activity plan was based in developing design and collaboration skills among the participants while familiarizing them with some of the more production and locative aspects of smartphones like QR codes and GPS functionality. The first sessions begin by having kids play board games like Chutes and Ladders to understand that games are systems. Things move on from there to modding games—sometimes in ways that included adding new elements (see Figure 1 for a modified game of Monopoly that includes origami cranes), and other times in ways that created new rules for existing game elements. After gaining the insight that games are malleable systems, we teach about the potential game functionality that could be employed when moving games from a two-dimensional board to a three dimensional space using an iPhone smartphone. We encourage this dimensional shift by having kids play games using QR codes. Where possible, we also utilize a locative authoring tool such as ARIS to support richer, locative gameplay. The workshop concludes when teams create their own mobile games, which they play-test with one another.

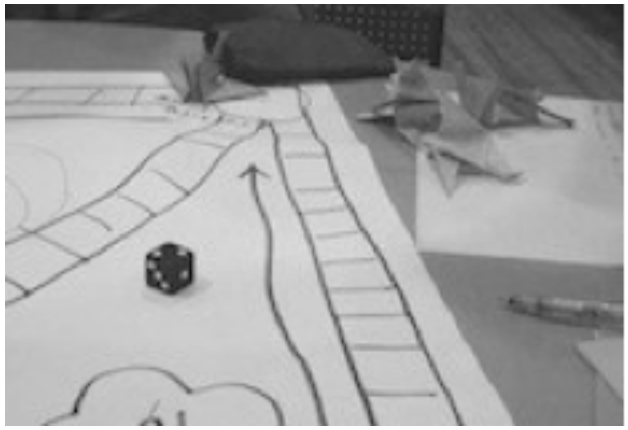


***Figure 1*. Modding Monopoly with added origami elements.**

The participants of the 'GameMaker' workshop at the public library were a group of young people who frequented the library on a daily basis to play videogames on the public computers. They were all from the immediate neighborhood, the Chinatown section of New York City, and ranged in age from 9 years old to 14 years old. Most self-identified as 'gamers', and were particularly interested in and adept at playing web-based videogames from Asia. Participation in the workshop was voluntary, but over the course of the 8-week workshop term a core group of 8-10 kids came regularly to the design sessions held on successive Monday and Wednesday afternoons.

Our metrics for success for the workshop were two-fold. First, did participants move in self-identification from being game players—and thus seeing technology as a platform primarily for consumption—to game designers—correspondingly identifying technology as a potential platform for production? Second, did participants use their nascent game design skills to create games that expressed personal or team creativity? During the workshop that we report on here, Hillary and her collaborator, Kyle Li, a member of the teaching team at Quest to Learn (3), served as workshop facilitators; Ingrid Erickson administered pre- and post-surveys and observed a series of workshop sessions as project researcher.

Emergent Findings

We have three early takeaways from the New York Public Library GameMaker workshop. First, kids' interest in games doesn't necessarily translate to an interest in creating games. While many of our participants knew quite a bit about the details and mechanics of games and game play from their time playing games in the library after school, when they were encouraged to move from player to creator, it took them a while to realize the wealth of their own knowledge. Kyle got kids to move into this creator frame of mind by getting them to complain about the games that they played regularly. These complaints evolved into reimagining idealized game features, which triggered a nascent self-awareness that instead of just being expert players, constrained by the systems they were playing on, they could instead be creators. Prior to this moment, the highest aspiration many of the young people sought to achieve was the role of 'game master' because they felt that this was the position that would garner them the most power.

The shift from two-dimensional to three-dimensional space was also challenging for our participants. Our project is intended to use New York City as a "game board," however in the case of the library we were restricted to using the library space itself (see Figure 2) as our three-dimensional canvas because of parental permission issues. The most successful usage of this space for game play was when youth mapped story elements from popular fiction onto different areas in the library. In this four-story space, the basement, for example, was often associated with a nefarious or illicit locale. The elevator was sometimes endowed with magical powers. Given that the usage of GPS was impossible within this setting, kids also had to make due with using QR codes as their sole link between physical and digital game space. The most successful genre of game that fit these constraints was the scavenger hunt, particularly with the added element of hiding codes where they would be difficult to find, such as under window shades, within books, or in hidden sections of bookshelves. We consider the three-dimensional games that our participants produced in the workshop a first step along the broad spectrum of three-dimensional game design—one that was particularly successful in disassociating mobile devices merely with their media consumption capabilities.

***Figure 2*. Thinking of the library as a three-dimensional game space.**

Finally, kids reported that creating and articulating the rules for their games was the hardest part of being a game designer. When they reached the section in the workshop dedicated to creating their own games, participants were typically not at a loss for generating thematic ideas. One group of older girls was particularly adept at this part of the design process once they became confident in their role as designers. They first explored the possibilities for translating stories from *The Percy Jackson and The Olympians* series; in another instance they figured out how to develop a game based on the birthdays of the members of a favorite Korean boy band.

What was particularly difficult for participant groups was translating their creative enthusiasm for themes and game genres into structured rules for game play. This portion of game design definitely tests the understanding of a game as a system. The group dedicated to creating a game about their heartthrob boy band ended up devising a complicated system of grouping members by birth dates and years (see Figure 3) to define a challenge that had players order all fifteen members from oldest to youngest. Players were given clues to assist them via QR codes. In testing the game, it became obvious that the importance of rules is not only their logical, but also their social, function: a game is not a game if it cannot be played by other people. Much as the game made sense to its creators, it failed to coherently compel any other teams in the group.

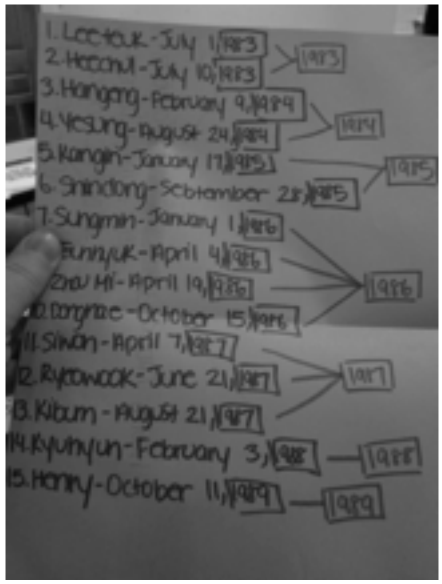


***Figure 3*. Rules for a game based on the birthdays of all the members of a Korean boy band.**

Conclusion

Our early findings regarding the relationship of game design, mobile technology, and creativity are just that—early. We attempt herein to share some of the moments during our workshop with a group of kids at a branch of the public library that provoked pause and begged for reflection. We were interested to note an initial reticence by kids to adopt the role of creator, but were also pleased when they imaginatively generated ideas for games based on their own interests and passions. Certain constraints on mobility in this case may have impacted the shift from 2D to 3D game design. We will see whether this perceptual is any more natural when the game space is a city street instead of a city building in future workshops. Finally, the dual nature of rules as both social as well as logical characteristics of a game suggest that creativity in game design is not merely a matter of content, but equally of structure.

The early days of this project yield one particular insight overall: the power to be a creator, even a modder, is not encouraged enough when it comes to kids and games. We should celebrate not merely learning through play, but learning through design. We will have more to say on this topic as our research progresses.

Endnotes

(1) QR codes are 2-dimensional bar codes that can be read by a smartphone to reveal an attached message, image or link to a webpage.

(2) For an example of this style of big urban game, see the project 'Settlers of Manhattan' developed by Colleen Macklin, David Carroll and their students at Parsons the New School for Design using the mobile authoring tool 7Scenes.

(3) Quest to Learn is a new public middle school in New York City whose curriculum is entirely organized around games.

References

Burleson, W. (2005). Developing creativity, motivation, and self-actualization with learning systems. *International Journal of Human-Computer Studies, 63*, 436-451.

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York: Harper Perennial.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the Psychology of Discovery and Invention*. New York: Harper Perennial.

Gee, J. P. (2008). Learning and Games. In K. Salen (Ed.), *The Ecology of Games: Connecting Youth, Games and Learning*. Cambridge, MA: The MIT Press.

Ito, M., Horst, H. A., Bittanti, M., boyd, d., Herr-Stephenson, B., Lange, P. G., et al. (2008). *Living and Learning with New Media: Summary of Findings from the Digital Youth Project.* Chicago, IL: The John D. and Catherine T. MacArthur Foundation Reports on Digital Media and Learning. Available online at http://digitalyouth.ischool.berkeley.edu/files/report/digitalyouth-WhitePaper.pdf.

Jenkins, H. (2006). *Convergence Culture: Where Old and New Media Collide*. New York: New York University Press.

Jenkins, H. (2009). *Confronting the Challenges of Participatory Culture: Media Education for the 21st Century*. Cambridge, MA: The MIT Press.

Loveless, A. M. (2002). *Report 4: Literature Review in Creativity, New Technologies and Learning*. Bristol, UK: FutureLab. Accessed September 28, 2009 at http://www.futurelab.org.uk/resources/publications-reports-articles/literature-reviews/Literature-Review382.

Norman, D. A. (1993). Things That Make Us Smart: Defending Human Attributes in the Age of the Machine. New York, NY: Basic Books.

Partnership for 21st Century Skills. (2008). *21st Century Skills, Education & Competitiveness: A Resource and Policy Guide*. Accessed on September 12, 2009 at http://www.21stcenturyskills.org/documents/p21_framework_definitions_052909.pdf.

Resnick, M. (2006). Computer as Paintbrush: Technology, Play and the Creative Society. In D. Singer, R. Golikoff & K. Hirsh-Pasek (Eds.), *Play=Learning: How Play Motivates and Enhances Children's Cognitive and Socio-Emotional Growth*. New York: Oxford University Press.

Salen, K. (2008). Toward an Ecology of Gaming. In K. Salen (Ed.), *The Ecology of Games: Connecting Youth, Games and Learning* (pp. 1-17). Cambridge, MA: The MIT Press.

Shneiderman, B. (2007). Creativity Support Tools: Accelerating Discovery and Innovation. *Communications of the ACM, 50*(12), 20-32.

Soloway, E., Norris, C., Blumenfeld, P., Fishman, B., Krajcik, J., & Marx, R. (2001). Handheld Devices are Ready-at-Hand. *Communications of the ACM, 44*(6), 15-20.

Acknowledgments

We would like to thank the participants of our GameMaker workshop for their willing cooperation; the staff of the library for their patience as kids ran throughout their building; our advisors (Katie Salen, Richard Arum, and Caroline Haythornthwaite) for their constructive comments on our curriculum and research agenda; and the National Science Foundation for funding this research (Award # 1002850).

Critical Gameplay Gone Critically Wrong: Third World Shooter

Lindsay Grace, Miami University, 800 High Street, Oxford, Ohio, Email: LGrace@MUohio.edu

Abstract

This paper serves as a postmortem for the game Third World Shooter. The game was completed as part of the Critical Gameplay project. The project endeavors to analyze common game mechanics and create games that demonstrate alternate ways to play. Third World Shooter was as a docugame employing critical gameplay. This paper illustrates how the design of Third World Shooter dovetails into the more successful designs of other critical gameplay games.

Background and Introduction

The Critical Gameplay project is an ongoing investigation into alternate ways to play. The games of the Critical Gameplay project are designed to critique the standards of digital gameplay. These games have been shown at a variety of venues in Europe, Asia and the Americas [Grace 2010]. The games are typically designed and implemented by one person, in under one week. They are designed to create alternate play experiences by offering players new play models. Where typical games may require players to shoot or collect, critical gameplay games require players not to collect [Levity] or to unshoot [Healer]. Critical gameplay games do not always invert gameplay models, as games such as Wait simply require players to balancing seeing and doing (2009).

Docugames are games created to document an historical moment. They are digital gameplay's equivalent of documentary film. There are relatively few docugames in existence. Examples include Kuma War (2011) and Paris Riots (2006). Prior to the Third World Shooter project, no Critical Gameplay project game had endeavored to apply the critical dameplay design pattern to the production of a docugame. Third World Shooter was a first, somewhat unsuccessful attempt at creating such a docugame.

Third World Shooter was designed and developed between December, 2008 and April, 2009. Third World Shooter aimed to provide an entertaining opportunity to explore the experience of being one of several contributors to the War of Independence. The War of Independence is the common name for the struggle to liberate colonial Guinea Bissau and Cabo Verde from Portugal. The war lasted 11 years, from 1963-1974. The history of these African nations is not well documented in popular media(Lobban, 1995). As originally designed, players of Third World Shooter would be afforded the opportunity to play the roles of a variety of citizen action groups, political figures and military fighters seeking independence.

This document outlines the success and failures of such a design. In the process it illuminates design oversights, demonstrates characteristics of effective rapid design, and describes how this game informed other, more successful Critical Gameplay games. It is hoped that this retrospective analysis will benefit makers of docugames, games of rhetoric, and educational game makers.

The Third World Shooter Game

Third World Shooter (see figure 1) began with several fairly lofty design goals. The history of the War of Independence is full of complex politics that could find analogy to the stalemates of the contemporary war on terror. The people seeking independence from the Portuguese colonial system were considered enemies of the state. To gain independence, the African Party for the Independence of Guinea and Cape Verde (PAIGC) used propaganda, sabotage and military action. As a Marxist group, funding and support for the liberating PAIGC often came from communist China and the then USSR. Despite the country's cold-war era allies, Cape Verde in particular has a very strong relationship with the United States.

***Figure 1*. Screenshot of the Third World Shooter game.**

Players of the game were asked to take the role of various PAIGC members, soliciting political support from non–player characters, sabotaging military equipment and firing upon Portuguese soldiers. Players moved through a space that was a reasonably accurate representation of urban life in Guinea Bissau and rural life in the forests.

While these aspects were typical for a docugame, the game also endeavored to be critical. Unlike many first person games which tie the success of an overarching goal to the success of a single player, the game attempted a system where objectives were met through player death. Players worked toward an overarching goal, understanding that they may die, but that their mission goal may be perpetuated by their death. The central question of the critique was why a game must end when the player dies? While not entirely successful, the goal was to investigate the production of a game that employed a self-sacrificing style of altruism.

The game was also aware of its potential as propaganda. It emphatically championed the efforts of the PIAGC, the political party that lead the War of Independence, through player dialogue and game situation. As an educational practice, it was hoped that the game could be used to discuss the complex history through another perspective. Many of the documents of this event were generated by the Portuguese colonial power.

Although several hours of gameplay were designed, the game was released as a beta version including approximately one hour of gameplay over 2 levels. The first level required the player to move through the city of Pijiguiti to gather political support through canvassing the general public. The level was designed around the infamous dock worker strike of 1959 at the

Pijiguiti pier. At the end of level 1, the player is killed in crossfire in what is commonly called the Pijiguiti Massacre. This historical event involved at least 40 non-military victims who were fired upon by Portuguese police during a simple strike for improved wages (Lobban, & Saucier, 2007).

The player begins the second level as a fresh military recruit in rural Guinea Bissau. The player must prove their mettle by first stealing a military communications device from a Portuguese outpost. The player is then asked to collect weapons and use them on military targets. If the player succeeds, they return to their burning military outpost which has been struck by Portuguese soldiers in retaliation. The player is shot shortly after witnessing the carnage.

In retrospect, the errors in design are quite clear. The game suffered from three primary design mishaps. These are the challenge of balancing archive with document, the complexity of employing critical gameplay in a large game, and a failure to employ iterative design evaluations. Several other factors lead to the relative failure of the game, but these are the most prominent.

Documentary or Archive

When designing docugames, it is important to balance design efforts between appropriate documentation and entertainment. While this would seem the most obvious challenge in designing such games, it is actually only a surface level concern. Deeper analysis reveals that like film, there is considerable editing that must occur to successfully create a useful document. In games the rules and structure of that editing are complicated by the non-linear experience. Where a film editor can dictate moments and experience to adhere to three-act structure or Campbell's Heroes' Journey, game narratives are not as easily structured.

The game endeavored to be an accurate representation of the experience of PAIGC soldiers. As such, the game included a tree system that generated over 30 environmentally appropriate shrubs and trees for the forest environment. As a PAIGC soldiers spent much of their time in the deep jungle and as such, to accurately recreate the experience, players are asked to move through the expansive virtual jungle in the game. So much so, that in beta testing the game, players spent as much as 30 minutes of the game's 1 hour play simply moving through the jungle. This is a clear short falling of the game so enormous, that it is comical. Nearly half the game becomes a walk through the forest, potentially changing the focus of the game from the War of Independence to the trees and plants of Guinea-Bissau.

This problem of balancing historical accuracy in experience and environment points to general challenge with the production of docugames. Besides forming an educationally supportive narrative structure, designers must find a middle ground between archival and document. Third World Shooter is full of overly specific efforts to match buildings, clothing, vehicles, and other elements to their historical references. As digital game production can be a very large effort in itself, it seemed fundamentally distracting to put too much effort into create an accurate environment. In total there are more than 70 3D model assets (see figure 2) created for the game. Of those, roughly 12 are essential to the experience of the game. Future developers of docugames would be wise to avoid making historically accurate environments, unless those environments relate directly to the goals they seek. As with any software project, it is essential to balance efforts. Third World Shooter's four month development schedule was dominated by development of elements of accuracy, not entertainment or engagement.

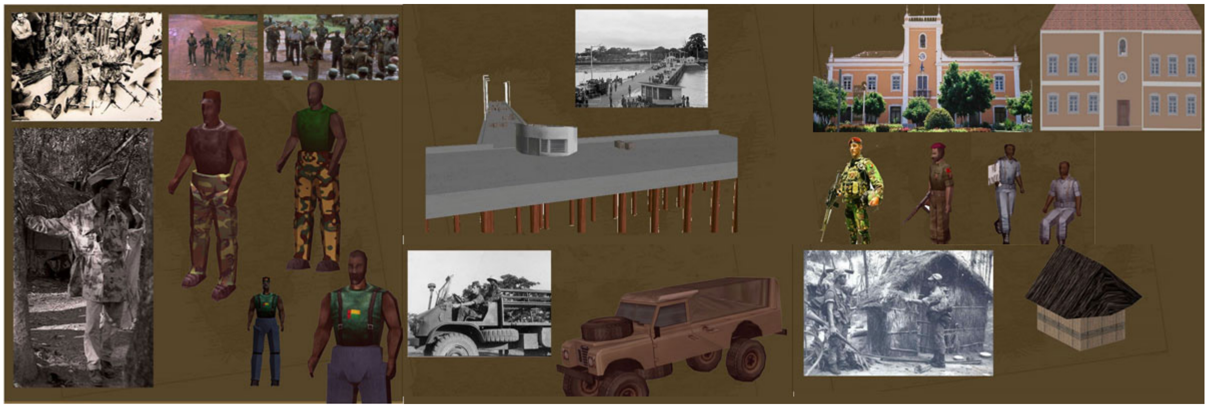


***Figure 2*. Sample collage of 3D assets created for the game with reference images.**

Third World Shooter never found its space between accurately archiving and providing useful documentary. This is a balance between the high fidelity of an archive and the conciseness of an effective document. Many experiences were accurately depicted, but because they accurately represented, they failed. Players were asked to gain support for the PAIGC in the first level, yet PAIGC support didn't grow until after the Pijiguiti Massacre. To be accurate, players were subject to a series of non-player character rejections. Two out of three times a player asked for support from a non-player character, they were rejected. This is not an inspiring way to start a game experience.

Likewise, players were asked to shoot and steal as common game verbs. True to the ratio of experience of the early PAIGC, players shot very little. Players did not earn a gun until they had completed three-quarters of the game. Players steal, but stealing was a very tense experience, as the player was aware that they had no recourse and no defense if caught.

Critical Gameplay and Game Verbs

Third World Shooter also employed a couple of critical gameplay design goals. The most important of which was the notion that players should die in order to meet the goals of the PAIGC group. This critical gameplay goal came from the relative absence of such philosophies in games. Where war may produce suicide bombers and kamikaze pilots, few games, save for zealous squad based players, encourage players to die in the game to meet a larger goal.

In practice, Third World Shooter was not the game to investigate the possibilities of this type of play. First, as a first-person perspective game, there is little opportunity for players to even realize that they have changed characters. Every new level did not feel like the role of a new character, it merely felt like a new level. Secondly, it raised questions about why a player would want to play a game which rewards success and failure the same way – in death. The fundamental design goal was to create an experience that inspires the player to see the value in mutual benefit, not just self-sacrifice. It was not enough to have the player practice self sacrifice, it was hoped the game would tie the players sacrifice to the success of a larger game goal.

This never worked well in Third World Shooter, but it was re-employed in two later Critical Gameplay games called Healer (2009) and Simultaneity (2010). Healer is a third person unshooter, in which players must pull bullets from victims instead of putting bullets into them. The player character in Healer has no weapons. To prevent their recently revived victims from dying again, the player must put themselves in the way of bullets. Healer's first levels are based on the Rape of Nanjing, an historical conflict between China and Japan that is often recognized as the largest historically massacre in human history (Chang, 1997).

Simultaneity requires players to manipulate several characters through one control. The goal is to move as many characters as possible through misaligned exits. The player must employ a strategy which evaluates the situation of all the pieces on the game board to find a solution of optimal benefit. These two games employ the critical gameplay design goal of mutual benefit more concisely and engagingly than Third World Shooter.

Other elements of the game were designed to recreate the experience of being a member of the PAIGC. These include the explicit effort to create the emotions of fear and isolation. The second level for beta testing was explicitly designed to emphasize the loneliness of moving through the forest searching for soldiers. In gathering feedback, more players felt helpless and lost than lonely and fearful. In retrospect it should also be asked if it makes sense to create an educational game that endeavors to create loneliness and fear in a player. Layering too many designs goals in a fairly small project clearly muddled the resulting game.

Game Complexity and Iteration

Once all of these elements were combined, the game lost its ability to deliver any one element well. The game failed to be an effective docugame because it introduced sometimes off-putting critical gameplay experiences. True to critical gameplay experiences, the player experienced a critical distance which detached any emotional engagement by injecting intellectual curiosity.

The game was also lofty in its pursuit of technical goals. In order to offer avoid the monotony of a very simply game played over several hours, the game sought to employ varies technical systems to make the experience more complex and nuanced. These proved to be more noise than benefit.

Third World Shooter was developed in Blitz3D, a 3D game-making environment in existence as early as 2003. Development time was spent on a day/night system, artificial intelligence that was sensitive to in-game lighting, and accurate rendering of water. In total 12 technical objectives were pursued during the short four month development period. Most of these did not improve the game's ability to impart history. They merely made the game behave more like a commercial release.

Many designers will affirm that complexity does not make a game better. This is true of technical complexity as well as design complexity. Yet, in the pursuit of a better Third World Shooter, complexity was layered into design and technical implementation. This complexity also made the game much harder to test without adding much benefit to the experience. Since many of these new elements were integrated, evaluating them individually did not inform the complete experience. Subsequent critical gameplay games return to the model of one game in one week. Since critical gameplay requires players to change the way they play, simply games with one or two changes seems to be much more fruitful.

Conclusion

It is hoped that this retrospective analysis of the development and design of Third World Shooter will help future developers of docugames and games of rhetoric. It is not accurate to reflect on the experience as a failure. A failed experience would imply that little was learned and even less mined. The game themes found new space in later games. The programming code has been reused in other projects. The experiment itself worked like an experiment should. It revealed what can work and what can't. Yet, unlike a good experiment, Third World Shooter failed to investigate a single hypothesis well. Instead it was an amalgam of theories, which complicated observation. It is not clear if Third World Shooter was a bad idea, a poorly executed idea, or merely subject to its own lofty goals. At the very least it is hoped that it stands as a useful example of potential challenges in designing docugames that are not merely reporting experiences, but rhetorical and experimental in their approach.

References

Chang, I. (1997). The rape of nanking: the forgotten holocaust of world war ii. New York, NY: Basic Books.

Critical Gameplay. (2010). Healer [PC game]. Chicago, IL: Lindsay Grace

Critical Gameplay. (2009). Levity [PC game]. Chicago, IL: Lindsay Grace

Critical Gameplay. (2009). Simultaneity [PC game]. Chicago, IL: Lindsay Grace

Critical Gameplay. (2009). Wait [PC game]. Chicago, IL: Lindsay Grace

Grace, L. (2010). Creating critical gameplay. Proceedings of the 7th international conference on advances in computer entertainment technology (pp. 91-95). New York: ACM. Levity

Lobban, R. (1995). Crioulo colony to independent nation. Boulder, CO: Westview Press.

Lobban, R. A., & Saucier, K. (2007). Historical dictionary of the republic of cape verde. Lanham, MD: Scarecrow Press.

Kast, Michel. (2006). Paris Riots [PC Game]: Paris, France. http://parisriots.free.fr/

Kuma Reality Games. (2011). Kuma War [PC game]. New York, NY: Kuma Reality Games

Game Design for Cultural Studies: An Experiential Approach to Critical Thinking

Sabine Harrer, University of Vienna, Lerchengasse 28-30/21, 1080 Wien,
Email: sabine.harrer@gmx.at

Abstract

How can game design be used to foster critical reflection and render cultural studies less boring (Grossberg, 2006)? This paper discusses the design process of *Cutting Edges*, an abstract mini-game made to encourage students and scholars of cultural theory to actively explore abstract philosophical claims. The initial intention was to produce a well-rounded game that could be used in a classroom setting to expand and mediate discussion on gender identity through playful experience. Focusing on the pressures of gender-related social ascription, *Cutting Edges* was an attempt to use the metaphorical potential of game rules and mechanics to make tangible what is at stake in gender-critical thinking. While making the game, the creative process of finding meaningful mechanisms of representation turned out to be a rewarding resource for reflecting cultural theory. Design activities demand reflection, evaluation, and planning and might thus be promising tools to expand our notion of critical thinking.

Introduction

By and large, declaring cultural studies dead has turned a fashionable sport in contemporary academia but small is the number of critics who actually start an attempt to fight for the comatose patient's reanimation. This paper starts off from the assumption that cultural studies goals are worth pursuing even if they need some serious update. This could happen via an arranged marriage with game design, whose work of "designed experiences" (Squire, 2006) might spark an approach towards cultural theory that is more engaging and less boring than what currently counts as cultural studies (Grossberg, 2010).

I will first sketch out what needs to be rescued about the initial cultural studies idea and explain why the whole project has become so dreadfully discredited throughout the last couple of years.

I then will discuss gameplay as an activity that might directly benefit and reform intellectual and pragmatic practice, as well as describe how it might expand the range of what is deemed possible in the field of games and learning by discussing the mini-game *Cutting Edges*, which was designed in order to make students and scholars approach gender theory via game experience. The paper will be rounded off by a conclusive statement about what the design process has taught me about the relation between making a game and reflecting about its subject.

Cultural Studies Reloaded: Theorizing Experience and Experiencing Theory

To its early founders, cultural studies has been understood as an intellectual and pragmatic project that pursued the goal of dismantling and challenging structures of dominance. It thereby took a clear political stance and borrowed freely from social science disciplines to arrive at a radically contextualized understanding of how power relations pervade popular culture

(Sandard & van Loon, 2004). Initially, then, this project has been about democracy, about handing agency to the people who are most marginalized by hegemonic powers. If we compare this early mission statement to the canonized work that students now encounter in their unpalatable textbooks, we might rightly doubt that cultural studies has measured up to its ideals (Rodman, 2010, p. 155).

Yet before we cast it off as a lost cause, why not attempt to carry on its central proposition to a new context that makes us appreciate its relevance in a world of abounding socio-cultural inequalities? What if we released cultural studies from its present deathbed of institutionalized order and took it to an informal, ordinary game setting? Would that help us reestablish the lost link between theoretical abstraction and pragmatic action? From the perspective of game studies, which argues in favor of games as effective learning spaces (Gee 2003; Koster 2005, p. 54) this looks like a promising endeavor. After all, games require us to learn their inherent rule systems through active exploration. As such, game mechanics possess expressive qualities whose rhetoric instruments are based on the experiential involvement of the player (Rusch, 2009). Why not leverage this potential in order to encourage players to wander around in social and cultural theory and discover the implications of their actions? That way, the current cultural studies trend of theorizing experience could be fruitfully expanded by the practice of *experiencing* theory.

Cutting Edges: A Game About Gender Theory

This consideration sparked the idea of *Cutting Edges* (*CE*), which attempts to turn gender criticism, one of the major thinking tools in cultural studies, into a game. Most basically, it represents the possibility space that we have as human beings born into a world based on a radical binary masculinity/femininity distinction. Given that our bodies are already coded in either way, and that we are raised to orient our decisions in life towards the rules of this code, we can choose whether to affirm the socially constructed gender roles ascribed to our biological bodies or work against them. The former would warrant social stability, while the latter would be sanctioned by means of social pressure. In early feminist Simone de Beauvoir's terms, "one is not born, but rather becomes a woman" (1949) only so through the constant affirmation of the things and behaviors that are constructed as feminine. This is the basic argumentative structure on which *CE* is based. It is what I found to be the most salient characteristic of a tradition that seeks to dismantle the gender binary as a social construction stabilized only by continuous performance (Butler, 1999).

CE never pretended to stand for itself as an autonomous game, but it was intended as a tool to complement and deepen theoretical discussion. This means that *CE* was especially designed for the cultural studies college classroom in order to support—not to substitute—intellectual debate. The reason I dwell on this point so extensively is because *CE* is an abstract 2D game which draws most of its representational power from its unspectacular use of very basic objects and its subversive use of simple game conventions.

The player starts off as a full circle on the bottom of the screen, which can be navigated to the right and left. A small window in the right upper corner of the screen displays a rectangle or a triangle respectively. This is supposed to represent biological fate as the goal condition we are assigned to upon birth. As we move our circle around, rectangular and triangular objects spawn on the top of the screen and fall to the ground. Whenever they touch the player's circle they cut off a piece towards the shape of the respective object. Also, they trigger audible feedback: If the touched object is identical with the goal shape there is applause; if the caught object is 'wrong' there is booing. This audible layer is intended to represent the social sanctions that set in whenever we perform a gendering act.

It is possible to play *CE* in at least two different ways, depending on whether the player acts in affirmation or confrontation to the game rules: If the player bases her decisions on the visible and audible incentives and only gets in touch with those objects that get her in the 'right' shape she will soon find her circle to have transformed into a shape that is identical with her aspired goal. By then, she might have put a lot of effort into politics of avoidance, trying to run away from the 'wrong' objects. And as a 'reward' for such behavior, the final screen compliments her on her successful identity project: "Congratulations, you've turned into a stereotype. Individuality is overrated!" The converse strategy, i.e. getting in touch with whatever object comes around without paying attention to the social noise will make you maintain an individual shape. After a certain number of 'resisting' actions, they transform into a magical ringing sound indicating that the player has grown beyond the choir of sanctioning voices that are constantly assessing and evaluating every one of her steps. Even though it is never possible for the avatar ever to return to the flawless state of unconditional roundness throughout the game, it is possible to end the game by maintaining one's individual shape over a certain period of time. In this case the player is cheered for her belief in resistance as a resource to embrace her unique self.

CE seeks to exploit the player's knowledge of popular game conventions, such as displaying a goal condition on the fringe of the screen or giving immediate feedback to give some hints about the game rules. It plays with the basic expectations that a player has when she engages in playing a game, as opposed to less interactive activities, i.e., reading a book or watching a movie. Take the simple expectation that there will be a conflict whose stakes need to be learned in order to reach the end of a game. Since players know that they are supposed to engage in a play activity in *CE* they have taken for granted expectations that they never really challenge. The option to play against the seeming game objectives is only explored if the player is willing to challenge the basic assumption that the reward system is valid. In other words, the player is invited to "outplay" the game system as an analogy to what it takes in real life to counteract gender ascriptions.

Game design as reflective tool

As *CE* is still a work in progress, it has not yet been play-tested in a suitable setting that might tell us whether the central design goals are actually applicable. Nevertheless, there are experiences and insights to be shared that I gained solely from working on the first *CE* prototype. After all, thinking about what is at stake with games such as *CE* has tremendously enriched my understanding of what I deem possible in game design when it comes to its implementation in cultural studies.

One of the most painstaking challenges related to the making of *CE* was the process of deciding on the most important aspects of gender theory that might be turned into a conclusive ludic system. The results, as I have pointed them out, are the results of an intense negotiation process in which I struggled to cut complexity down to its basic foundation. Determining the basic foundations required a substantive amount of relational knowledge. I realized that through the activity of selection I was often pushed to reread theory in regard to its underlying argumentative dynamics. Not only was this a very holistic approach towards literature, it was also fun because it seemed like a meaningful riddle that I wanted to solve for the higher end of making a game for others.

Once I surpassed this hurdle, there was the question of how to best include my chosen features in a working game system. It should work both on the level of game mechanics and in terms of adequate theme choice. Games' inherent rewards systems seemed at once like a suitable metaphoric instrument to generate an analogy to social sanctioning mechanisms. But is the sanctioning mechanism in *CE* really strong enough to enable an understanding of the pressures involved in the decision to affirm traditional gender roles even if one desires to explore them more freely? Hardly. If games are understood as possibility spaces, exploration and trial-and-error are central gameplay experiences. If a player realizes that a certain strategy turns out to be boring or unsuccessful she will dig deeper and explore the game rules until she determines how they work. My reservation about the reward system in *CE*, then, is whether the audible feedback invites players to explore rather than push them to go for the 'right' decision. However, if players simply believe in the validity of game conventions and don't understand the necessity of pondering possibilities other than catching the 'right' pieces, the final surprise might be successful.

What all of these considerations concerning the representational logics of *CE* have boiled down to is a deep reflective process on the stakes of gender theory. This has convinced me that my design activities around *CE* have been more beneficial to my own understanding of cultural studies than the play experience enabled by a well-balanced game could ever be to a student/scholar. This takes me to a new level of argumentation on which I suggest game design activities as tools through which to gain a more holistic understanding of theoretical claims. Translating cultural studies claims into a ludic format requires us to set to use what we somehow already need to have under our belts: understanding of cultural theory. Game design as a reflective tool in cultural studies, then, is one of the more advanced instruments by which to gain an understanding of society. It is one that demands students and scholars to actively negotiate what for them are the most salient aspects of an approach and how they can be represented via games' causal links.

Concluding Remarks

To sum up, my initial goal to make a game that might be used in cultural studies classrooms to help students and scholars overcome cultural studies' current numbness induced me to work on *Cutting Edges*, a game that should make feminist criticism tangible via simple game mechanisms. It was only during the design process of *CE* that I realized how much I benefited from thinking about how to create such a game. As a corollary, I learned that there are two different things at stake in the marriage of cultural studies and game design: First, there is the playable artifact, the game, which might be used in combination with an extensive discussion of the socio-cultural issue at stake; second, there is the game design activity as practice that requires us to expand our range of creative knowledge acquisition and evaluation. Along the lines of this twofold agenda of game design in theory much can be done to counteract the widespread complaint that cultural studies has lost its grip on the initial mission to tackle the very structures and relations of power from cross-disciplinary perspectives (Crawford and Rutter, 2006, p. 149). Game design could be a pathway towards a more creative and experience-based theorization culture in academia. It is desirable for both game design and for cultural studies to take an active part in this experiential turn.

References

Butler, J. (1999) Gender trouble: Feminism and the subversion of identity. New York: Routledge.

Crawford, G. & Rutter, J. (2006). Digital games and cultural studies. In Rutter, J. and Bryce, J. (Eds.) Understanding digital games. London: Sage, pp. 148-165.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. New York: Palgrave Macmillan.

Grossberg, L. (2010). Raymond Williams and the absent modernity. In Horak, R. & Seidl, M. (Eds.) About Raymond Williams. London/NY: Routledge, pp. 18-33.

Grossberg, L. (2006). Does cultural studies have futures? Should it? (or what's the matter with New York?, Cultural Studies 20(1), 1-32.

Johnson, M. (1987). The body in the mind: The bodily basis of meaning, imagination, and reason. Chicago/London: UCP.

Koster, R. (2005). A theory of fun. Scottsdale, AZ: Paraglyph Press.

Lakoff, G. & Johnson, M. (1980). Metaphors we live by. Chicago: CUP.

Milner, A. & Browitt, J. (2002). Contemporary cultural theory. An introduction. 3rd ed. London/NY: Routledge.

Rodman, G. B. (2010). Cultural studies is ordinary. In Horak, R. & Seidl, M. (Eds.) About Raymond Williams. London/NY: Routledge, pp. 153-164.

Rusch, D. (2009). Mechanisms of the soul. Tackling the human condition in videogames. Proceedings from DiGRA 2009: Breaking New Ground: Innovation in Games, Play, Practice and Theory. Brunel University, London.

Sardard, Z. & Van Loon, B. (2004). Introducing cultural studies. Cambridge: Icon Books.

Squire, K. D. (2006). From content to context: Video games as designed experiences. Educational Researcher, 35(8), 19-29.

Acknowledgments

I am deeply indebted to Doris C. Rusch for her unconditional support and her power to demonstrate that playfulness can be a source of love, agency, and character. I am grateful for Monika Seidl's never-ending belief in my ideas and my capacity to turn them into projects.

Gaming, World Building, and Narrative: Using Role-playing Games to Teach Fiction Writing

Trent Hergenrader, University of Wisconsin-Milwaukee, 508 Curtin Hall, 3243 N. Downer Ave, Milwaukee, WI 53201, Email: wth@uwm.edu

Abstract

This paper reports on the findings from an experimental creative writing course entitled "Gaming, World Building, and Narrative" that incorporated digital and tabletop role-playing game principles to teach fiction writing. Students studied the narrative unit operations (Bogost 2006) present in short fiction, films, and the videogame *Fallout 3* before collaboratively creating an immersive fictional world by populating a wiki with items, locations, and characters. Students explored their newly created world through tabletop role-playing campaigns and wrote vignette-length stories from their characters' perspectives. Students strongly preferred this approach to the traditional workshop method commonly used in creative writing classes, citing stronger understanding of character and motivations as well as the significant benefits derived from collaborative writing. Role-playing also fostered a strong and supportive community for student writers. Despite institutional challenges, role-playing games offer a compelling way to improve current fiction writing pedagogical practices and encourage new modes of collaborative writing.

In *Reforming Creative Writing Pedagogy*, Joe Amato and Kassia Fleischer (2002) offer several alternative approaches to teaching creative writing, moving away from the traditional workshop method most commonly used in universities nationwide. Instead, they promote innovative approaches that make use of computer technology and digital networks to inspire a different kind of student writing, one that encourages experimentation, collaboration, and play. I developed an experimental introductory creative writing course entitled "Gaming, World Building, and Narrative" to put several of Amato and Fleischer's ideas into action and: to emphasize collaborative writing; to incorporate varieties of media, such as images and video; to make the work publicly available on the Internet; and to allow students to determine the shape of the project, since they would be the primary contributors. Additionally, I wanted to attend to some creative writing craft concerns, most notably to shift emphasis away from trying to imbue a story with some deep philosophical meaning. Too often in creative writing classes I see work where students abandon technique in order to deliver a grand pronouncement about the meaning of life. For this course, I wanted to keep a tight focus by limiting stories to vignette-length of one thousands words or less, and to have writers concentrate deeply on both their characters and the fictional world they inhabit.

To accomplish this, I built the course around role-playing games. I have two older brothers and growing up we played role-playing games obsessively, buying every new genre TSR published. I adored creating new characters and having them explore new worlds. As a speculative fiction writer—I generally write fantasy, science fiction, and horror—I have no doubt that role-playing deeply influenced my imagination and writing habits. Tabletop role-playing games are inherently a collaborative storytelling experience. As these excerpts from the role-playing game *Vampire: The Masquerade* (1998) state, the player-characters and game master (GM) work together to create a compelling fiction:

> You [the GM] plan the twists and turns the story will take, and I [the player] will tell you how the [character] navigates them. Only you know how the story ultimately ends, but only I know how the [character] will arrive there. Along the way, the work you put into the story gives my [character] the chance to grow and develop, and her actions breathe life into the world you have created. (p. 254)

The GM's world building helps the players develop their characters through decision-making, and those decisions add detail and nuance into the fictional world. The uniqueness of each character and the decisions he or she takes is fundamental to a successful and satisfying role-playing campaign.

This description of role-playing is very similar to traditional creative writing advice. As Flannery O'Connor (1969) wrote in her book on fiction writing:

> In most good stories it is the character's personality that creates the action of the story. In most [workshop stories], I feel that the writer has thought up some action and then scrounged up a character to perform it. You will usually be more successful if you start the other way around. If you start with a real personality, a real character, then something is bound to happen; and you don't have to know what before you begin. In fact, it may be better if you don't know what before you begin. You ought to be able to discover something from your stories. If you don't probably nobody else will. (p. 105-6)

O'Connor emphasizes the importance of discovery in good fiction; the author learns about the character just as the character learns about herself, with the implication that this sense of discovery carries through to the reader as well. In John Gardner's (1984) canonical creative writing text *Art of Fiction* he speaks to the connection between characters and their environment. The writer must create convincing human beings, Gardner says, who come to know themselves and reveal themselves to the reader (p. 14-15). This happens in what he calls an "expanding creative moment" (p. 29) reminiscent of the earlier role-playing description, where both the world and character become fuller and deeper through a constant interplay.

Gardner describes shaping a story from three distinct yet related components: character, plot, and setting. Analyzing fiction this way reminds me of what videogame critic Ian Bogost (2006) calls unit operations, which he describes as, "modes of meaning-making that privilege discrete, disconnected actions over deterministic, progressive systems" (p. 3) as opposed to system operations, which are "totalizing structures that seek to explicate a phenomenon, behavior, or state in its entirety" (p. 6). To apply this to fiction writing, one could say that students who search for a fixed immutable "meaning" in a text could be said to be examining systems operations, looking for clues that would reveal the totalizing structure that serves to inform a correct interpretation of the work. To counter this tendency in creative writing, I wanted to start my course not with the analysis of theme or plot in narrative, but rather have students look the discrete narrative units of characters and settings.

In the first part of the course we read nine short stories from a post-apocalyptic fiction anthology, watched the films *The Road* and *Mad Max Beyond Thunderdome* and played the digital role-playing game *Fallout 3*. For the stories and games, we cataloged both the primary and secondary characters, listing their dispositions and physical traits as well as their personal inventories; we repeated the process with the various locations, noting not only their physical descriptions, but also what social and political institutions had not survived the apocalypse and which had been rebuilt.

We analyzed *Fallout 3* in a similar way, but this time we were participants in the narrative. Like most digital role-playing games, *Fallout 3* begins with a robust character creation process where players customize their character's appearance, abilities, and skills, and we discussed how these decisions impacted gameplay. *Fallout 3* presents players with hundreds of choices to be good, evil, or neutral. We also discussed their characters' decision-making process in the context of a harsh and violent wasteland, where theft and even murder may be justified if survival was at stake. Such conversations forced them to expand their conception of world building to include things like the politics and economies of a specific time and place, and how that shapes social interactions—both in fictional worlds as well as in our own.

The videogame also provided valuable insight into the mental state of fictional characters through what Gee (2007) calls an "embodied story" (p. 79), where the player and character become fused into a single psychological space. I asked students to take notes on their emotional and physical responses as they played the game. For example, when exploring a creepy dark tunnel, a players' hands will become clammy and breathing turns shallow; they'll jump or scream in fright at a sudden ambush; they'll feel elated when they find a trusty canine companion. When you as the player are confused and irritated with how to proceed in the game, it means your character is confused and irritated too. These same small details need to be included for compelling fiction writing as well, but beginning writers often forget that their characters are supposed to be living, breathing, sweating, emotional human beings. Rather than asking hypothetical questions about how a character from a print story might feel in a given situation, videogames give writers the chance to experience it for themselves.

Examining narratives as discrete units served us well in the second part of the course, where students built a post-apocalyptic version of Milwaukee by populating a wiki with fictional items, locations, and characters. With a class of 25 students, each student only had to create a few entries in each category in order to build a diverse and deeply immersive world. We spent portions of each class period discussing the fictional world's history, its competing factions, its economy, and other details that became woven into the interlinked wiki entries. The site was explicitly modeled after the *Vault*, a wiki dedicated to the *Fallout* series of games. I placed the content they created on a Google map with placemarks, all linked back to appropriate pages on the wiki.

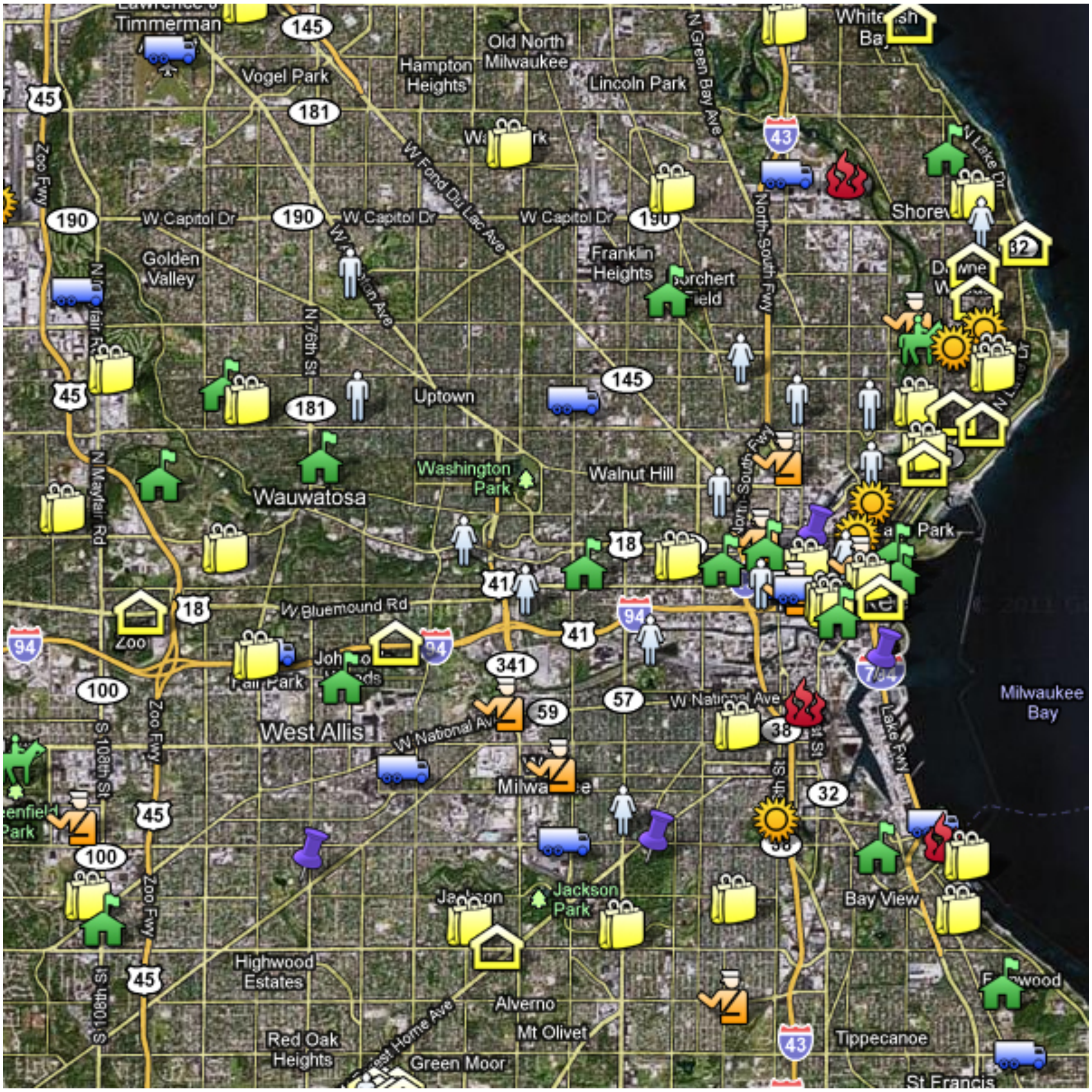


Figure 1:**Google map with placemarks.**

We spent the final five weeks of the course creating player-characters and exploring this world via tabletop role-playing. We devoted an entire week developing the students' characters, using a mix of traditional role-playing character sheets and creative writing exercise. One class period, I distributed ninety unique questions mostly culled from a creative writing book, ranging from "Does your character have any siblings?" to "What does your character want to accomplish in life?" to "What Halloween costume would your character wear to a party?" The students first had to answer the questions for their own character, and then they circulated throughout the room asking their questions of other students' characters.

Students formed into gaming parties and four students with previous game master experience assisted me in running campaigns for their classmates. Each Monday for one month, the groups spent an hour and fifteen minutes together playing through their campaign. Only the

GMs had access to the Google Map, and in typical role-playing fashion, described what the characters saw and who they encountered. With the Google Map linked to the wiki, it was a seamless process for GMs to move between the source material and gameplay. After each session, students wrote vignettes based on their character's experiences and posted them to the wiki. This compressed format required them to focus on a very small moment of time, reflecting on events from the campaign would have mattered most to their character, and we often wound up with a description of a specific event told through the lens of multiple unique perspectives.

The class turned out to be far a greater success than I'd hoped to dream. The first two-thirds of the course focusing on narrative across media and the wiki building were well received, but they did not compare to the popularity of role-playing. Attendance was perfect and participation was never a problem, even for students usually reticent to speak in class. Experienced gamers helped newcomers with how to role-play, and we formed a Facebook group which sprang to life every night after ten PM, with chats and posts centering on the events of the role-playing campaigns. As the instructor, I could see that this energy carried over into the writing. I found myself eagerly waiting to read each week's new set of vignettes to see what the writers had come up with. It seemed as though this had stopped being a class and became a labor of love for all parties.

Because of the experimental nature of the course, I asked students to take part in a series of four voluntary, anonymous surveys to record their observations on this course compared to their previous experience with creative writing. The majority of the class completed the surveys and they were generous in their responses, writing over 20,000 words. The questions themselves were open-ended and allowed students to answer in accordance with their interests. I've summarized their thoughts on various aspects of the course below:

On developing a fictional character: Many students said they were better able to step into their characters' heads thanks to role-playing, which allowed them to form detailed, relevant personal histories that helped explain the character's decision-making processes.

On wiki world building: Students cited a more personal connection with the world and its contents due to the fact that each of them contributed a good portion to it. Others mentioned the amount of generative material the wiki provided for future creative production.

Compared to the traditional workshop method: While students' attitudes towards the traditional workshop method varied, all agreed that approaching creative writing from a role-playing angle constituted a refreshing change, giving them a great deal of enjoyment and allowing for more leeway in their own creative production.

On collaborative storytelling through role-playing: These writers appreciated the ability to focus on fewer elements when writing fiction, and how the author only has control of limited elements of the story, making it easier to judge how the character may react, change, and grow over the course of a narrative.

On the social aspects of the class: Many students mention the deep friendships they formed in this class, and how the social aspects contributed to an open and encouraging learning environment. More remarkably, several students intended not only to continue their friendships, but also to do so by continuing to play games and write fiction even after the semester had ended.

General comments and suggestions: The overwhelming consensus was for more role-playing. It was not only the most fun, but also the most helpful in terms of teaching them about fiction writing. And throughout these anonymous surveys came dozens of heartfelt sentiments about how much the class meant to them personally

As the designer of this course, I will admit that while I hoped this approach to fiction writing would work, never did I think it work quite so well. We ceased to be instructor and students and instead became collaborators as we pieced together our fictional world; we seemed to become conspirators as well because it seemed to all of us that it was somehow wrong to come to a class and have so much fun. Although the institutional constraints of space and time that do not facilitate role-playing, it should be clear that this experiment was an unqualified success and one that I am eager to repeat at the earliest opportunity. Not only do I feel that students learned more about the craft of fiction, but through role-playing games we dramatically reconfigured the educational space, swapping traditional institutional hierarchies for friendships and genuine human connections. Despite the hurdles and uncertainties inherent in this role-playing game pedagogy, the reward is well worth any challenge, and this new kind of learning is a world that instructors and students can explore together.

References

Achilli, J., Bates, A., Brucato, P., Dansky, R.E., Hall, E., Hatch, R., & Lee, M.B. (1998). *Vampire: The masquerade (revised edition).* Stone Mountain, GA: White Wolf Publishing.

Amato, J. & Fleischer, H.K. (2002). *Reforming creative writing pedagogy*. ALTX Online Network. Retrieved from http://www.altx.com/ebr/riposte/rip2/rip2ped/amato.htm

Fallout 3. [Xbox 360]. (2008). Rockville, MD: Bethesda Softworks.

Bogost, I. (2006). *Unit operations: An approach to videogame criticism*. Cambridge, MA: MIT Press.

English 236 Website: *Rivertown Chronicles*. (n.d.). http://rivertown.wikispaces.com

Gardner, J. (1984). *The art of fiction: Notes on craft for young writers*. New York: Knopf.

Gee, J. P. (2007). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

O'Connor, F., Fitzgerald S. & Fitzgerald, R. (1969). *Mystery and manners: Occasional prose*. New York: Farrar, Straus & Giroux.

The vault, the Fallout wikia. (n.d.). http://fallout.wikia.com/wiki/Fallout_Wiki

Racing Games for Exploring Kinematics: A Computational Thinking Approach

Nathan R. Holbert, Uri Wilensky, Northwestern University, Evanston, IL
Email: nholbert@u.northwestern.edu, uri@northwestern.edu

Abstract

This paper describes the design and implementation of a prototype game, *FormulaT Racing*. *FormulaT Racing* is designed to be consistent with youth gaming culture while providing a thinking space for connecting intuitive notions of motion to everyday and formal representations of kinematics. A study with five children (ages 7-13) revealed players engage with novel representations and construction tools in the game to develop complex computational strategies. We contend that the intuitive controls, alternate representations, and construction tools included in *FormulaT Racing* encourage players to consider the track as a collection of functional units—units of action made up of both track features and corresponding velocity changes— leading to an alternate encoding of embedded kinematic content.

Introduction

While a growing body of research shows a positive potential for videogames as vehicles for learning (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Gee, 2003, 2007; Squire, 2005; Stevens, Satwicz, & McCarthy, 2008), there exists a tension between popular games created solely for entertainment purposes and educational games designed to teach content first and highlight entertainment second. In an effort to overcome this artificial dichotomy, our research agenda is to explore, create, and assess design principles that can be employed in popular commercial videogames to enable players to connect intuitive experiences of embedded science content, to real-world and formally taught representations. This paper describes a study of five children (ages 7-13) interacting with a prototype game, *FormulaT Racing* (Holbert & Wilensky, 2010), designed to encourage players to develop computational strategies to successfully navigate the physics embedded in this typical racing game.

There is a considerable amount of research literature examining children's understanding of motion. The overwhelming majority of this work has focused on "misconceptions," or children's tendencies to apply non-normative intuitive explanations to describe physical phenomenon (Carey, 1988; Duit, 2009; McCloskey, 1984). While science standards refer to Newtonian mechanics as "essential to understanding the natural world" (AAAS, 2002), research has shown an alarming number of high-school and college graduates fail to grasp these basic principles (McDermott, 1983). Researchers interested in physics education have begun to challenge the very notion of misconceptions and, in line with constructivist theories of cognition, suggest that learners' intuitive notions cannot simply be removed and replaced. Instead, learning occurs most effectively when intuition is leveraged and refined (diSessa, 1993; diSessa & Sherin, 1998; Hammer, 1996). The importance of prior experience and salience of situational cues in this theory suggests that designs meant to help children make sense of Newtonian mechanics must consider common motion experiences. Drawing on this literature, we argue that racing videogames, a genre popular among youth (Lenhart et al., 2008), likely contribute to children's intuitive notions of motion and, as such, is both a potentially powerful means of intervention and an important context for conducting research on students' developing conceptions of kinematics.

Simply playing racing games, however, isn't enough. To transform racing videogames into powerful kinematic thinking spaces we draw on the computational thinking literature. In the past few years there has emerged a consensus that it is important for 21st century students to be computational thinkers (diSessa, 2000; Guzdial, 2008; Resnick, 2001; Wilensky & Papert, 2010; Wing, 2006). The NRC has published a report clarifying the nature of computational thinking and its role in student learning (2010). While an official definition is still debated, we define computational thinking as the ability to translate or encode phenomena (real or imagined) into representations that leverage computational power. Often CT takes the form of utilizing abstractions to create algorithmic solutions to problems that can then be automated with computation.

Two core computational thinking practices on which we focus in this study are debugging and procedural thinking (Clements & Sarama, 1995; Noss, Healy, & Hoyles, 1997; Papert, 1980). Thinking procedurally involves chunking problems into smaller bits and recognizing patterns that can be effectively repeated (Papert, 1980). The NRC workshop on computational thinking (2010) suggests procedural thinking is about creating "a detailed step-by-step set of instructions that can be mechanically interpreted and carried out by a specified agent, such as a computer or automated equipment" (p. 11). Debugging involves systematic attempts to adjust a procedure or function in an effort to identify and correct the "bugs" or errors keeping a system from running properly. While games and software for building games have been proposed for teaching computational thinking (Kafai, 1995, 1996; Repenning, Webb, & Ioannidou, 2010), few have argued that simply playing videogames can be an effective way to practice computational strategies. We believe the practice of computational thinking should be central in the design of videogames.

In this paper we discuss the design and implementation of a prototype videogame, *FormulaT Racing*, for connecting intuitive notions of kinematics to real world and formal representations of physics through the practice and refinement of computational strategies. Our intent is not to create a finished game for distribution, but instead to explore design principles that can be utilized by the gaming industry and included in commercially produced racing videogames.

Theoretical Framework

FormulaT Racing (*FTR*) was designed specifically to tap into children's intuitive notions of kinematics and to connect these intuitions to formal representations while staying true to youth gaming culture. To be considered successful, our design should look and feel like a traditional racing videogame—one that participants could imagine sitting down to play after school, rather than in a classroom. However, we also intend *FTR* to be a game that participants will draw on in formal learning contexts as well as in common everyday experiences. Players may not become experts in kinematics by playing *FTR*, but they should be left with a sense that their experiences in the game are relevant to non-game motion experiences and players should be able to utilize qualitative foundational knowledge provided by the game to reason through more complex kinematic problems. To do this, *FTR* foregrounds specific features of kinematics using tailored representations and controls embedded within typical racing game design, while also providing powerful construction tools that allow players to manipulate and debug these ideas in novel scenarios.

In a pilot study we found that traditional racing game design led to a one-to-one mapping of game action—instantiated by controller buttons—to discrete kinematic concepts (Holbert, 2010). In other words, specific controller buttons became synonymous with game actions (such as a “gas button”), which in turn stood in for isolated physics constructs (such as “velocity”). In *FTR*, we employ alternate designs that encourage the player to utilize computational strategies, ultimately leading to a more useful and flexible encoding of kinematic concepts. We refer to this new encoding as a computational encoding—by which we mean knowledge elements are relationally connected and function to describe and measure dynamic processes. We argue that a game that encourages this computational encoding should include the following set of design principles:

1. An interface connected to the player’s intuitive and embodied understanding of physical phenomenon (Barsalou, 2008; diSessa, 1993; Papert, 1980).
2. Representations that foreground the relationships between embedded content (diSessa, 2000; Wilensky, 2006; Wilensky & Papert, 2010).
3. Opportunities to interact and create with these new representations (Papert, 1980; Papert & Harel, 1991).

The following sections describe in more detail the theoretical underpinning of each design principle as well as how the principle is instantiated in the design of *FTR*.

Intuitive and embodied controls

Research in the Learning and Cognitive Sciences suggests much of our intuitive notions of motion are created through physical experiences out in the world (diSessa, 1993; Nemirovsky, Tierney, & Wright, 1998; Piaget, 1952; Roschelle, Kaput, & Stroup, 2000; Wilson, 2002). Work by diSessa and colleagues with physics students indicates that the richness of experiences in the physical world lead to dynamic, yet extremely salient, intuitive explanations for most common phenomenon (diSessa, 1993; diSessa & Sherin, 1998; Hammer, 1996, Sherin, 2006). A number of educational designs have also been introduced over the years showing that young children can be extremely effective at interpreting and constructing complex mathematical representations using motion-sensitive controls (Nemirovsky et al., 1998; Roschelle et al., 2000). Drawing heavily from theories of embodied, or grounded cognition (Barsalou, 2008; Wilson, 2002), these designs provide tools that allow learners to use physical movement in the world—movement that can be felt and experienced directly—to make sense of abstract mathematical principles.

FTR makes use of the Nintendo *Wiimote*, a commercial videogame controller that includes multiple accelerometers for controlling the player car. The controls allow for continuous (rather than discrete) adjustments of acceleration as well as heading, and serve as a metaphorical carrier for the player’s idea of acceleration, connecting it firmly to bodily experiences (Papert, 1980, p. 63). In other words, the player’s natural bodily reaction to lean forward when wanting to “speed up” or backward to “slow down” changes the acceleration of the in-game car. In this way the control of in-game agents are naturally connected to conceptual “simulations” of motion (Barsalou, 2008).

Designing Restructurations

While representations in the world are often created with the intent to store, or embody some specific way of thinking, external representations also "become in a very real sense part of our thinking, remembering, and communicating" (diSessa, 2000, p. 6). Taking this theory of external representations seriously implies that alternate external representations may fundamentally change one's thinking process. To this end, *FTR* was designed to enact what Wilensky and Papert (2006, 2010) call *restructurations*—changes in knowledge encoding as a result of a change in the representational infrastructure of a domain (2010, p. 2). In the case of *FTR*, by changing traditional representations of kinematics and the means of interacting with the player vehicle the game provides an opportunity for kinematic restructuration.

We have made two key design choices to facilitate this restructuration: including additional spatial representations of motion, and replacing discrete measures of velocity with formal representations that highlight change. *FTR* builds on the traditional "passing background" visual cue to indicate vehicle speed but adds a new "color-trails" cue. In this cue, velocity is represented by a color-trail left by the player vehicle that changes as the player car's velocity changes. These visual color-trails provide a means to connect ones changing speed to the structure of the track. In other words, players can more easily see how they slowed down around sharp turns or sped up on straightaways. In addition, *FTR* substitutes a velocity versus time graph for a speedometer to provide an early connection to formal kinematic representations and to highlight the importance of change, rather than static speeds. This velocity versus time graph is then color-coded to connect it firmly to the left behind color-trails.

Construction Tools

Finally, *FTR* also includes construction tools that fundamentally change the way the player *causes* motion, further supporting kinematic restructuration. These construction tools are intimately connected to previously discussed controls and visual cues but are not explicitly introduced until the third phase of the game. This level was designed as a constructionist environment (Papert, 1980; Papert & Harel, 1991) allowing players to construct personal notions of motion by interacting with the representations of motion rather than the car itself. The player does this in one of two ways, either by painting the track different colors (that correspond to the color-trails they have become familiar with) or by constructing a velocity versus position graph.

In the "drive-by-paint" mode of the pit boss level the player utilizes the color palette of the color-trails to paint the track. The player can paint the track in any way they prefer, however, because each color corresponds to a particular velocity and the car's ability to effectively turn is impacted by its current velocity, the choices made in painting the track determine whether or not the car will successfully complete the race. In the "drive-by-graph" mode, players construct a velocity versus position graph by accelerating points up and down the y-axis using the Nintendo *Wiimote*. Once the graph is constructed, the car "downloads" the data and drives around the track according to the velocities defined in the player-generated graph. In this way, players directly connect the intuitive feeling of acceleration to formal graphic representations and can also explore how varying graphic features, such as sharp drops or plateaus in velocity, correspond to particular track features.

We contend that the intuitive controls, alternate representations, and construction tools included in *FormulaT Racing* encourage players to consider the track as a collection of functional units—units of action made up of both track features and corresponding velocity changes. As players interact with and build vehicle motion using previously seen visual representations, and plan successful races by enacting computational strategies such as procedural thinking and debugging, kinematic concepts such as velocity and acceleration become functional—ideas that are no longer about category membership, but concepts that "do something." In the following sections we will describe a study exploring children's interactions with *FTR*. We argue that, rather than directly map game action to controller buttons, players of *FTR* utilized game controls, novel representations, and construction tools in functional units leading to a computational encoding of kinematic concepts.

Method

In this study, five children (ages 7-13), recruited from various informal organizations in a large Midwestern city, volunteered to test and provide feedback on a prototype videogame, *FTR*. In a 15-minute pre-game interview session, researchers conducted a semi-clinical interview to gauge participants' understanding of kinematics and their interest in videogames. Two 45-minute game playing sessions were conducted a week later. In these sessions participants played *FTR*. Finally, a 15-minute post-game interview was conducted using the same prompts as the pre-game interview. Interviews and game play sessions occurred in the participants' homes or at an after-school program they were attending. All interactions with participants were videotaped and in-room recordings were synced with screen recordings of game play for analysis (Stevens, Satwicz, & McCarthy, 2008).

While we have done a larger analysis of *FTR*, this paper will focus on player interactions with the pit boss level. Here, video data was split into interaction units according to instances of strategy switching. In most cases, the obvious point of strategy switching occurs after a failed run, occasionally however, verbal or physical cues from the player indicate a strategy shift between track resets. Interaction units were coded using a scheme emergent from the data informed by the computational thinking literature (Table 1). An independent researcher verified game-play codes. Conflicts were discussed and resolved resulting in agreement on 97% of video time.

Code	Description	Example phrases	Examples in-game
Strategic	The player is painting the track in a strategic way. There is some indication that the player has an idea in their head they are trying to enact on the screen. There is a definite "plan" being enacted.		
Ordered	The player implements their plan in an ordered fashion from beginning to end.	"First I need to… and then…"	The player constructs his idea starting at the beginning of the track moving towards the end and may follow along with the track image using their finger
Motif	The player has created a strategic pattern that they are repeating—not unlike a procedure that's being used at specific times.	"Every corner is a fast color and every line is a fast one"	Colors are clearly related to track features and repeated when the feature repeats. Peaks and valleys in the graph are clearly related to track features.
Debugging	Attempts are made to identify and fix a problem. Players may try to add or change colors (or graph points) in systematic, but small, ways.	"Maybe if I add some purple here…"	Player quickly adds or removes color in only one or two locations before running again. Points on the graph are just "changed" rather than rebuilt from scratch.

Table 1: **The following excerpt from a larger coding scheme was used to analyze video data of players interacting with the construction tools. These three codes were identified as "complex computational thinking" by the researchers. The full coding scheme is available upon request.**

Results

Because *FormulaT Racing* is designed to provide a thinking space for players to explore and construct with kinematic concepts and representations, and not a game to *teach* physics, our analysis explores whether or not players engage with representations in complex and computational ways. Results suggest players develop systematic computational strategies to be successful in construction levels by leveraging game experiences and representations from previous levels.

Construction Tool Use

Players typically begin by testing uniform motion on the entire track, such as "painting" the track a color that causes the car to drive extremely fast. Gradually, players utilize intuitive knowledge of motion and in-game experiences to systematically debug constructions. Ultimately players begin to notice and reuse patterns of motion and track features to paint and graph successful solutions. Figure 1 shows the percentage of total time players enact a particular computational strategy while playing the pit boss level. While players spend some time simply exploring the model—painting the track all one color, "just to see what will happen," or to see how fast the car could go—players engage in sophisticated computational strategies (coded as strategic-ordered, strategic-motif, and debugging) 76% of the time.

A detailed analysis of each player's progression with construction tools shows evidence of not only computational thinking in action, but also paints a picture of computational strategy evolution. One of the youngest participants, Collin, struggled early to understand the mechanics of the construction levels. When painting the track, Collin was very strategic about his designs. When his construction would fail, Collin would work to understand what went wrong and systematically debug his design. He might add a fast color in a straightaway if he struggled to make it around the track in time or he may add a small strip of violet (a slow color) on a corner if he was crashing. However, if these small tweaks failed, Collin would often erase the entire track and claim, "I have another plan!" These early debugging attempts, such as putting only a small

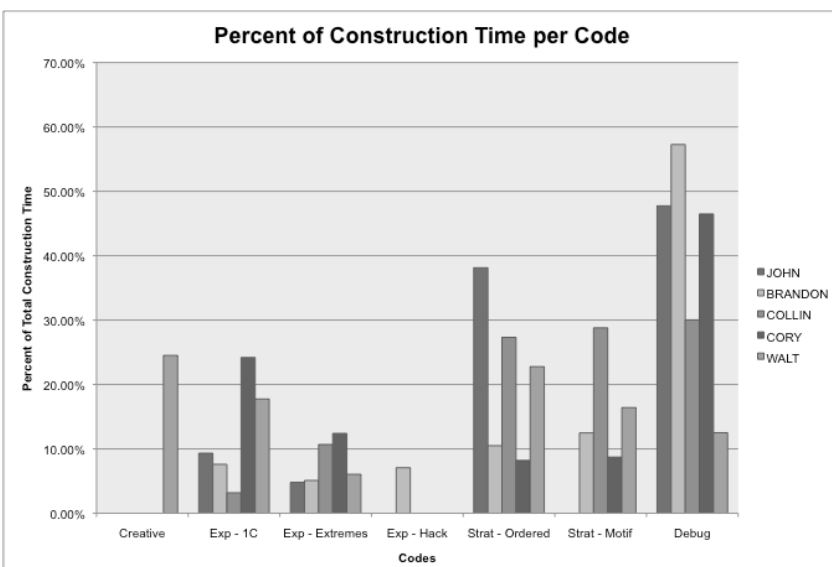


Figure 1. **This graph shows the breakdown of time each individual spent engaged in the coded activities. 76% of time spent using the construction tools was spent engaging in complex computational thinking.**

strip of violet in the exact location of a crash, indicate Collin had a disconnected understanding of acceleration and velocity—Collin knew violet indicated a slow color, but he didn't take into consideration the acceleration that would be required to reach this speed. As Collin continued to interact with the construction tools, *strategic motifs* began to emerge. Before painting on a new track Collin thinks out-loud and states:

> **Collin**: Oh but that won't work because then I'll have to do it over and over again and it will crash… (pause) my idea is just going to make it crash again. (pause) Well, I'll test it.
> **Interviewer**: What's the plan?
> **Collin**: *Every corner is a slow color and every line like this is a fast one.*

At this point, shortly before constructing a successful run, Collin has begun to break his strategy down into small "procedures" (italics) that include multiple colors related to specific track features that he then used repeatedly at key track points (Figure 2). This procedural painting suggests Collin has begun to see acceleration as highly related to velocity and that together these kinematic concepts result in very specific types of motion relevant to different aspects of the race.

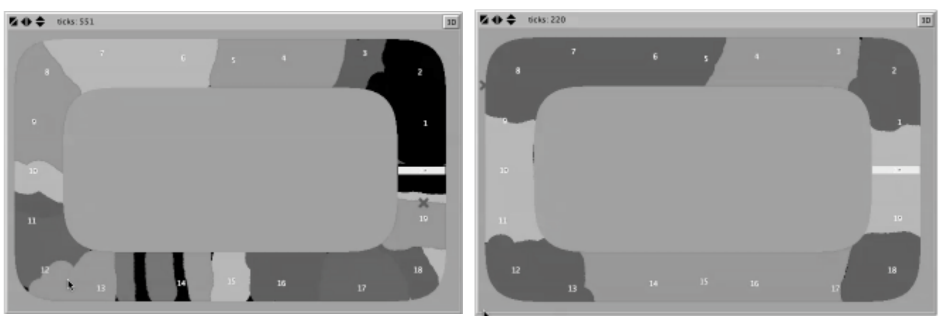


***Figure 2.* Collin's early and final attempts at painting the square track. His first attempt (left) was coded as "strategic - ordered." The final and successful version (right) indicates clear signs of "strategic - motifs" where slow colors are used in the corners and fast colors on the straightaways.**

Collin's first attempt in the drive-by-graph mode made use of strategic motifs immediately. Rather than plot all 20 points on the x-axis, Collin only plotted eight points directly corresponding to the number of straightaways and corners. When presented with an error due to not "filling" the graph, pointing to different segments of the track Collin states, "Oh I see, I was going just like, uh...fast, slow, fast, slow." What at first looked like repeated spikes, or moments of high positive acceleration followed by negative acceleration, was Collin's reinterpretation of the track as a collection of repeated kinematic motifs rather than a continuous series of motion moments. After editing his graph to include all 20 points, Collin struggles with the scale making the car go as fast as possible as soon as possible resulting in a spectacular crash early in the race. Seeing his failure he asks, "How do I know how fast it is? Oh yeah! By using the other side [indicating y-axis labels]!" Collin, a participant that had asked to skip the graphing task conducted in the pre-game interview, not only identifies graphing errors from vehicle motion, but also constructs a new successful graph on the very next attempt.

Brian engaged in a variety of different computational strategies, but spent a large amount of his time in *FTR* debugging. Brian often began by painting the track one color, and then added and removed colors systematically. After being successful on a track the interviewer questions why he altered the paint at various points. Brian's answers indicate a rich connection between the vehicle's acceleration and the track features:

> **Brian**: Every spot that I picked blue, was all the spots where he crashed previously.
> **Interviewer**: Any idea why it crashed?
> **Brian**: *Maybe it moved too fast and didn't have enough time to turn*. So I slowed it down with some blue paint. And whenever it still crashes *I'll just make the blue paint larger. At least large enough for it to have enough time to steer.*

For Brian, the debugging process allows him to focus on the dynamic and time-dependent nature of velocity as it relates to sharp turns and straightaways on the track.

The stories of the two *FormulaT* programmers show instances of computational strategies being employed and refined as they continue to interact with the game. As players progress in the pit boss level, insights gained early on in the painting version carried over into the graphing. As computational strategies become more sophisticated, player transcripts show evidence of a kinematic restructuration—players begin to talk about acceleration and velocity as interconnected units dependent on track features. In this new structuration, motion motifs continually interact with the previous and next motif resulting in a highly dynamic series of kinematic patterns.

Conclusions

Arguing for personal exploration in mathematics, Confrey (1991) claims, "if mathematics is viewed as functional, the emphasis is not with mirroring some unknowable reality, but in solving problems in ways that are increasingly useful in one's experience" (p. 136). Tools such as algebra and kinematics are simply designed artifacts that help us make sense of phenomena in the world. While it is likely that some representations are "better" at dealing with a wide variety of situations, such as formal physics conventions, these situations must be anchored in concrete experiences and embedded with personal meaning. Our work with *FormulaT Racing* suggests that popular videogames may be able to support this meaning making for scientific domains by leveraging computational thinking. The evidence presented here suggests that players utilized complex computational strategies when interacting with construction tools and representations that they had imbued with kinematic meaning leading to an alternate, computational encoding of the embedded kinematic concepts.

References

AAAS. (2002). *Middle grades science textbooks: A benchmarks-based evaluation* from http://www.project2061.org/publications/textbook/mgsci/report/Sci_Ins/SIS_ps2.htm

Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development*, *53*(1), 86-107.

Barsalou, L. (2008). Grounded cognition. *Annual Review of Psychology*, *59*, 617-645.

Carey, S. (1988). Reorganization of knowledge in the course of acquisition. In S. Strauss (Ed.), *Ontogeny, phylogeny, and historical development* (pp. 1-27). Norwood, NJ: Ablex.

Clements, D. H., & Sarama, J. (1995). Design of a LOGO environment for elementary geometry. *The Journal of Mathematical Behavior*, *14*(4), 381-398.

Committee for the Workshops on Computational Thinking. (2010). *Report of a workshop on the scope and nature of computational thinking.* Washington, D.C.

Confrey, J. (1991). Learning to listen: A student's understanding of powers of ten. In E. v. Glasersfeld (Ed.), *Radical Constructivism in Mathematics Education* (pp. 111-138). Netherlands: Kluwer Academic Publishers.

diSessa, A. A. (1993). Toward an epistemology of physics. *Cognition and instruction*, *10*(2 & 3), 105-225.

diSessa, A. A. (2000). *Changing minds: Computers, learning, and literacy*. Cambridge, MA: MIT Press.

diSessa, A. A., & Sherin, B. (1998). What changes in conceptual change. *International Journal of Science Education*, *20*(10), 1155-1191.

Duit, R. (2009). *Students' and teachers' conceptions in science: A bibliography* from http://www.ipn.uni-kiel.de/aktuell/stcse/stcse.html

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

Gee, J. P. (2007). *Good video games and good learning*. New York: Peter Lang.

Guzdial, M. (2008). Paving the way for computational thinking. *Communications of the ACM*, *51*(8), 27.

Hammer, D. (1996). Misconceptions or p-prims: How may alternative perspectives of cognitive structure influence instructional perceptions and intentions? *Journal of the Learning Sciences*, *5*(2), 97-127.

Holbert, N. (2010). Feeling fast: The role of intuitive thinking in video games. Poster presented at the annual meeting of the American Educational Research Association, Denver, CO, April 30-May 4.

Holbert, N., & Wilensky, U. (2010). *FormulaT Racing*. Evanston, IL: Center for Connected Learning and Computer-based Modeling.

Kafai, Y. B. (1995). *Minds in play: Computer game design as a context for children's learning*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kafai, Y. B. (1996). Learning design by making games: Children's development of design strategies in the creation of a complex computational artifact. In Y. B. Kafai & M. Resnick (Eds.), *Constructionism in practice: Designing, thinking, and learning in a digital world*. Mahwah, NJ: Lawrence Erlbaum.

Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. R., Evans, C., & Vitak, J. (2008). *Teens, video games, and civics.* PEW Internet & American Life Project.

McCloskey, M. (1984). Naive theories of motion. In D. Gentner & A. Stevens (Eds.), *Mental models*. Hillsdale, NJ: Lawrence Erlbaum.

McDermott, L. C. (1983). Critical review of research in the domain of mechanics*. First international workshop research on physics education* (pp. 139-182). Paris

Nemirovsky, R., Tierney, C., & Wright, T. (1998). Body motion and graphing. *Cognition and Instruction*, *16*(2), 199-172.

Noss, R., Healy, L., & Hoyles, C. (1997). The construction of mathematical meanings: Connecting the visual with the symbolic. *Educational Studies in Mathematics*, *33*(2), 203-233.

Papert, S. (1980). *Mindstorms*. New York: Basic Books.

Papert, S., & Harel, I. (1991). Situating constructionism. In S. Papert & I. Harel (Eds.), *Constructionism*. New York: Ablex Publishing.

Piaget, J. (1952). *The orgins of intelligence in children*. Madison, CT: International Universities Press, Inc.

Repenning, A., Webb, D., & Ioannidou, A. (2010). Scalable game design and the development of a checklist for getting computational thinking into public schools*. 41st ACM technical symposium on computer science education.* (pp. 265-269). Milwaukee, Wisconsin

Resnick, M. (2001). Revolutionizing learning in the digital age. In M. Devlin, R. Larson & J. Meyerson (Eds.), *The internet and the university: Forum 2001* (pp. 45-64). Boulder, CO: EDUCAUSE.

Roschelle, J., Kaput, J. J., & Stroup, W. (2000). SimCalc: Accelerating students' engagement with the mathematics of change. In M. J. Jacobson & R. B. Kozma (Eds.), *Innovations in science and mathematics education: Advanced designs for technologies of learning* (pp. 47-76). Hillsdale, NJ: Earlbaum.

Sherin, B. (2006). Common sense clarified: The role of intuitive knowledge in physics problem solving. *Journal of Research in Science Teaching*, *43*(6), 535-555.

Squire, K. (2005). Changing the game: What happens when video games enter the classroom? *Innovate: Journal of Online Education*, *1*(6), 25-49.

Stevens, R., Satwicz, T., & McCarthy, L. (2008). In-game, in-room, in-world: Reconnecting video game play to the rest of kids' lives. In K. Salen (Ed.), *The ecology of games: Connecting youth, games, and learning* (pp. 41-66). Cambridge, MA: MIT Press.

Wilensky, U. (2006). Complex systems and restructuration of scientific disciplines: Implications for learning, analysis of social systems, and educational policy. Paper presented at the *annual meeting of the American Educational Research Association*. San Francisco, CA.

Wilensky, U., & Papert, S. (2010). Restructurations: Reformulating knowledge disciplines through new representational forms. In J. E. Clayson & I. Kalas (Ed.), *Constructionism 2010*. Paris, France

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, *9*(4), 625.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33-35.

Tug-of-War: a Card Game for Pulling Students to Fractions Fluency

Osvaldo Jiménez, Dylan Arena, Ugochi Acholonu
Stanford University
485 Lasuen Mall, Stanford, CA 94305
Email: ojimenez@stanford.edu, darena@stanford.edu, acholonu@stanford.edu

Abstract

We propose that adoption of game-based-learning principles can be increased by providing standardized-test evidence of learning from gameplay. This paper describes a game called *Tug-of-War* as a candidate for such evidence. *Tug-of-War* is designed to help fourth-grade students build fluency with fractions. Development of the game followed an iterative design process of user testing and rules refinement, culminating in an experimental trial in which a single fourth-grade class was divided into two cohorts. Each cohort played *Tug-of-War* for six or seven weekly 75-minute sessions while the other cohort participated in unrelated research. Results indicate that both cohorts achieved significant learning gains by playing Tug-of-War in addition to the traditional curriculum. Playing *Tug-of-War* was also shown to significantly improve scores on the fractions subsection of a statewide standardized test.

Introduction

Games are compelling both as models for learning and as pedagogical tools. Much good research has been done to explore the educational benefits of gameplay (e.g., Nelson et al., 2005, Barab et al., 2007, Squire & Klopfer, 2007), but there are still relatively few studies showing benefits on traditional measures that skeptics would value—most notably standardized test scores, which are the currency of the realm in today's policy debates (Honey & Hilton, 2011). One strategy for increasing the adoption of game-based learning principles is to provide evidence of learning from gameplay on such traditional measures. Providing this evidence with some methodological rigor could be useful for helping the research gain traction, especially in the policy sphere (Barlett & Anderson, 2009). Of course, not all game-based-learning research need be concerned with addressing skeptics: a few demonstrations of gameplay leading to learning that can be measured by standardized tests would go a long way toward supporting the broader arguments our field makes about the value of the learning that can occur during gameplay. We hope that the research we are presenting here on a game we have designed, called *Tug-of-War*, can serve in that role.

***Figure 1*. Teammate card and Trick card.**

Designing *Tug-Of-War*

The Concept

After mastering natural numbers, students are faced with the daunting task of learning about rational numbers. When confronted with fractions, children often rely on their whole-number interpretations (Mack, 1995). For example, when asked to circle 1/4 of 12 stars printed on a page, children frequently rely on their counting skills to identify and circle both a single star and a group of four stars; such children have not yet grasped the part-whole interpretation of fractions (Kerslake, 1986). Also difficult for children is realizing that different symbolic representations can refer to the same quantity (such as 1/2 and .5). We hoped to design a game that would help children understand fractional operations on whole numbers and reconcile different representations of the same quantity.

The Design

We chose to model our game after popular children's card games such as *Pokémon* and *Yu-Gi-Oh!*, which have been noted by researchers as being both popular (Ito, 2006) and highly sophisticated (Gee, 2010, Buckingham & Sefton-Green, 2003). Gameplay in this genre involves mustering "troops" and choosing cards from one's hand to attack an opponent's troops or defend one's own. In our game, *Tug-of-War*, the "troops" are groups of teammates on either side, and the "attacks" and "defenses" are pranks (e.g., stink bombs) or fibs (e.g., "I hear the ice cream truck!") and their countermeasures (e.g., air fresheners and radios).

Once our game genre was settled, we embedded our learning objectives within the game's narrative and mechanical structure. This technique was described by Malone (1981) as intrinsic fantasy and has been more fully explored by Habgood and colleagues (Habgood, Ainsworth, & Benford, 2005), who term it intrinsic integration and express it in terms of flow, core mechanics, and representations. The basic notion is that the game elements that are essential to learning should be incorporated into the narrative flow of gameplay, linked to the core mechanical operations players undertake in the game, and enacted using pedagogically sound representations to anchor thinking about the learning objectives.

Consistent with this notion, the cards for attack and defense in *Tug-of-War* (stink bombs, air fresheners, etc.) fit into the narrative of a playground tug-of-war. Mechanically, each card contains a rational number (represented as a fraction, decimal, partially filled meter, or ratio) that is applied to one of the whole-number teammate groups, weaving both of our main learning objectives into the basic game mechanic. To explain how the game represents fractional operations on whole numbers, we will use a concrete example. The left image in Figure 1 shows a group of 8 teammates (the Johnson Family), and the right image shows an attack card (a Stink Bomb) with the value 3/4. To play the Stink Bomb on the Johnson Family, players would first decide how to split the Johnson Family into four equal subgroups (the denominator of the Stink Bomb fraction); once those subgroups were formed, players would choose three of those subgroups (the numerator of the Stink Bomb fraction) to be scared away from the tug-of-war by the Stink Bomb. This process of forming and choosing subsets of whole-number quantities is our main representation for fractional operations on whole numbers in *Tug-of-War*. As players repeat this process throughout gameplay, they develop a situated understanding (Gee, 2003) of what it means to take some fraction of a whole-number quantity.

Integrating Learning Principles

Our basic design in place, we piloted with children from local after-school clubs and sports teams to resolve any problems with understanding of the rules, boredom, or unsatisfying gameplay. Once we had a fun, easy-to-understand game, we began working on ways to improve its value for learning about fractions in school. We incorporated learning supports based on observations of gameplay and post-test measures in an iterative design process. We also continually checked to ensure the game remained fun. Below are two brief examples of how learning principles were incorporated.

First, we quickly realized that children had trouble executing the fractional operations that occur in gameplay. To help students visualize and think through the operations, we added manipulatives, which have been shown to support students' transition from natural to rational number interpretations (Martin and Schwartz, 2005). The addition of stylized miniature people both supported our narrative and offered a concrete representation for our central mechanic (see Figure 2). One drawback of the manipulatives was that their appeal risked distracting from our learning objectives; our introduction to *Tug-of-War* now includes a period for children to simply play with them, making towers or using them as dolls, so that they are not distracted during gameplay.

***Figure 2*. Manipulatives**

Piloting also revealed that the expertise children developed in *Tug-of-War* was not transferring to more formal contexts. We needed a bridge that linked the manipulative-based method we taught children for resolving fractional operations to the resources they would have available in school. Our solution was the *paper method*: players draw spaces for each subgroup to be formed, draw dots in each space sequentially until they reach the number of teammates, and then circle the number of subgroups they want. For example, to find 3/4 of 8, players would draw four spaces for subgroups, draw a first dot in each subgroup while counting to 4 and then a second while counting on to 8, and then circle three of the four subgroups. The six circled dots would be the answer players sought. (See Figure 3.) This *paper method* serves as a scaffolding bridge between our initial manipulative-based method and a level of fluency at which students can perform the operations entirely in their heads.

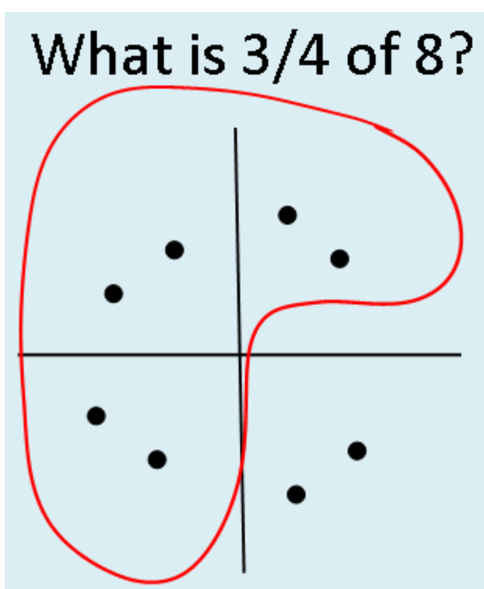


***Figure 3*. Illustration of the Paper Method**

Several other learning principles were incorporated during our cycles of development. Card designs were modified to ensure that children actually interpreted multiple rational-number representations rather than relying on just one. Gameplay became team-based, to foster improved discourse (Barron, 2003) about card choice and strategy. We also refined how children collaborated to encourage them to actively monitor one another's play, mindful that in early learning it is easier to monitor another person's performance than one's own (e.g., Gelman & Meck, 1983; Siegler, 1995; Okita, 2008).

Current Design

The game's narrative is a friendly series of tug-of-war battles between two teams of children on a school playground at recess (each "team" in the story is played by a pair of students). *Tug-of-War* includes two decks of cards: a deck of Teammates, representing groups of children who have been recruited to help one's own team in the tug-of-war, and a deck of Tricks, representing ways to either reduce the number of teammates in one of the other team's teammate groups or defend against such attacks. The game also includes a set of miniature figures as manipulatives, to represent teammates (See Figures 1 and 2 above).

During each round of play, each team tries to have the most teammates by protecting their own teammates while reducing the number of teammates on the opposing team. Points are scored based on the disparity in teammates at the end of each round. The basic game mechanic is to choose and play Trick cards (fractional effects) on opponents' or one's own Teammate cards (whole numbers of children) and to perform the corresponding fractional operations (at first by using the manipulatives, then by using the *paper method* described above, and eventually without any scaffolds); much of *Tug-of-War*'s strategy focuses on choosing when and how to play Tricks to optimally shift the number of teammates in one's favor.

Teams begin each round with two Teammate cards and four Trick cards. Each team starts by playing both of their Teammate cards, gathering the appropriate number of manipulatives to represent each card (see Figure 2). Teams then take turns playing Trick cards on their opponents' groups (or their own, to defend against attacks). After both teams finish playing Trick cards, players must count how many teammates each team has remaining and find the difference, which is the number of points earned by the team with more teammates that round. The winner is the first team to accumulate 20 points.

Experiment

Subjects

Thirty-one students (15 boys and 16 girls) from one fourth-grade class participated in the study. On the students' third-grade Standardized Testing And Reporting (STAR) report, 91% were categorized as economically disadvantaged, and 75% were categorized as English learners.

Experimental Design

We administered a pre-test of fractions concepts to the class (with no feedback about right or wrong answers), which was then divided in half to balance gender and math achievement. One half (Cohort 1) played *Tug-of-War* for one 75-minute session per week for seven weeks, in place of the students' regular math work, while the other half (Cohort 2) participated in unrelated research. We then re-administered the same math test to the entire class (again without feedback) and switched conditions; Cohort 2 played *Tug-of-War* for six weekly

75-minute sessions while Cohort 1 participated in unrelated research. Finally, we administered our math test a third time.

Procedure

In our first weekly session for each cohort, students learned how to play the game by watching a short instructional video and were then assigned to mixed-ability groups of three or four students each. (We used videos to ensure that both cohorts received identical instruction.) One of four researchers worked with each group, forming teams, assigning tasks (dealing cards, organizing manipulatives, and keeping score) to individual students, clarifying rules, and adjudicating conflicts. Subsequent sessions proceeded similarly: videos were played to reinforce various aspects of gameplay, and groups were periodically rearranged to provide novel opportunities for collaboration. Researchers continued to moderate for each group but gradually withdrew to more peripheral roles as students became familiar with the game. The paper method was introduced by video in the fourth session. By the sixth session students were encouraged to rely entirely on the paper method or mental calculations and use the manipulatives only if they became stuck; students were also encouraged to run the entire game session on their own, with researchers observing but not interacting unless absolutely necessary.

Measures

Our own assessment was given as a pre-, mid-, and post-test. Our assessment contained 22 dichotomously scored items testing our learning objectives: performing fractional operations on whole numbers (e.g., “Circle 1/4 of these 12 stars” or “What is .8 of 10?”) and reconciling different representations of the same quantity (e.g., “Which one has the same value as 2/3?”).

The classroom also underwent its annual state-mandated California Standards Test (CST) administration after only one session of Cohort 2’s gameplay, thus providing a rough natural measure of external validity for our game. The specific measure we looked at was the CST subtest dealing with decimals, fractions, and negative numbers.

Results

As shown in Figure 4, the two *Tug-of-War* cohorts did not differ at pre-test, $t(27.55) = -.17$, *n.s.* Students in Cohort 1 showed significant gains from pre- to mid-test, $t(15) = 9.05$, $p < .0001$, whereas students in Cohort 2 did not, $t(14) = .83$, *n.s*. Once Cohort 2 got to play *Tug-of-War*, they showed significant gains from mid- to post-test, $t(14) = 6.71$, $p < .0001$, while Cohort 1's scores did not change significantly from mid- to post-test, $t(15) = -1.35$, *n.s*., even though they had not played the game for almost 3 months. Thirty out of thirty-one students showed learning gains from playing *Tug-of-War*.

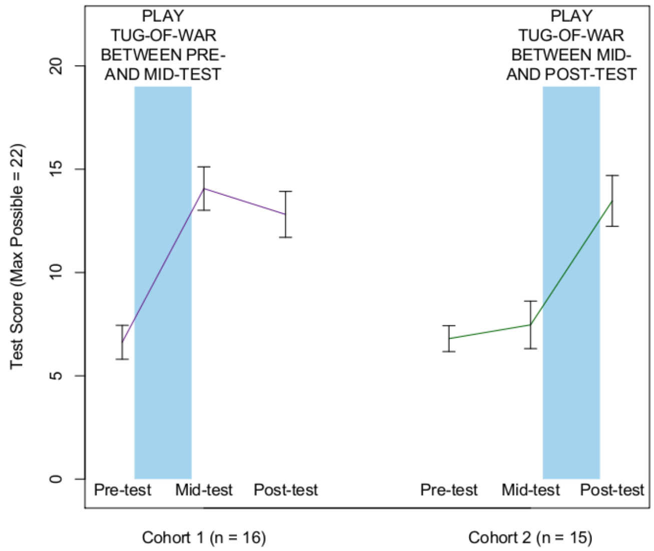


Figure 4. **Pre-, Mid-, and Post-test Means and Standard Errors**

As shown in Figure 5, Cohort 2's performance on this subtest did not differ from that of the classroom teacher's students from the year before, $t(24.81) = 0.32$, *n.s.,* while Cohort 1 outperformed both the previous year's students, $t(40.14) = 3.17$, $p < .005$, and Cohort 2, $t(21.46) = 2.13$, $p < .05$, despite the fact that Cohorts 1 and 2 had been created to balance math achievement, including achievement on their third-grade CST math scores, $t(25.84) = .61$, *n.s*. The *champagne graph* style of Figure 5 (inclusion of individual observations in the bar graph) illustrates that gameplay seems to have reduced bimodality in Cohort 1: one interpretation of this is that playing *Tug-of-War* especially helped lower achieving students.

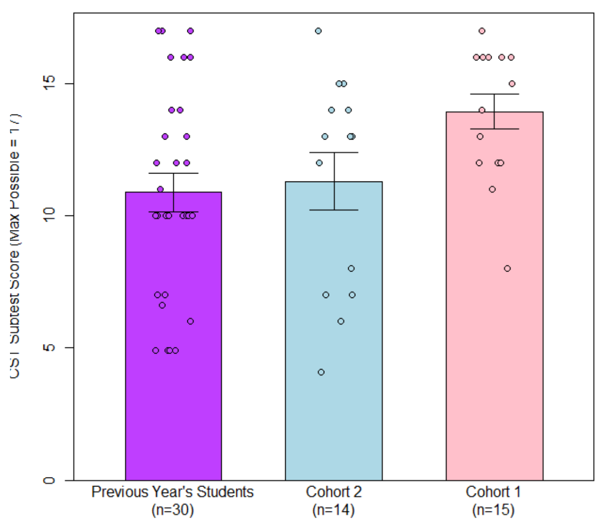


Figure 5. **CST Subtest Individual Scores, Mean, and Standard Errors**

Future Directions/Conclusion

We are currently working on the development of a digital version of the game, for which the existing version has served as a lo-fi paper prototype. This digital version will allow us to greatly increase the variety of fractions available in the game and offer different "skins" and overarching narratives (e.g., a space race instead of a tug-of-war). Perhaps most importantly, a digital version of the game would be able to fill the instructing and moderating roles played by researchers in the existing version, which will allow us to deploy the game in classrooms without relying on specially trained instructors.

In this paper we have described the development, evaluation, and validation of a successful educational game. We hope that the design process we followed—starting by wedding key learning outcomes to core game mechanics, building a fun game around those mechanics, and then tweaking as necessary to support learning—can serve as a model for future educational game designers. We also hope that addressing skeptics' concerns about the benefits of game-based learning by providing evidence of learning on traditional measures that skeptics value can begin to influence policy and provide support for incorporating more game-based learning into school curricula.

References

Barab, S. A., Sadler, T. D., Heiselt, C., Hickey, D., & Zuiker, S. (2007). Relating narrative, inquiry, and inscriptions: Supporting consequential play. *Journal of Science Education and Technology*, 16(1), 59-82.

Barlett, C. P., Anderson, C. A., & Swing, E. L. (2009). Video game effects—Confirmed, suspected, and speculative. *Simulation & Gaming*, 40(3), 377-403.

Barron, B. (2003). When smart groups fail. *Journal of the Learning Sciences*, 12(3), 307–359.

Buckingham, D., & Sefton-Green, J. (2003). Gotta catch'em all: Structure, agency and pedagogy in children's media culture. *Media, Culture & Society*, 25(3), 379.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Palgrave/McMillan.

Gee, J. P. (2010). *New digital media and learning as an emerging area and "worked examples" as one way forward*. Cambridge, MA: MIT Press.

Gelman, R., & Meck, E. (1983). Preschoolers' counting: Principles before skill. *Cognition*, 13, 343–359.

Habgood, M., Ainsworth, S., & Benford, S. (2005). Endogenous fantasy and learning in digital games. *Simulation & Gaming*, 36(4), 483-498.

Honey, M., & Hilton, M. (2011). *Learning science: Computer games, simulations, and education*. Washington, DC: National Academies Press.

Ito, M. (2006). Intertextual enterprises: Writing alternative places and meanings in the media mixed networks of Yugioh. *Encountering the Extraterrestrial: Anthropology in Outerspaces*.

Kerslake, D. (1986). Fractions: Children's strategies and errors: A report of the strategies and errors in secondary mathematics project. Windsor, England: NFER-Nelson.

Mack, N.K. (1995). Confounding whole-number and fraction concepts when building on informal knowledge. *Journal for Research in Mathematics Education*, 26(5), 422–441.

Malone, T.W. (1981). Toward a theory of intrinsically instruction. *Cognitive Science*, 4, 333–369.

Martin, T., & Schwartz, D. L. (2005). Physically distributed learning: Adapting and reinterpreting physical environments in the development of fraction concepts. *Cognitive Science: A Multidisciplinary Journal*, 29(4), 587–625.

Nelson, B., Ketelhut, D. J., Clarke, J., Bowman, C., & Dede, C. (2005). Design-based research strategies for developing a scientific inquiry curriculum in a multi-user virtual environment. *Educational Technology*, 45(1), 21-27.

Okita, S. Y. (2008). Learn wisdom by the folly of others: Children learning to self correct by monitoring the reasoning of projective pedagogical agents (doctoral dissertation, Stanford University, 2008). Retrieved from ProQuest Dissertation Abstracts International.

Siegler, R. S. (1995). How does change occur? A microgenetic study of number conservation. *Cognitive Psychology*, 28, 225–273.

Squire, K., & Klopfer, E. (2007). Augmented reality simulations on handheld computers. The *Journal of the Learning Sciences*, 16(3), 371-413.

Acknowledgments

We would like to thank Dan Schwartz, whose suggestions and support have undergirded this research from its inception. We would also like to thank Ilsa Marie Dohmen for her constant researcher/moderator role in our school studies, as well as the teachers, facilitators, and students whose help has made this research possible. This work was supported by a grant from the National Science Foundation (NSF#0354453). Any opinions, findings, and conclusions expressed in this paper are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Games for Learning in Embodied Mixed-Reality Environments: Principles and Results

Mina C. Johnson-Glenberg, Tatyana Koziupa, David Birchfield,
School of Arts, Media, + Engineering at Arizona State University, Tempe, AZ
Email: Mina.johnson@asu.edu, tkoziupa@asu.edu, David.birchfield@asu.edu
and
Kyle Li at Institute of Play, NYC, NY, Email: kanyangli@gmail.com

Abstract

Mixed-reality learning platforms are coming of age. We review several studies that demonstrate increased learning when students are in embodied, mixed-reality environments compared to learning in regular instruction environments where teacher and content are held constant. Two scenarios are described in-depth and a set of gesture-based design principles is presented. Embodied, mixed-reality environments can support significant gains in learning because multiple sensori-motor systems are activated when learning. In addition, classroom discourse is more focused in these collaborative environments and language may serve as a mediating variable for change.

What is an embodied mixed-reality environment?

The Situated Multimedia Arts Learning Lab (*SMALLab*) is an example of a mixed-reality learning environment. *SMALLab* is an educational platform that engages the major modalities (i.e., the sense systems including visual, auditory, and kinesthetic) that humans use to learn. The platform is considered embodied because it is kinesthetic and based on physical movement. It is easy to enter/exit because there is nothing to strap on or wear. *SMALLab* uses twelve infrared motion tracking cameras to send information to a computer about where a student is in a floor-projected environment. The floor space is 15 x 15 feet and the tracked space extends approximately seven feet high. Students step into the active space and use a "wand" (a trackable object) that allows the physical body to function like a 3D cursor in the interactive space. The environment also allows for multiple students (up to four) to be tracked simultaneously. With turn-taking, entire classrooms with 30 students are able to physically experience a learning scenario within a typical class period. Students outside of the active space sit around the open periphery and collaborate with each other and with the active students.

We believe that the introduction of the affordable *Xbox Kinect* system will greatly advance the field of embodied learning. Research into the type of learning afforded by motion capture (or gesture control) technologies in classrooms is direly needed. It is important to note that gesture-based learning is not content constrained. We have studied learning in embodied environments in several different content domains, including language arts (Hatton, Birchfield, & Megowan, 2008), science, technology, engineering, and mathematics [STEM] content (Birchfield & Johnson-Glenberg, 2010; Johnson-Glenberg, Birchfield, Savvides & Megowan-Romanowicz, 2011; Tolentino, Birchfield, Megowan-Romanowicz, Johnson-Glenberg, Kelliher & Martinez, 2009), and special education with a focus on individuals with Autism Spectrum Disorders (Savvides, Tolentino, Johnson- Glenberg & Birchfield, 2010).

Learning Gains

A previous geology study examined student learning related to earth's "layer cake" morphology that is formed through complex, dynamic processes (Birchfield & Johnson-Glenberg, 2010). Many of our in-school studies use a waitlist control group design, i.e., one group of students will go through the *SMALLab* intervention first and one group will go through regular instruction first—then the order of intervention will switch. Three invariant tests were administered. Statistically significant learning gains were seen whenever the students were in the embodied *SMALLab* learning condition. In the regular instruction condition, students created hands-on paper timelines and discussed the dynamics of geology in small groups. Thus, it was an active and appropriate control that also resulted in learning gains. However, the gains seen in regular instruction were not statistically significant. We propose three primary reasons for the consistently higher gains whenever students are in a mixed-reality, embodied environment: embodiment, collaboration, and novelty, as well as the two important "mediator" variables of language and gameplay.

Embodiment and Collaboration

Multiple research areas now support the tenet that embodiment is a powerful underpinning of cognition. The various domains include (but are not limited to): neuroscience and mirror neurons (Rizzolatti & Craighero, 2004), cognitive psychology (Barsalou, 2008; Glenberg & Kaschak, 2002; Glenberg, 2010), linguistics (Lakoff, 1987), math (Lakoff & Nunez, 2000), gesture (Hostetter & Alibali, 2008), and dance (Winters, 2008). Glenberg (2010) contends that all cognition comes from developmental embodied interactions with physical environments. It follows that all thought—even the most abstract—is built on the foundation of physical movement. Our position regarding embodied learning is that the more modalities (sensorimotor systems) that are activated during the encoding of the information, then the crisper and more stable the representations will be in schematic storage. These crisper representations, with more modal associative overlap, will be more easily recalled. Better retrieval leads to better performance on assessment measures. If gestures are another modality—and they emerge from perceptual and motor simulations that underlie embodied cognition (Hostetter & Alibali, 2008) —then creating an embodied learning scenario that reifies the gestures (motor traces from and to cognition) should be a powerful teaching aid.

In addition, all of our scenarios rely on collaboration. Collaborative learning generates significantly higher achievement outcomes, higher-level reasoning, better retention, improved motivation, and better social skills (Johnson and Johnson, 1984; Johnson and Johnson, 1989; Johnson and Johnson, 1991) than traditional didactics. We have found that more focused, education-oriented language and productive gameplay are two constructs that fall out of well-designed collaborative experiences.

Mediators of Language and Gameplay

We have pilot evidence from teacher and student discourse in a chemistry experiment with three high school classes (Johnson-Glenberg, Birchfield, Koziupa, & Tolentino, submitted) supporting that language is affected by the environment. When in *SMALLab*, 100% of student discourse was on-topic and related to the content to be learned. When students were in small groups working on a project-based, wet lab lesson only 66% of the content-per-discourse-turn was task-related. Language in mixed-reality environments appears to be more on-topic and learning directed; this may be related to the collaboration built into the design. In addition, students know they will shortly be in front of the entire class performing. Because all students will eventually be “center stage”, they are extremely motivated to get it right. When students have been placed in small groups they are motivated to not let down their peers. Using principles from game design we have kept errors somewhat “low stakes”. It is not egregious to make mistakes in *SMALLab*, students receive immediate visual and sonic feedback regarding the veracity of their choices and errors can be quickly corrected. Thus, it is safe to fail. It is necessary to fail early on so that observers learn from the previous mistakes. Nonetheless, it is human nature to want to perform without mistakes and we think this motivates students to attend to the content.

Our hypothesis is that there is something about the affordances of a mediated, co-located collaborative process when combined with gameplay that alters language-use in a classroom. The on-topic language, in turn, affects learning gains. The learning, in turn, affects the flow of the gameplay and these variables continuously interact to create a powerful learning loop that is extremely motivating for students.

Learning Scenario 1 – Disease Outbreak

All of our scenarios rely heavily on gameplay (Gee, 2007; Salen & Zimmerman, 2003). At the School of Arts, Media, and Engineering at ASU, we have assembled a multi-disciplinary team that creates scenarios that end with a game. Often students are placed into small teams for benign competition (“Which team can make the solution neutral in the fewest moves possible?”). We include two examples of scenarios in this paper and encourage readers to explore more online at www.*SMALLab*learning.com.

The Disease Outbreak scenario was developed with a veteran science teacher in an attempt to dispel several misconceptions surrounding disease transmission. Since we were attempting to model a complex phenomenon that would include many different variables, we decided to constrain the system model and we focused on: 1) the difference between bacterial infections and viruses, 2) the difference between antibiotics and vaccines; 3) antibiotic resistance; 4) symptomatic and asymptomatic carriers, and 5) concept of limited resources (e.g., medicine supply, nutrition). We considered how we might leverage the unique features of a mixed reality environment to engage the students and motivate them to participate. The scenario was designed so that the students would not only develop an understanding of how a disease could be transmitted in a closed system, but so they would be able to generalize their new insights to other systems as well.

We are proponents of student-created content and have worked with students to create original pieces of complex media. In this study, we needed to start gradually. We asked students to first create their own avatars by using an avatar creation website (doppleme.com). They saved their images as .gif files and submitted them to the teacher. The avatars were distributed around the perimeter of the *SMALLab* floor projection so that students could sit behind them and manipulate them during play. This ownership proved to be very engaging; indeed, all students who did not have a self-created avatar on the first day of the study made certain they had created one by the second day. To engage the students even further and create a sense of urgency, each avatar’s health would reduce over time until a “skull and crossbones” appeared (Figure 1). The health reduction speed was an element that could be adjusted for each run of the simulation. An inner ring of color surrounding each avatar indicated whether it was healthy (white), symptomatic (red), or asymptomatic (yellow). To encourage the students to move within the

SMALLab space, we placed two centrally located "Supply" icons in the center of the floor; one represented medicine, while the other represented nutrition or water (Figure 2).

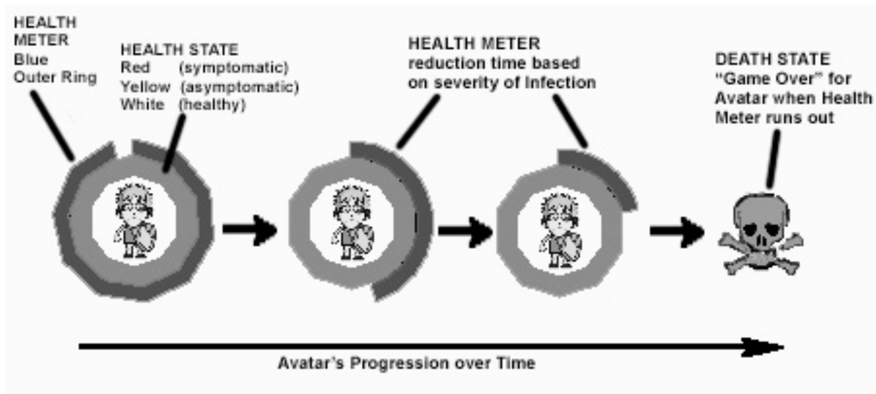


Figure 1. **GamePlay Mechanics for Each Avatar**

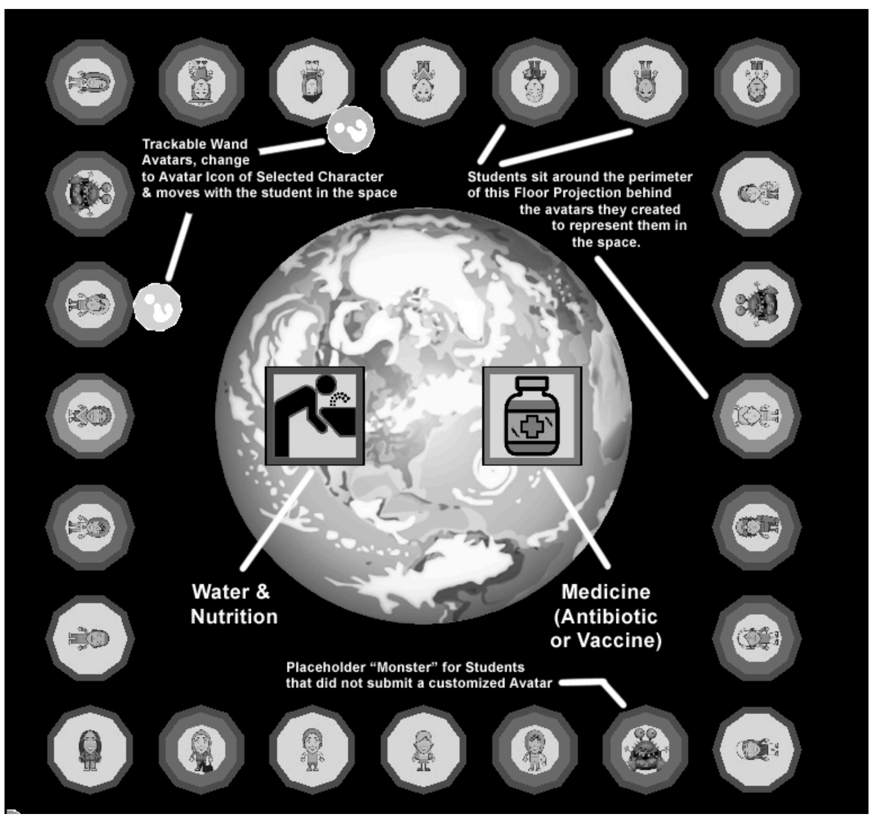


Figure 2. **The floor projection for Disease Outbreak. Avatars ring the outside.**

One design challenge was to present a large amount of information in the space without overwhelming students. We chose a framework wherein we gradually increased the complexity of the information being presented in the space as stages were mastered. Thus, different “levels” of complexity were presented when the teacher ascertained that students were ready. When students hit certain “targets”, or collaboratively made and agreed upon a correct observation, new components were introduced that made the game more difficult. In this waitlist (or crossover) design, each group spent three days in SMALLab. On the first day, the teacher as facilitator encouraged the students to deduce the method of transmission, and to explore the types of interactions that were possible in the space. This included selecting or "picking up" an avatar, and bringing it to either the water or medicine icons in the center of the space. On the second day, students deduced that avatars with “red” or “yellow” inner disks would have a faster rate of decline for their health meter. All instruction followed the model of inquiry-based science learning. On the third day, further complexities were introduced into the system, e.g., limiting the supply of medicine, hiding the asymptomatic carrier symbol, or setting a threshold for antibiotic resistance. The teacher would simply tell the students that something was now being modified in the simulation, and that they would have to discover what had changed. Finally, we would vary the infection type to be either viral or bacterial (such that a “vaccine” would need to be administered prior, as opposed to an antibiotic being given after the illness was present). In the controlled study the two groups were matched at pretest. See Table 1 for a description of the design. Group 1, the one that first received the SMALLab intervention made significantly greater learning gains by the midtest compared to the group that received regular instruction matched for content and teacher (Johnson-Glenberg, Birchfield, Koziupa, & Tolentino, submitted).

Table 1: Experimental design

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Group 1	**Pretest** *SMALLab*	*SMALLab*	*SMALLab* **Midtest**	Regular	Regular	Regular **Posttest**
Group 2	**Pretest** Regular	Regular	Regular **Midtest**	*SMALLab*	*SMALLab*	*SMALLab* **Posttest**

On day four, the intervention switched; by posttest, the students in Group 2 receiving *SMALLab* demonstrated statistically significant gains compared to the regular instruction group that displayed a very small effect size.

Learning Scenario 2- Quest to Learn’s PUSH.

Quest to Learn (Q2L) is an innovative 6th-12th grade school in New York City that has a *SMALLab* structure permanently installed in the school. The public charter school has been designed to help students bridge old and new literacies through learning about the world as a set of interconnected systems. *SMALLab* scenarios are integrated into existing curricula. Similar to the ASU team, Q2Lteachers work closely with game designers and instructional technology specialists to create engaging, self-motivating content for the students. The brainstorming sessions with teachers help to define a learning goal that is often inspired by a common misconception. Here we describe PUSH an embodied scenario designed to explore concepts surrounding Simple Machines (a standard covered by Q2L 6th grade math and science domain called “The Way Things Work”).

PUSH was designed specifically to create a game-like learning experience through collaboration and embodied play. In PUSH, students work in groups of 2, 3, or 4 to help a group of digital creatures (reoccurring through the curriculum) called Troggles push an object (i.e., a hat) up a hill. Figure 3 shows the hat, Troggles, and the white lines representing the incline. Students stand over the image and maneuver their wands in a “pushing” motion to exert force and get the hat to the top of the incline. They receive immediate visual feedback about Newtons used. The scenario is extremely embodied in that students’ muscles feel fatigue as the ‘work’ continues. When the top is summited, the Troggles jump for joy and high-five each other. The learning is accompanied by worksheets, and students discuss hypotheses about how work, force, distance, and angle of incline relate to each other. An experienced teacher will find moments during PUSH to take advantage of opportunities for learning and reinforce the fundamental concept of mechanical work.

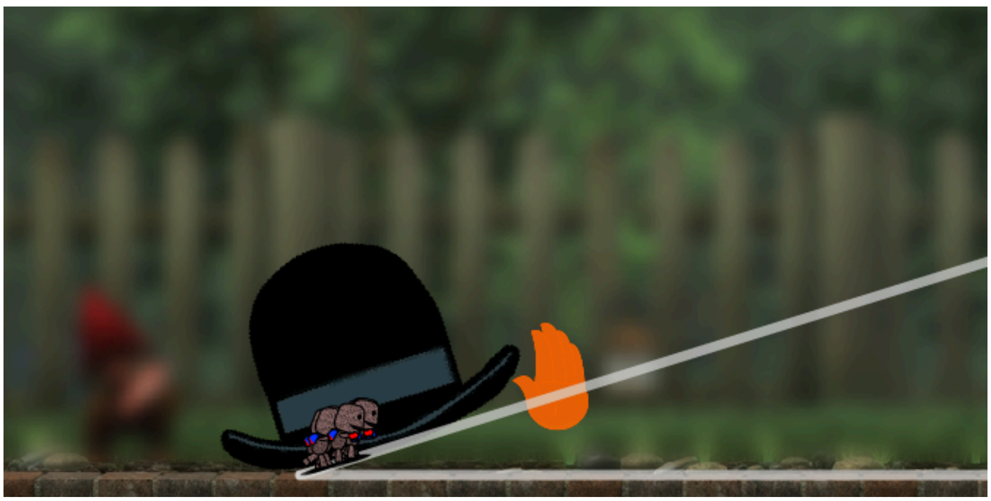


Figure 3. **Troggles pushing a hat up an incline.**

Design Principles

When designing for embodied, mixed-reality environments, we strive to better understand the scope and role of embodiment in these emerging learning environments. We have developed a set of design principles intended to frame the realization of embodied learning experiences in computer-mediated environments (Birchfield, Johnson-Glenberg, Megowan-Romanowicz, Savvides, & Uysal, 2010) These principles apply to the design of interactive experiences, not simply to the affordances of a given technology. Specifically:

1. Direct Impact - Learners’ physical actions should have a direct and causal impact in the simulated environment.
2. Map to Function - A learner’s gesture should closely align with its function and role in the simulated environment (e.g., physical throwing gestures should align with throwing actions in the simulation, waving a wand along an angle should align to the projected object moving along same angle).

3. Human Scale - Computer interfaces should support movement on a human scale (e.g., degrees of freedom, size and speed of a gesture).
4. Socio-Cultural Meaning - The communicative aspects of human presence and gesture should be accounted for (e.g., human co-location affects learning interactions, the cultural meaning of a gesture, the information conveyed by a gesture needs to be addressed).

Conclusions

Learning in embodied, mixed-reality environments is novel and engaging for students, but does that environment have a significant impact on the content being learned? We have published several studies that support this contention; however, we also acknowledge that it is difficult to run rigorous, controlled studies. Real world classrooms are extremely complex environments where peripheral subject variables like a teacher's comfort level with technology can produce outsized effects on learning outcomes. It is a challenging experimental world for those trained in traditional inferential statistical analyses because it is difficult to capture causal factors in mixed-reality environments. Statistical tests using traditional methods are made more powerful when a large N is used, however, the current, hardware-heavy motion capture environment is stationary and only one physical classroom in the school can be used. It is difficult to do hierarchical linear modeling with so few classes in a building covering the same content. Large N studies have been elusive and we have not been able to adequately tease out the unique and shared amounts of variance explained by the five variables mentioned earlier. Indeed, there may be more explanatory variables beyond these five: 1) embodiment, 2) collaboration, 3) novelty, 4) language use, and 5) gameplay, e.g., motivation and individual differences (i.e., prior knowledge, students' comfort with technology) may prove to be extremely powerful predictors of learning in these environments as well.

The one-room constraint will surely change with the advent of affordable skeletal-tracking input devices (e.g., the *Kinect*). At this time, educators and game designers creating serious content in mixed-reality spaces can design for the environments keeping mind that engagement will probably be enhanced and language will be more on-topic when students are in embodied, collaborative mixed-reality environments. We believe that the comparatively larger learning outcomes we have seen may be facilitated (mediated) by game-like components and more on-topic language use, but we do not know this conclusively, via one degree-of-freedom tests. We cannot say which variable explains the *most* variance. For now it may be enough to design with all variables present and optimized as more refined methods of assessment and delivery begin to emerge. We sincerely believe that embodied, mixed-reality environments hold great promise for the future of learning.

References

Barsalou, L.W. (2008). Grounded cognition. Annual Review of Psychology, 59, 617–645.

Birchfield, D., & Johnson-Glenberg, M. C. (2010). A next gen interface for embodied learning: SMALLab and the geological layer cake. International Journal of Gaming and Computer-mediated Simulation, 2, 1, 49-58.

Birchfield, D., & Megowan-Romanowicz, C. (2009). Earth science learning in SMALLab: A design experiment for mixed-reality. Journal of Computer Supported Collaborative Learning, 4, 4, 403-421.

Gee, J. P. (2007). Good Video Games + Good Learning: Collected Essays on Video Games, Learning, Glenberg, A. M. (2010). Embodiment as a unifying perspective for psychology. Wiley Interdisciplinary Reviews: Cognitive Science. DOI 10.1002/wcs.55

Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. Psychonomic Bulletin and Review, 9, 558-565.

Glenberg, A. M., Sato, M., & Cattaneo, L. (2009). Use-induced motor plasticity affects the processing of abstract and concrete language. Current Biology, 18, 7, 290-291.

Graesser, A. C., Chipman, P., Leeming, F., & Biedenbach, S. (2009). Deep learning and emotion in serious games. In U. Ritterfeld, M. Cody, & P. Vorderer (Eds.), Serious games: Mechanisms and effects (81-100). New York and London: Routledge, Taylor & Francis.

Hostetter, A. B., & Alibali, M. W. (2008). Visible embodiment: Gestures as simulated action. Psychonomic Bulletin & Review, 15, 495-514.

Johnson, R. T., & Johnson, D. W. (1994). An overview of cooperative learning. In J. Thousand, A. Villa & A. Nevin (Eds.), Creativity and Collaborative Learning. Baltimore: Brookes Press.

Johnson, D. W., & Johnson, H. (1991). Learning Together and Alone: Cooperation,Competition, and Individualization. Englewood Cliffs, NJ: Prentice Hall.

Johnson, D. W., & Johnson, R. T. (1989). Cooperation and Competition: Theory and Research. Edina, MN: Interaction Book Company.

Johnson, D. W., & Johnson, R. T. (1984). Cooperative Learning. New Brighton, MN: Interaction Book Co.

Johnson-Glenberg, M. C., Birchfield, D., Megowan, C., Tolentino, L., & Martinez, C. (2009). Embodied games, next gen interfaces, and assessment of high school physics. International Journal of Learning and Media. 2. http://ijlm.net/

Johnson-Glenberg, M. C., Birchfield, D., & Usyal, S. (2009). SMALLab: Virtual geology studies using embodied learning with motion, sound, and graphics. Educational Media International, 46, 4, 267-280.

Johnson-Glenberg, M. C., Birchfield, D., Savvides, P., & Megowan-Romanowicz, C. (2011). Semi-virtual Embodied Learning – Real World STEM Assessment. In L. Annetta & S. Bronack (eds.) Serious Educational Game Assessment: Practical Methods and Models for Educational Games, Simulations and Virtual Worlds. pp. 241-258. Rotterdam: Sense Publications.

Johnson-Glenberg, M. C., Birchfield, D., Koziupa, T. & Tolentino, L. (Submitted).

Lakoff, G. (1987). Women, Fire, and Dangerous Things: What Categories Reveal About the Mind. Chicago: University of Chicago Press.

Lakoff, G., & Nunez, R. (2000). Where Mathematics Comes From: How the Embodied Mind Brings Mathematics Into Being. Basic Books, New York

Rizzolatti, G., & Craighero, L. (2004). The mirror -neuron system. Annual Review of Neuroscience, 27, 169-192.

Salen, K., & Zimmerman, E. (2003). *Rules of Play*. MIT Press.

Savvides, P., Tolentino, L., Johnson-Glenberg, M. C., & Birchfield, D. (2010).

A mixed-reality game to support communication for students with autism. Poster presented at SITE: Society for Information Technology & Teacher Education in San Diego, CA, April.

Winters, A. (2008). Emotion, embodiment, and mirror neurons in dance/movement therapy: A connection across disciplines. American Journal of Dance Therapy, 30, 2.

Acknowledgements

This work has been supported by Intel, and the MacArthur Foundation under a grant titled, *Gaming SMALLab*, by the National Science Foundation CISE Infrastructure grant under Grant No. 0403428, NSF IGERT Grant No. 050464 and NSF DRK12 Grant No. 1020367. We would also like to thank Lisa Tolentino, Christobal Martinez, Sibel Uysal, Colleen Megowan, Michael Edwards, and Katie Salen.

Insights into Learning Offered by the Dispositions of Second-Generation "Newbie" Gamers

Shawna K. Kelly, Annenberg School for Communication & Journalism, University of Southern California, Los Angeles, CA, and Intel Corporation, Interaction and Experience Research Lab, 2111 NE 25th Ave., JF2-60, Hillsboro, OR 97124, Email: shawna.kelly@usc.edu

Abstract

Concerns about the content of videogames continue to hold media attention, but researchers like Gee (2003) and Thomas and Brown (2007, 2011) have dug deeper in order to explore how the merging of play and learning within game structures encourages learning and a "gamer disposition" (Brown and Thomas, 2008). Building on research into communities in computer-mediated spaces (Boellstorff, 2008; Nardi, 2010; Rheingold, 2000; Taylor, 2006; Turkle, 1995), this paper argues that the majority of *World of Warcraft* players are not stereotypical "first-generation" gamers but are instead "second-generation" gamers who are new to online game spaces and do not have a firm grasp of gaming culture or a gamer disposition. By examining their gameplay styles, social interaction, and entry into gaming culture, the dispositions of second-generation gamers contrast with "the gamer disposition;" however, as these players become more invested in gaming culture, they can develop a first-generation disposition.

Introduction

Concerns about the content of entertainment available on the Internet and through videogames are a continuing source for media attention. In recent years, researchers like Gee (2003) have dug deeper than content to explore how the structure of a game itself can encourage learning. Thomas and Brown (2007) examined the mindset that is encouraged by play:

> More than simply a means to learning, play is a way of thinking about more than what we know. It is, following Gilbert Ryle's (1949) notion of mind, a disposition toward the world, a way of not only seeing the world but of seeing ourselves in it and the various possibilities that the world presents (pp. 156).

In 2008, Brown and Thomas list how the learned dispositions that gamers develop would benefit employers, specifically outlining the traits acquired through the merging of play and learning within the socially created environment within the game space.

In this paper, I look at differences in dispositions between "first-generation" gamers, like those discussed by Brown and Thomas (2008), and newer and more common "second-generation" game players who are entering the game space without a firm grasp of gaming culture. These second-generation players generally do not react to the game or to other players like more experienced players and are often labeled as "newbies," in reference to their poor playing skills—to first-generation gamers, second-generation gamers are simply playing the game wrong. The friction between first-generation and second-generation gamers offer insights not only into what behaviors are expected and are missing on the part of the second-generation gamer, but also how the general dispositions of thinking differ between the two groups and what that suggests about a the second-generation gamer disposition.

Second-Generation Gamers

From its advent, game studies researchers have described the culture that develops within a community of game players (e.g. Rheingold, 1993/2000; Turkle, 1995). Gamer culture is the topic of in-depth anthropological inquiries (e.g. Boellstorff, 2008; Nardi, 2010; Taylor, 2006), as well as academic journals, e.g. *ELUDAMOS Journal of Computer Game Culture* (Singapore-MIT GAMBIT Game Lab) and *Games and Culture* (SAGE). However, within the past five years, the number of digital game players has increased, as well as news and media coverage increasing the public's awareness of "gamer culture." The cultural norms and idiosyncrasies of these virtual communities have been a point of entry for many researchers, myself included (e.g. Boellstorff, 2008; Kelly, 2005, 2007a, 2007b, 2008; Nardi, 2010; Pearce, 2009; Taylor, 2006). However, in this paper I argue that as videogames have become a more popular and accessible form of entertainment, the majority of players in even the massively multiplayer online (MMO) games are no longer "hardcore" gamers who have a strong connection with gamer culture. This paper strives to makes a distinction between first-generation hardcore gamers who play games within the cultural framework described by previous games studies scholars, and second-generation gamers who are only familiar with the culture and conventions of gaming from an outsider's perspective.

The defining characteristics of second-generation are based, not on the amount of time they spend playing, e.g., Juul's (2010) "casual" gamer, but on their gameplay behaviors and their interest in and ability to immerse themselves in the dominant gamer culture of the first-generation gamers. Second-generation gamers:

- Are not hardcore gamers. *World of Warcraft* is generally their first MMO.
- Don't have the latest computers and may not have a fast Internet connection.
- Focus on leveling, questing, and exploration, rather than complex end-game content.
- Have little to no understanding of game mechanics.
- Feel disconnected from gamer stereotypes about gender, age, and ethnicity. Second-generation gamers are parents, grandparents, Caucasian, Asians, Latinos, African Americans, heterosexual, lesbian, and gay.
- Often break the norms of gamer culture in language and actions.

There is an inherent conflict between the playing styles of first- and second-generation gamers. First-generation gamers have little patience for players who do not know what they should be doing; hence, they refer to second-generation gamers as newbies—noobs, nubs, n00bs, newbs, etc. First-generation gamers see themselves as the elite, dedicated few who have watched their game from its birthing pains to the present. To them, second-generation gamers are interlopers, people jumping onto the bandwagon after *World of Warcraft* is "cool." First-generation gamers are not subtle about their feelings of superiority, but second-generation gamers bring their own interests to the game and play it their own way. Why "crunch the numbers" and do all the "math stuff" to make your character better when someone else has already done it? Why collect multiple pieces of rare equipment to compare their stats when other users have already compiled "Best in Slot" gear lists? The challenge is not about exploring the min-max aspects of the game, but about experiencing its richness to the fullest. It's a different kind of challenge because second-generation gamers are, essentially, playing a different game within a game.

Identifying Second-Generation Gamers

For this study, I focused on Activision Blizzard's *World of Warcraft*. Initial probes were conducted during the first few months after the release of *World of Warcraft* in 2004, while the main research was conducted between 2005 and 2009. The data was collected using an ethnographic exploration of communication and social interactions in *World of Warcraft* and in-depth interviews with 105 players.

As a case-study videogame in the MMO genre, *World of Warcraft* is a popular game with a well-developed game culture. McGonigal (2011) described the enthusiastic participation of players in the community, saying "They're the *World of Warcraft* fans who are so intent on mastering the challenges of their favorite game that, collectively, they've written a quarter of a million wiki articles on the WoWWiki—creating the single largest wiki after Wikipedia" (p. 2). Combined with an active player community, after its release in late 2004, *World of Warcraft* had a massive surge in subscriptions to play the game and included incentives for people who would not normally play an MMO to try the game. This brought in a lot of new players. In Castronova's (2005) book, he noted that "Blizzard's *World of Warcraft* broke single-day PC game sales records at its release on November 23, 2004. As this book goes to press, it is on target to reach several hundred thousand subscribers" (p. 134). In contrast, by 2010, Blizzard Entertainment announced that they had 12 million *World of Warcraft* subscribers worldwide (Blizzard Entertainment, 2010). Although Castronova was only estimating the potential popularity of the game, his guess actually suggests the number of gamers in 2004 who would be likely to play a game like this—the first-generation gamers who are deeply immersed in gamer culture. When compared to the total number of players, even if "several hundred thousand" is interpreted as 400,000 players, that number of first-generation players is less than 5% of the whole. This begs the question: Who are the other 95%? These newbie second-generation gamers are a strong presence within *World of Warcraft*, making this particular game an excellent space within which to examine this understudied group of players.

The specific subjects were selected through a combination of two elements: identifiable gameplay habits made apparent by the structure of play in *World of Warcraft* and my own gameplay choices. During the course of this research, I changed game servers multiple times for work and personal reasons and generally leveled multiple characters per server. The choices I made to limit my deep connections to one server, one guild, or one character became an integral component of my research methodology and contained several benefits. First, I spent a lot of time "pugging"—playing with pick-up groups (PUGs) of random players in the area or players doing the same activity I wanted to do. This meant I was frequently exposed to new players, rather than maintaining a more consistent relationship with a fixed set of players. Second, I was often a solo player, which made me appear more available for conversation and for joining forces with other people in the same in-game area. Third, while leveling new characters, I met a large number of my subjects in areas of the game geared toward characters in the 40s and 50s levels, or, after the level caps had been raised, in the 60s or 70s levels. Players who were just trying the game and did not like it rarely made it to these levels, while the first-generation players already knew the most efficient means of gaining experience and quickly leveled out of these areas, often recruiting a higher level member of their guild to help them "power level" faster. That left players who did not know the areas or the quests because they were hitting this level for the first time, often because they had purchased *World of Warcraft* late, after hearing friends/siblings/significant others raving about what a fun game it was. These second-generation gamers, who in many cases seemed to be playing a different game than the one my first-generation gamer friends discussed, became the subjects of this research.

The Gamer Disposition

Brown and Thomas (2008) examined the mindset that is encouraged by the kind of coordinated play that takes place within a MMO like *World of Warcraft*. Talking about first-generation gamers, Brown and Thomas describe the gamer disposition as "more than attitudes or beliefs, these attributes are character traits that players bring into the gamer worlds and that those worlds reinforce" (¶2). According to Brown and Thomas, the gamer disposition has five key attributes.

Gamers:

- "are bottom-line oriented" (¶3).
- "understand the power of diversity" (¶5).
- "thrive on change" (¶7).
- "see learning as fun" (¶9).
- "marinate on the 'edge'" (¶11), i.e., experiment with crazy solutions to problems.

Contrary to stereotypes about gamers being lazy and unreliable people, Brown and Thomas' analysis of the disposition of gamers indicated that they are goal-oriented, engaged, creative, and dedicated. They argue that gamers make the kind of committed and creative employees that businesses should look for in their hiring practices.

The Second-Generation Gamer Disposition

Unlike first-generation gamers, second-generation gamers who have not yet assimilated gamer culture exhibit a disposition more passive, easy, predictable, and requiring an on-demand schedule. Following the structure of Brown and Thomas' (2008) gamer disposition, second-generation gamers prefer ease-of-use, embody diversity, thrive on consistency, learn only what is necessary, and rely on proven solutions.

They are ease-of-use oriented

Second-generation gamers are not interested in working too hard. This is entertainment, not work. These are players with full-time jobs, families, and friends. They prefer to find a balance between the game and their other activities. They are looking for an enjoyable diversion from life, something they can plug into when they have free time, but they are not looking for the commitment of consistent playing or the dedication of nightly raiding. They resent anything that interferes with the entertainment elements of the game. This includes technical factors like

Internet connectivity problems and program glitches, or design features like grinding for long periods of time, or social factors like griefers or spammers. They are willing to consider shortcuts to success that first-generation gamers find offensive. Gold farmers sell gold to second-generation gamers.

They embody diversity, but practice autonomy

Physically, second-generation gamers are more diverse from the stereotype. While there have always been exceptions to the young, Caucasian male norm, second-generation gamers push the edges in terms of age, gender, sexual orientation, ethnicity, and socio-economic status. Second-generation gamers also embody diversity in-game. Where the structure of the game encourages and enforces collaboration through the Tank-Healer-DPS triangle or through crafting, second-generation gamers want to do it all on their own. They try many different character classes and gravitate toward balanced, self-sufficient classes that can solo. They create alts to level all of the crafts to limit reliance on other players.

On the surface, dabbling in many character classes and trying different aspects of the game seems similar to the Explorer (first-generation) player type described by Bartle (1996). The difference lies in the depth of exploration. First-generation Explorers are driven to fully map out aspects of the game. In *World of Warcraft*, these kinds of first-generation players might fill in the entire world map, level three different versions of the same character class to try all the available options, or repeatedly attack (x+1) number of mobs to determine the limits of their character's ability. In contrast, second-generation gamers are driven more by curiosity and the desire to be self-sufficient. They explore multiple character classes, but not fully—they will often have multiple characters at low to mid-levels, especially characters that are more difficult to level outside a group, like warriors and priests.

They thrive on consistency

For second-generation gamers, videogames are a chance to relax and unwind, not a foray into the unknown. Changes to the game system are upsetting and frustrating. A player in her 60s told me she quit *World of Warcraft* and had no interest in playing again because of changes in the latest expansion, despite the fact that her son and husband both played. "They changed the maps again. I had enough trouble getting around before without them changing the maps on me."

They learn only what is necessary

Second-generation gamers want to learn how something works quickly, and then not have to think about it again. They have little desire to explore the underlying structures of the game and many players are happy to follow the lead of experienced players, more concerned with overcoming the obstacle than in learning why or how it was defeated. For example, very few second-generation gamers are familiar with the *World of Warcraft* game lore because it is not integral to playing the game.

They rely on proven solutions

Second-generation gamers trust that first-generation gamers have already generated answers and strategies for in-game challenges. They utilize guild chat and general chat as a forum for questions on where to find items or how to complete quests. If they are more comfortable with technology, they pick a knowledge database like www.wowwiki.com and refer to it to answer all of their questions, but they rarely contribute information or comment on forums.

Gamer Culture and the Gamer Disposition

The second-generation version of the gamer disposition looks more like general media consumption than a specialized mindset learned by playing videogames. Second-generation gamers are, in essence, strangers coming into the gaming space and slowly learning how to behave like a gamer. Some never learn, but others start investing themselves into gaming culture. These second-generation gamers begin to understand what behaviors are expected of them, and learn about the underlying mathematical calculations of the game structure. They are likely to join a guild and eventually learn how to "walk" and "talk" like a first-generation gamer. As these second-generations players become more immersed in gaming culture, they develop game play behaviors that are more similar to Brown and Thomas' (2008) gamer disposition. Therefore, rather than contradicting Brown and Thomas' research, this paper supports their findings by suggesting that the gamer disposition can be taught to players through the combination of play and learning found in *World of Warcraft*.

Future Directions

As gaming increases in popularity, the gamer culture discussed by the media and studied by games researchers will continue to change and develop. This paper uses the playing habits of second-generation gamers to identify them both as distinct from first-generation gamers, and as a group who can tell us something new about what players learn from videogames; however, the numerical order of the generations is meant to describe a players' entry into videogame playing culture, not how long they have been playing videogames. Some second-generation players will morph into first-generation players as their investment into and understanding of videogames increases. I also anticipate a third-generation wave of players who have a different set of conceptions about what it means to be a gamer and may approach a game like *World of Warcraft* from a different perspective, leading to a third flavor of gamer disposition. For the moment, the second-generation gamer disposition suggests a way of understanding why different players approach the same game in different ways as well as the fact that the game environment fosters a first-generation gamer disposition.

References

Boellstorff, T. (2008). Coming of age in Second Life: An anthropologist explores the virtually human. Princeton, NJ: Princeton University Press.

Brown, J. S. & Thomas, D. (2008, Feb. 14). The gamer disposition. Harvard Business Review Blogs. Retrieved from: http://blogs.hbr.org/cs/2008/02/the_gamer_disposition.html

Castronova, E. (2005). Synthetic worlds: The business and culture of online games. Chicago, IL: University of Chicago Press.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. New York: Palgrave Macmillan.

Juul, J. (2010). A casual revolution: Reinventing video games and their players. Cambridge, MA: The MIT Press.

Kelly, S. (2005, December). Third-person perceptions of addiction in video game players. Presented at USC School for Communication Conference on Statistical Methodology, Los Angeles, CA.

Kelly, S. (2007a, May). A how-not-to manual: Reading gamer-produced artifacts as proscriptive codes of conduct. Presented at Games for Learning, Development & Change, Los Angeles, CA.

Kelly, S. (2007b, July). Importance of humor in gamer culture. Presented at Games, Learning & Society, Madison, WI.

Kelly, S. (2008, July). Women and Passing in online games. Presented at Games, Learning & Society, Madison, WI.

McGonigal, J. (2011). Reality is broken: Why games make us better and how they can change the world. New York: The Penguin Press.

Nardi, B.A. (2010). My life as a night elf priest: An anthropological account of World of Warcraft. Ann Arbor, MI: University of Michigan Press.

Pearce, C. (2009). Communities of play: emergent culture in multiplayer games and virtual worlds. Cambridge, MA: The MIT Press.

Rheingold, H. (2000). The virtual community: Homesteading on the electronic frontier (Revised ed.). Cambridge, MA: The MIT Press.

Taylor, T. L. (2006). Play between worlds: Exploring online game culture. Cambridge, MA: The MIT Press.

Thomas, D. & Brown, J. S. (2007). The play of imagination: Extending the literary mind. *Games and Culture*, 2(2): 149-172.

Thomas, D. & Brown, J. S. (2011). A new culture of learning: Cultivating the imagination for a world of constant change. Lexington, KY: CreateSpace.

Turkle, S. (1995). Life on the screen: Identity in the age of the internet. New York: Simon & Schuster Paperbacks. *World of Warcraft* [Computer Software]. Irvine, CA: Blizzard Entertainment.

Writing the Games-Based Dissertation

Shawna Kelly, Interaction and Experience Research Lab, Intel Corporation, 2111 NE 25th Ave, JF2-60, Hillsboro, OR 97124, Email: shawna.kelly@usc.edu
Moses Wolfenstein, Academic ADL Co-Lab, University of Wisconsin-Extension, 5602 Research Park Boulevard, Suite 300, Madison, WI 53719, Email: moses.wolfenstein@gmail.com
Mark Chen, College of Education, University of Washington, 1100 NE 45th St, Suite 200, Seattle, WA 98105, Email: markchen@uw.edu
Shira Chess, Dept. of Mass Communication, Miami University of Ohio, 19 N Poplar St, Oxford, OH 45056, Email: shira.chess@gmail.com
Cynthia D'Angelo, Wisconsin Center for Education Research, University of Wisconsin-Madison, 1025 W. Johnson St., Suite 499, Madison, WI 53706, Email: cmdangelo@wisc.edu
Todd Harper, Singapore-MIT GAMBIT Game Lab, Massachusetts Institute of Technology, 77 Massachusetts Ave NE25-379, Cambridge, MA 02139, Email: tlharper@mit.edu

Abstract

As games studies efforts continue to proliferate across the academy in a wide range of disciplines, there has been a substantial increase in the number of doctoral students writing games-based dissertations. A "fireside chat" panel discussion held at GLS 7.0 brought together a handful of recently minted PhDs from different programs to talk about the conditions that affect the process of writing a games-based dissertation in various American institutional contexts. From this discussion, the authors have compiled advice concerning four challenges that game studies scholars face: when to stop reading/writing/playing, choosing which game(s) to research, collecting data in/through games, and possessing expertise in the subject matter beyond that of the committee members.

Introduction

When a student enters graduate school, he/she has many thesis- and dissertation-writing resources available, including books, help groups, and time-management tools, not to mention many sites on the Internet. This paper is meant to supplement those resources and is aimed specifically at students (possibly you!) who are doing their graduate work about, around, or through digital games. Based on a lively "fireside chat" discussion at the seventh annual Games+Learning+Society Conference, we have compiled insights from our own experiences that focus on four specific challenges game studies scholars face:

- When to stop reading/writing/playing
- Choosing which game(s) to research
- Collecting data in/through games
- Being the subject-matter expert

When to Stop Reading/Writing/Playing

Reading

When you are doing your literature review, start with the foundational writings from your particular field and think about how games challenge or express those theories in new and interesting ways. Then explore games studies books, articles, and conference proceedings to look for similar discoveries that could help push your thinking forward. Before you decide that no one has looked at games the way you are, try searching for games-related research in other disciplines—the benefit of an interdisciplinary area of research is that you can bounce your ideas off of research from many different perspectives. Ultimately there will likely be more material to read than you will have time for. Before committing to an in-depth analysis of any literature, make sure that it speaks directly to your research question. Just because a piece touches on both your discipline and games does not necessarily mean it will be essential in supporting your inquiry.

Writing

Your dissertation will not be the best or the last thing that you ever write. As with all dissertations, the goal is not to write the most brilliant prose of your life, but to write it in a way that is satisfactory to committee members, departments, mentors, and other scholars in your field. No one expects your dissertation to be perfect, but they do expect it to be completed within a reasonable amount of time.

It may be helpful to think of your scholarly work as contributing to an existing conversation. As such, you ought to focus on the arguments of that conversation you want to engage with—this helps you limit what and how much you read and what you write. Again, the multidisciplinary nature of games research can play in your favor, as you may be bringing new ideas to the conversation from seemingly disparate sources.

Playing

It pays to be familiar with different types of games from different genres. For instance, even if you have no personal interest in playing *Hello Kitty Online*, if you're looking at virtual worlds it may be important to understand how it relates to other games in terms of:

- Genre – massively multiplayer online game accessed through a web browser on the Internet
- Player base – aimed at tween and younger females
- Impact – has an active community of players including videos, blogs, wikis, etc.
- Pop culture – made fun of (indirectly) on a *South Park* episode, resulting in a "Hello Kitty Island Adventure" game mod for *World of Warcraft*; also connected to a *Doom 3* game mod that makes the flashlight shine a picture of Hello Kitty on the horrific monsters you battle.

Take every chance you have to learn more about games, be it design or culture, but at the same time, remember that your most important goal is to finish your thesis/dissertation. There will be times when you have to stop playing, stop exploring new ideas, and sit down to write about the ones you already have in your head.

Choosing Which Game(s) to Research

If you are engaged in design-based research or conducting evaluative work around a game designed within your institution, then the question of what game or games to focus on in your dissertation is likely moot. However, if you're doing work studying commercial games, then game selection becomes a necessary aspect of determining your topic of study.

When deciding which games to write about, one beneficial approach is to look at interesting games that others have not considered critically within your discipline. While certain popular games might be a lot of fun to write about, the dissertation and journal essay market is often more saturated with work around those titles, particularly in fields like media studies and communication where games research is better established. On the other hand, if you are working in a field that is less saturated with games research, it might be beneficial to form your study around a well-established game that has been looked at through other disciplinary lenses. Either way, it is often useful to play games that might be slightly off your (and others') radar but that might have some interesting implications for your research. Whether you ultimately choose to focus on a widely known game or a lesser-known title, exploring games at the margin will deepen your understanding of the medium.

Do not worry about perceptions that you "cherry picked" your game(s). It is your dissertation and it is ultimately your choice which games you want to write about and which ones you feel are particularly important. Be able to back up your choices with explanations, but do not feel you need to cover every game in a specific genre. (In fact, this would likely make for a worse and far more tedious dissertation.)

Remember that the beauty of "games" being such a broad category is that each game can offer different opportunities and insights. Games help you explore the elements of social science (or the humanities) that are of interest to your department. For example, a massively multiplayer online game offers opportunities to discuss communication, culture development, and group organization, while a designed game or simulation offers measurable interactions and the ability to tailor the playful environment to a specific topic or area of study. The game or games you select for research should ultimately offer an appropriate focus for your research question, afford access to types of data that complement your methodological choices, and have the potential to bring novel insights to non-games scholars in your field. Finally, you should know there is a high probability that by the time you are done with your dissertation, you will be completely burnt out on the title(s) you have chosen to study.

Collecting Data In and Through Games

Even though your research involves a digital space, dealing with data from games can be challenging. Whether your research involves players, player culture, game content, or game design, you and your committee need to have a clear understanding of how you will select, record, and analyze data. Test and re-test your data-collection methods. Be prepared to hit technical limitations like file size limits on collecting in-game chat, file names that automatically overwrite themselves, slow or non-responsive networks (especially if you are collecting data in a school), difficulties accessing data after it has been collected due to how it is stored, or the unwillingness of commercial game companies to share their data. It is usually a good idea to practice or run through the entire data collection process, preferably at the same scale and on the same networks and computers as your "real" data will come from. This will allow you to see problems that may not have been visible to you before.

In addition, when your research topic includes videogames, be prepared to struggle with technology. Ideally, everything works the way you expect all of the time and "reading" a game is as easy as reading a book. In reality, you will run into technical difficulties: design limitations, connectivity issues, headsets or mice or controllers that do not work the way they are supposed to. Remember to think things through in advance if possible and to be flexible when things do not turn out the way you anticipated they would. The technical problems may not be within the scope of your project, but they may still offer opportunities to collect data about people's expectations and interactions with technology.

Another issue is Institutional Review Board (IRB) and Human Subjects concerns designed to protect participants' privacy. While the specific constraints around your research will vary, there seem to be certain persistent issues for games researchers. For instance, when studying gaming culture *in situ*, researchers need to identify themselves as a researcher, either through their name or by announcing to the group who they are and why they are participating. (For comprehensive guidelines on ethical issues surrounding research in online venues, see http://aoir.org/documents/ethics-guide/.) On the institutional side some review boards might not have a great deal of familiarity with videogames. To prepare for this contingency, be ready to describe your research activities at depth to assure your IRB that you are taking human subjects protection seriously. Many IRBs are willing to work with researchers who are collecting lots of data and can automatically make it anonymous. But of course, you may not want anonymous data if you need to match player data from the game to an out-of-game measure. These sorts of issues are easier to sort out and plan for earlier in the dissertation process rather than later and, of course, through discussions with your adviser, your committee, and your institution's review board.

Being the Subject-Matter Expert

Remember that you are working toward a degree in your specific department and the dissertation is, in part, meant to show off your expertise in the methods and canons of your field. Games are simply the conduit through which you apply, explore, and make sense of key discussions going on in your field.

While many students worry about not having advisers or other departmental "expertise" on videogames, this is not necessarily a bad thing. What is most important is to find an adviser and a committee that is *open* to researching videogames. Having advisers and committee members that are not "videogame" people gives you the possibility of adding a fantastic degree of depth to your topic. All of these people have their own area of research and interests, and their non-videogame knowledge can add a great deal of richness to your subject matter. Do not limit yourself to just researching games and gaming culture in disciplinary ways that have been done before—find new approaches and ideas by picking the brains of your non-gamer committee. At the same time, having non-gamers on your committee will force you to *explain* gaming concepts which might (now) seem obvious or commonplace to you. This will help you clarify ideas in your head and make your work accessible to a larger audience in the long run. Ultimately, no matter what your dissertation is about, you will emerge with more expertise on that specific topic than any member of your committee.

There is a corollary problem with having a committee who is unfamiliar with the game(s) or cultures you are writing about, however. Sometimes you need to talk to someone who *is* an expert. Luckily, games researchers tend to also be technically inclined, easily reachable through the Internet, and, as it turns out, almost all of us are friendly! Before contacting someone from a different institution, do a bit of homework: read their stuff, and, when you contact them, introduce your topic in a way that relates to their work and ask specific questions that you think they are particularly capable of answering or thinking about.

Notes on Writing and Conclusion

Many people say to write every day; however, you need to be flexible and adaptive about how and when this happens. Also be flexible about what constitutes "writing" since writing a dissertation can involve quite a bit of looking things up, citations, formatting in APA style, etc. It can help to iterate on an outline a few times, and get feedback on it before diving into serious composition. A good outline can serve as a focus for brainstorming what content needs to go into which parts. If you have a sense of the content but find yourself struggling with sequence, you may want to try starting with a list of content, and then sort various elements into categories that can eventually become an outline. For something as huge as a dissertation, it helps to get your ideas down and organize them before just unleashing your fountain of text or, even worse, staring at the blank page not knowing where to start.

If we have any one piece of advice, it is to have others read your drafts. Enlist volunteers from all over—not just your home discipline and not just academics. Gamers themselves are a great resource for making sure that you have captured the essence of the game in your discussion. Alternately, non-gamer readers can help identify concepts that just did not come across clearly.

Ultimately, writing a thesis/dissertation is difficult and time-consuming regardless of your topic. Luckily, studying games makes your data collection a little more enjoyable, your subjects a little more eager, and the entire process a little more fun. Plus, when people ask what your dissertation was about, you can say, "I studied videogames," and watch people look at you in puzzlement. It can be a great icebreaker for starting conversations, almost as good as, "Trust me, I'm a doctor."

Space Vector: A Videogame to Teach Introductory Physics

Eric Keylor, Arizona State University and Carnegie Mellon University (Visiting), Entertainment Technology Center, 700 Technology Drive, Pittsburgh, PA, 15219, Email: Eric.Keylor@asu.edu
Shauna Sweet, University of Maryland – College Park, College of Education, University of Maryland, 1230A Benjamin Building, College Park, MD 20742, Email: Ssweet@umd.edu

Abstract

Space Vector is a two-dimensional, 80's-style, science fiction themed casual game designed to introduce preliminary concepts of Newtonian mechanics and eliminate some common misconceptions about motion. The game focuses on horizontal and vertical vectors, uniform motion, and acceleration. Players fly over extraterrestrial planets and drop objects on targets. Missions may contain incorrect physics that the player must identify at the end of the mission. Also, players have to make predictions about how objects will fall from their ships given a horizontal speed and gravitational constant. Players then see whether their predictions are correct. An initial pilot study showed improvement in understanding that weight does not affect acceleration and in understanding the trajectory of falling objects. Improvement needs to be made to help students understand the independence of horizontal and vertical motion as well as acceleration. This paper describes the first iteration of *Space Vector* and our vision for future work.

Introduction

Physics instruction is particularly challenging because nearly everyone develops misconceptions about motion through lived experience (Hestenes, 2006), so physics instructors have the dual challenge of not only teaching physics concepts but also dislodging firmly held misconceptions that have developed over a lifetime of daily observations. Students commonly believe that heavier objects fall faster than lighter objects and that objects that are thrown into the air are pushed upward by some "impetus" force (Halloun & Hestenes, 1985; Hestenes, 2006). These beliefs as well as many other misconceptions are contrary to Newton's laws of motion. Overcoming these misconceptions is necessary for developing an understanding of Newtonian mechanics.

Videogames show promise as instructional tools for teaching introductory physics concepts, as they present instructors with an opportunity to systematically address both concepts and misconceptions. Videogames can simulate incorrect physics, so they are able to make manifest students' ideas about motion, force, and mechanics and challenge those ideas when they are incorrect.

Space Vector is a videogame under development to teach introductory physics concepts to beginning physics students. Through careful choices of game mechanics, content, and structure, the game addresses both concepts and commonly held misconceptions about Newtonian mechanics and focuses on the ideas needed to understand freefall, such as vectors, velocity, uniform motion, and acceleration. In this paper, we describe the first prototype of *Space Vector* (*Space Vector 1.0*) and discuss the ongoing development of *Space Vector 2.0*. We also discuss our vision for integrating educational assessment with game design and using the evaluation of student performance to inform future versions of *Space Vector*. Given that videogames can simulate both correct and incorrect physics, can be played anytime, and can collect fine-grained data of student performance, we believe that videogames can have a powerful role in the future of introductory physics education.

Space Vector 1.0

Space Vector is a two-dimensional, 1980's-style arcade game that belongs to the side-scroller genre (the game elements scroll horizontally across the screen over time) of arcade games. It has a science fiction theme, in which the player acts as a pilot who chooses either to drop supplies to help explorers or to drop bombs on enemy robots. The science fiction theme both justifies the game mechanic (the primary action of the game, which is dropping objects from a spaceship) and provides a context for changing different parameters such as gravitational constants. Players score points when dropped objects hit their targets. After the player completes all the instructional units and achieves a certain point level, the player wins the game.

In *Space Vector 1.0*, the player works through a series of tutorial levels in which s/he learns to control the spaceship and practices dropping objects (see Figure 1). Eventually, more game elements are included such as ground missiles to add difficulty.

***Figure 1*. Tutorial mission where the player is dropping a supply.**

After the tutorial missions are completed to ensure that the player has mastered the game mechanic, instructional units are introduced. Each unit addresses a separate concept in Newtonian mechanics, and these units are presented in the following order: vectors and horizontal velocity, uniform motion, acceleration, and displacement. After each unit of instruction, the player is asked to make accurate predictions about the behavior of supplies or bombs that are being dropped. As shown in Figure 2, the player is presented with a grid with a ship and supplies or bombs, a horizontal velocity, and a gravitational constant. The player has to predict where the ship and object will be after 1, 2, and 3 seconds.

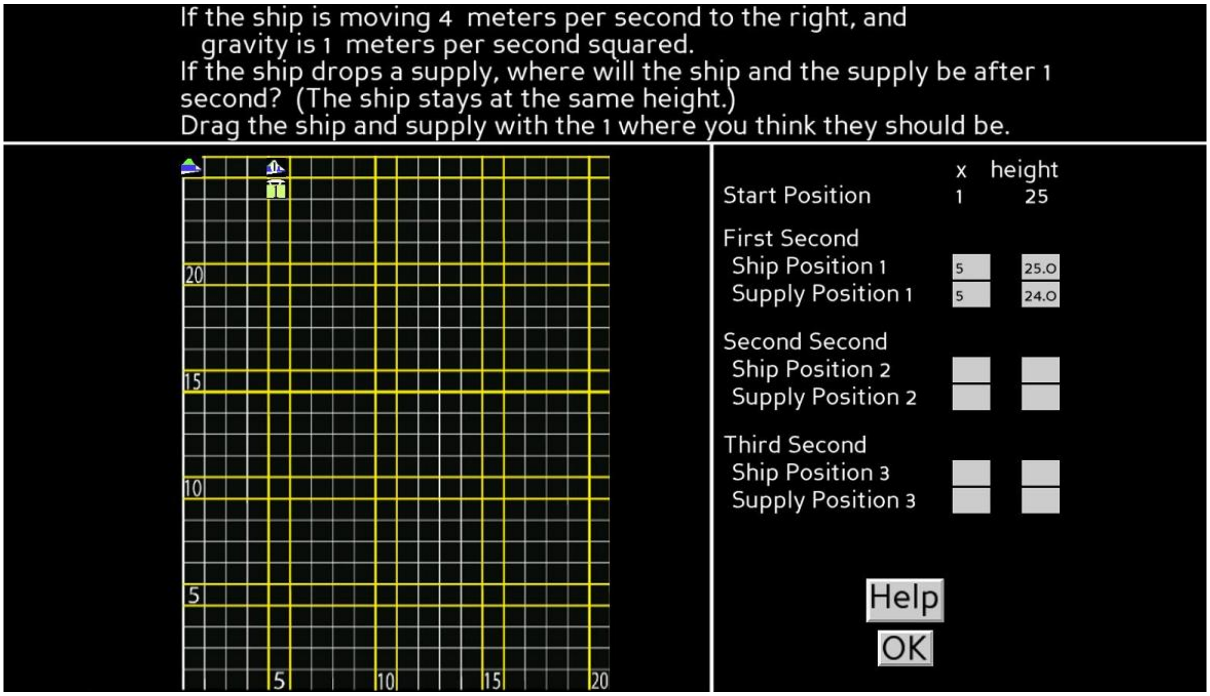


***Figure* 2. An example of the prediction grid.**

Once the predictions are made, the player becomes a copilot who no longer steers the ship and, instead, watches as the game engine's artificial intelligence steers the ship and drops the bombs or supplies according to the player's predictions on which the success of the mission depends. The player watches as targets are hit or missed. If the predictions are not correct, the player is asked to revise the predictions using what was learned as the copilot and also using hints that may be given if the player has difficulty making an accurate prediction.

Following a prediction mission, when the player embarks on a new mission as the pilot, the physics during the mission may be incorrect. For example, the supplies or the bombs can have two different masses (10 kg or 100 kg), and the heavier objects fall noticeably faster than the lighter objects. After the mission, the player is asked to identify what, if anything, was amiss (see Figure 3). If something was incorrect and the player identifies it correctly, the player receives bonus points.

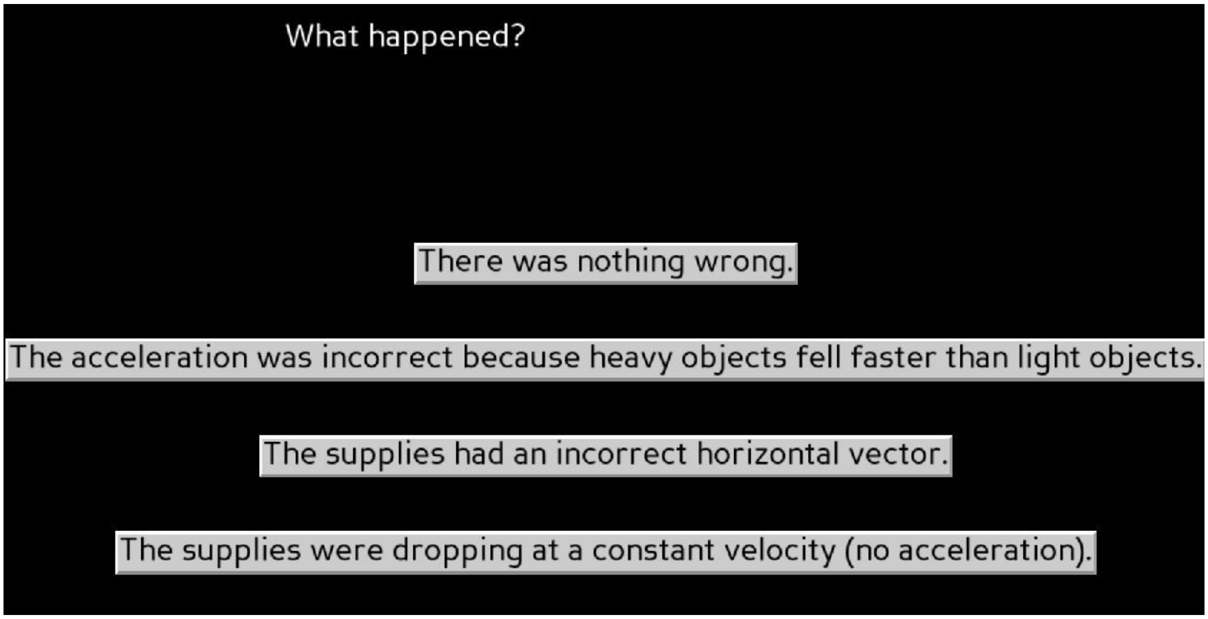


***Figure 3*. The player is asked to identify if the physics of a mission was incorrect.**

Space Vector 1.0 Pilot Study

After the first version of the game, *Space Vector 1.0*, was completed, a pilot study was conducted to examine students' understanding of Newtonian mechanics before and after game play. Students were recruited from an undergraduate educational technology class (a 300 level course) at Arizona State University, and students received course credit for participating in the study. The pilot study was conducted over two weeks, during which students came to a computer lab set up for the videogame and completed a background survey, a pre-test, a session of approximately ninety minutes of game play, a post-test, and an attitude survey in a single session lasting approximately two hours in total. Students arrived at the computer lab in groups of four to six though all work was completed independently.

The study sample was comprised of sixty-five students. Nearly twice as many women participated than men (41 women, 24 men), and the mean and median age among participants was 20 years old. Students were not asked their grade level to ensure confidentiality. Approximately two-fifths (42%) of the students who participated in the study had no prior physics instruction and another quarter of the sample (26%) had last taken a physics course in high school. Nearly half (46%) of those who participated in the pilot reported playing videogames "never or very rarely"; among those who reported ever playing videogames, "Sports and Racing" and "First Person Shooter" games were the two most popular genres with 77% and 39% respectively.

The pilot study utilized a single group pretest-posttest design. The students were asked to complete a pre-test to ascertain their level of understanding of physics concepts, they played the videogame, and then they completed the same test of physics concepts. The pre- and posttest was a subset of the Force Concept Inventory (FCI), a test developed to test students' understanding of force after a semester of physics instruction (Hestenes, Wells, & Swackhamer, 1992). It is a multiple-choice test with five choices per item. The FCI is especially useful since it can be used to identify specific misconceptions that students have about force. Fifteen questions (half the original test) were used. The questions selected covered the same concepts as those addressed in the game, specifically the relationship between weight and acceleration, trajectories of items in freefall, the application of forces, and distinguishing position, velocity, and acceleration.

With a single-group design, there is not sufficient evidence to support claims about the effectiveness of *Space Vector* as an instructional tool, but, as a formative assessment of the game's design, we feel the results of the pilot study were sufficient to identify both strengths and weaknesses of the first version of the game. A comparison of students' pre- and posttest scores suggests that students are learning something about physics from playing the game, but perhaps they are not making as many gains in all of the conceptual areas covered by the *Space Vector* instructional units. The mean pretest score was 4.14 ($M = 4.14$, $SD = 2.66$), and the mean posttest score was 5.15 ($M = 5.15$, $SD = 3.04$). Of particular interest was students' improved performance on specific items that deal with concepts addressed during game play.

Table 1: Test items with the number of correct pretest and posttest responses.

Item	FCI Item Number	Pretest Correct (%)	Posttest Correct (%)	Change (%)
1	1	26 (40)	47 (72.3)	21 (32.3)
2	2	19 (29.2)	32 (49.2)	13 (20)
3	3	17 (26.2)	24 (36.9)	7 (10.8)
4	8	28 (43.1)	27 (41.5)	-1 (-1.5)
5	9	17 (26.2)	16 (24.6)	-1 (-1.5)
6	12	25 (38.5)	31 (47.7)	6 (9.2)
7	13	5 (7.7)	4 (6.2)	-1 (-1.5)
8	14	15 (23.1)	19 (29.2)	4 (6.2)
9	19	20 (30.8)	21 (32.3)	1 (1.5)
10	20	8 (12.3)	10 (15.4)	2 (3.1)
11	21	18 (27.7)	15 (23.1)	-3 (-4.6)
12	22	25 (38.5)	28 (43.1)	3 (4.6)
13	23	10 (15.4)	18 (27.7)	8 (12.3)
14	24	24 (36.9)	29 (44.6)	5 (7.7)
15	30	12 (18.5)	14 (21.5)	2 (3.1)

As shown in Table 1, students made the greatest improvement on items 1-3, gains that are consistent with the design of the game as the misconception that weight affects acceleration was a focus during game play. Students' performance on items 6 and 8 concerning the trajectories of objects during freefall did not improve as much as expected, suggesting that more support is needed for students to understand the types of trajectories that are made during freefall. The verbal instruction given in the units, the prediction grid, and observation during missions might not be sufficient for students to accurately perceive a parabolic trajectory. Likewise, for improvement on other items, game content needs to be modified.

Space Vector 2.0

A second iteration of *Space Vector* is now under development to address some of the instructional weaknesses of *Space Vector 1.0* that were suggested by the pilot study results. As noted above, students are not coming away from the game with a clear sense of an object's trajectory during freefall. There are several potential explanations for why students' understanding didn't increase as expected, including the sequencing and depth of content coverage as well as how content is being presented to players. Following the initial pilot, we identified several modifications that would make the game and the material more engaging to players, in turn increasing the game's effectiveness. In the first version, all the instruction was presented as written text, but, in *Space Vector 2.0*, interactive examples and interactive annotations will be added. Players can work through examples and generate examples, as well as practice the concepts before making predictions. Another modification to the game will be to use explicit visualizations to further illustrate key concepts. For example, if incorrect physics is simulated during a mission, players will be shown an example trajectory and allowed to change their frame of reference, i.e., they can watch an object fall from the spaceship from the perspective of someone on the ground or from the perspective of a ship flying alongside the spaceship. This will allow players of *Space Vector 2.0* to watch trajectories without having to infer them purely from observation and without being distracted by game elements as they may have been in the first version.

Integrating Educational Assessment and Game Design

The process of developing a second version of the game presents us with another opportunity to think not only about game design features but also to think critically about how those game design features facilitate learning. In general, when developing an educational game, decisions about the inclusion of content, the sequencing of levels, and the combination of types of tasks necessarily reflects our understanding of (or at least our expectations about) how players learn. In developing Space Vector 2.0, we are working to ensure that all of these game features are consistent with how students learn foundational physics concepts.

In the case of introductory physics, it has been argued (e.g. Hestenes, Wells, & Swackhamer, 1992; 1995) that our everyday understanding of force is actually dominated by commonly held misconceptions. Developing a Newtonian understanding of force requires overcoming six families of misconceptions and mastering six discrete families of distinct—though interrelated—families of concepts. As shown in Figures 4 and 5 below, each of these concepts might be mastered in a particular order. If we are thinking about learning physics as achieving conceptual mastery, this might lead us to implement a particular sequencing of missions versus an underlying model that describes overcoming misconceptions.

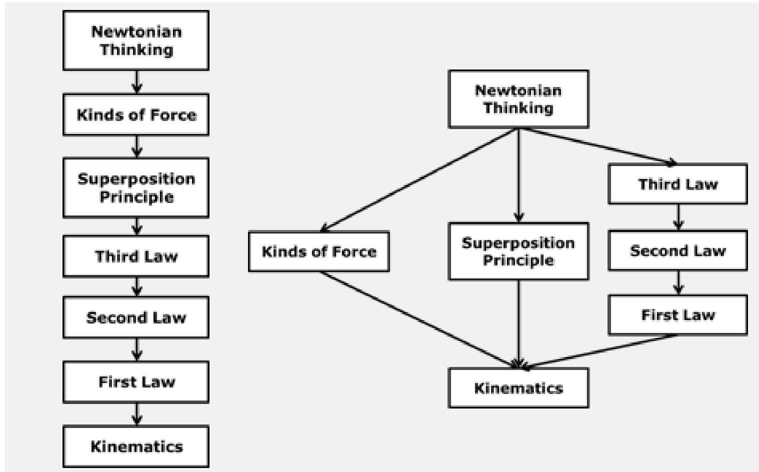


Figure 4. **Candidate student models of Newtonian thinking.**

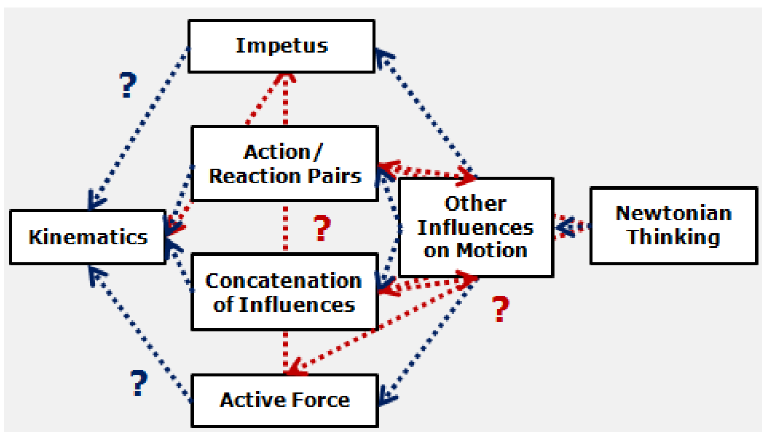


Figure 5. **Alternative student models of Newtonian thinking.**

For each of these concepts, or families of concepts that comprise a Newtonian understanding of force, we can imagine that students could be total novices, they could already be Newtonian thinkers, or they might have achieved only partial mastery. It is not uncommon to see learners achieving only partial mastery of physics concepts: there are many students who achieve a purely mathematical understanding but have difficulty linking those mathematical formulae to those concepts as seen or experienced "in the real world" (Hestenes, 2006). There are other learners who may learn by doing but still are not able to grasp the mathematical underpinnings, even if they "know it when they see it." It is these students who are working to achieve mastery but need additional instructional support that are of particular interest when modifying Space Vector 2.0 to be a more effective mode of physics instruction.

Mastering Newtonian mechanics requires mastering both the underlying concepts and the mathematics behind Newtonian mechanics and making appropriate linkages between them. Gaming environments may engender a conceptual understanding but provide little guidance to connect students' understanding gained through action to the underlying mathematical principles. Our observation of students' persistent difficulty understanding object trajectories in freefall even after playing the first version of Space Vector is consistent with this. In the development of the second version of the game, the additional visualizations and annotations provide additional support for making linkages between the mathematical, albeit at a very rudimentary level, and conceptual dimensions of Newtonian thinking.

In *Space Vector 2.0*, the content, structure, and features embedded within each mission are designed to build Newtonian physics concepts in a systematic way that can help eliminate specific misconceptions. Success requires that players demonstrate a conceptual and a preliminary mathematical understanding. Self-assessment and practice missions establish a baseline that can help to identify particular misconceptions. Players' performance in missions facilitates conceptual mastery, and predictive missions then require players to demonstrate the necessary mathematical as well as conceptual understanding. For those students who are successful in one but not both venues, interactive examples and game annotations are designed to make explicit the linkage between the mathematics and the concepts as they are captured through the action of the game.

Making explicit the theory of learning underlying the game's construction also aids in building game features that will facilitate (or hinder) the assessment of learning as well as supporting the learning itself, because some of what players do may reflect how they play games rather than how they learn, and it will become necessary to distinguish between the two. For example, as demonstrated in the pilot, although students may be computer literate they are not necessarily familiar with this genre of game, and it is important to ensure that students' performance in the game is a reflection of their knowledge and not their gaming ability or lack thereof. In Space Vector 2.0, one-dimensional and two-dimensional practice missions ensure that students are familiar with game mechanics independent of their mastery of the instructional material. In a similar vein, game literacy may impact how people formulate strategies of play, which could then impact learning. Even for those familiar with similar types of games, different styles of play emerge. For example, some players fly as slowly as possible to hit everything they possibly can; other players proceed as quickly as possible through each mission. The identification of data as evidence of learning must recognize these different strategies.

References

Halloun, I., & Hestenes, D. (1985). Common Sense Concepts about Motion. *American Journal of Physics*. 53, 1056-1065.

Hestenes, D. (2006). Notes for a Modeling Theory of Science, Cognition and Instruction. In E. van den Berg, A. L. Ellermeijer, & O. Slooten (Eds.), *Proceedings GIREP conference 2006: Modeling in Physics and Physics Education* (pp. 34–65). Amsterdam: University of Amsterdam.

Hestenes, D., Wells, M., & Swackhamer, G. (1992), Force Concept Inventory. *The Physics Teacher*. 30, 141-158.

Acknowledgments

We would like to thank Dr. James Paul Gee and the MacArthur Foundation for their generous support.

Promoting Human Rights while Polarizing Political Perceptions with a Serious Game

Elias Klemperer, Richard LeDonne, Erik Nilsen, Lewis & Clark College, Portland
Email: elias.klemperer@gmail.com, richienwl@gmail.com, nilsen@lclark.edu

Abstract

This pilot study explores the impact of an online serious game named Safe Passage. The game, created by Gisha (2010) aims to raise awareness for Palestinian's right to travel within Israel. Twenty-seven participants were assigned to one of three conditions: 1) play *Safe Passage* and then read information relevant to the issue, 2) read information and then play the game, or 3) only read information along with the text presented in the game. Pre and Posttest measures of general interest and political attitudes were used along with participants' willingness to donate money to Gisha. Playing the game resulted in 1) an increase in interest with the subject matter and 2) a blanket shift in political attitudes toward a 'pro-Palestine' view. Finally, trends indicate that the order of game play matters.

Introduction

Garnering support for and encouraging engagement in political, social and humanitarian issues has long been the struggle for advocacy groups and educators alike. In the distracted and media-saturated society in which we live, how can we get individuals to focus on issues that matter? In this vein, Gisha (a multicultural Israeli human-rights organization) has created an online serious game, Safe Passage, intended to attract foreign attention, gain support and promote specific humanitarian causes (Gisha, 2010). Serious gaming is a growing field that attempts to fuse the attractive properties of videogames, that have captured the undivided attention of millions of people, with a particular topic or purpose that goes beyond pure entertainment (Susi, Johannesson, & Backlund, 2007). The last decade's advancements in videogame and telecommunication technologies have allowed organizations to produce more advanced simulations of real-world activity with the capacity for immediate and widespread dissemination. However, can a video game actually educate or motivate? Could it make a person change their mind? A growing body of evidence demonstrates the learning potential of serious games (Gee, 2004; Gee, 2007; Schank, 2002; Prensky, 2001), which has, in part, fueled the rapid market growth in the video game industry (Breuer & Bente, 2010). However, more research is needed to determine if and how serious videogames influence the player. Which of the numerous and complex properties inherent in these games change attitudes or motivate learning, and under what conditions?

In previous studies exploring games' effects on the Israeli-Palestinian situation, Nilsen (2008; 2011) reported significant decreases in bias and increase in hopefulness in participants who played the serious game PeaceMaker. In PeaceMaker, players try to achieve a two state solution by making strategic decisions from the perspective of the Palestinian President and the Israeli Prime Minister. PeaceMaker's positive effects on attitude have been related (Nilsen, LeDonne, Klemperer, & Olund, 2011) to Gordon Allport's contact theory (1954). Contact theory explains that direct contact between opposing groups can decrease intergroup hostility and increase positive intergroup attitudes. Furthermore, recent research concerning contact theory has shown that observing or imagining positive group interaction can reduce prejudice (Crisp & Turner, 2009; Wright, Aron, Mclaughlin-Volpe, & Ropp, 1997). Finally, a meta-analysis of 515 contact theory studies showed a highly significant negative relationship between contact and prejudice (Pettigrew & Tropp, 2006). \

In the current study, we expand on the research concerning PeaceMaker and other serious games (Gee, 2007; Nilsen, 2008; Nilsen et al., 2011; Prensky, 2001; Schank, 2002) by exploring Safe Passage, an online serious game related to the Israeli-Palestinian conflict. Specifically, we control for, and measure, the effects of participants' level of *interaction* with the information. We hypothesize that participants who interact with the information by playing the serious game will display significantly greater changes in interest and attitudes than participants who are limited to a textual version of the same information. The nature of the interaction in Safe Passage is from a single perspective (Palestinian) rather than both perspectives used in Peacemaker. Therefore, we believe that the game play will increase political bias instead of decreasing it.

Method

Participants

The study consisted of 27 undergraduate students from Lewis & Clark College during the fall of 2010. Participants were acquired through an upper division psychology lab course.

Materials

Safe Passage is a serious game promoted by Gisha in order to gain awareness and support for the human right to travel in the Middle East. Specifically, Gisha aims to "protect the freedom of movement of Palestinians, especially Gaza residents (Gisha, 2010)." Gisha produced the serious game in order to integrate legal documents with Gazans' personal accounts of their attempts to travel within Israel.

At the beginning of Safe Passage, the players are prompted to choose a character to represent their attempts to travel. For our research, all participants played the game as a family attempting to travel from Gaza to the West Bank. The game consists of animated Palestinian characters and box-like Israeli officials. An Israeli official splits up the Palestinian family between Gaza and the West Bank and the player spends the rest of the game trying to reunite the family members. Though there are only two true decisions in the game, players are prompted to interact with the information (by clicking on icons) at seven different points. Six of these interactions result in pop-ups presenting paraphrased versions of Israeli documents with links to the full legal documentation.

The game consistently results in a divided family in which the father is in Gaza and the child and mother are in the West Bank. Thus, the player loses regardless of the decisions made. The serious game concludes with the explanation that this separation is a common occurrence for Palestinians in Israel and provides the player with the option to take action by donating to Gisha (the creators of Safe Passage.)

Dependent Variables

A well-established scale developed by the political scientist William Stover (2005; 2006) was used to assess changes in the perception of political behavior of Israel and Palestine. Furthermore, Stover goes on to explain the importance of these measures in understanding the effectiveness of simulating political dynamics. The scale informs participants to "consider your perceptions about the political activities of Israel/Palestine in relationship to the Palestinian-Israeli conflict. As you think about the political activities of Israel/Palestine in relationship to the Palestinian-Israeli conflict, check the response that most closely corresponds to your perception of their political behavior in international relations." Participants are then instructed to rate each country on five different 5-point Likert scales with each question anchored by negative and positive adjective pairs. The adjective pairs used are 1) Friendly/Hostile, 2) Defensive/Aggressive, 3) Peace Loving/Warlike, 4) Satisfied/Expansionist, and 5) Trustworthy/Deceitful.

A behavioral measure lead participants to believe that they were, if they chose, able to directly and anonymously donate any portion of their $10 personal compensation to Gisha (2010). The lab did not, however, donate any of the compensation for the participants. Instead, at the end of the study participants were given Gisha's donation website in case they wanted to donate independently. The purpose and the details of the behavioral measure were thoroughly explained during the debriefing. Finally, participants were explicitly asked to measure how interested they were in the Israeli/Palestinian conflict.

Procedure

Each participant was assigned to spend one hour in one of three conditions. Nine participants were assigned to the game-first condition, nine were assigned to the game-second condition and nine were assigned to the reading only condition. All participants took a fifteen-minute online survey (SurveyMonkey) the day before their in-lab session. The primary survey included the political scale developed by Stover (2005; 2006) and an explicit question measuring participants' overall interest (described above in *Dependent Variables.*)

Participants in the game-first condition played Safe Passage as the "family" character and then viewed a PowerPoint presentation containing three documents concerning Israeli and international legal framework presented by Gisha (2010). The game-second group read the same documents and then played Safe Passage under the family settings. The reading only group acted as a control by reading Gisha's documents and all of the information presented in the game instead of playing the game itself. Finally, participants in all of the groups took another fifteen-minute survey (SurveyMonkey) that consisted of all of the measures described above in *Dependent Variables.* The session was concluded with a debriefing including an opposing point of view from Israel's government website, an explanation of the measures, and $10 compensation for each participant.

Results

The analyses reported below are based on comparisons between online surveys taken the day before and immediately after participants' in-lab session. The dependent variables examined here include 1) Stover's (2005; 2006) political scale used to measure attitude, 2) an explicit question measuring participants' overall interest in the Israeli/Palestinian conflict, and 3) a behavioral measure concerning participants' willingness to donate to Gisha (2010), the creators of Safe Passage.

We conducted a 2 (Pre/Post test) x 3 (Presentation Condition) mixed model ANOVA in order to assess participants' change in political attitude toward Palestine given Stover's (2005; 2006) measure. For the following analyses we used the average rating from the five adjective pairs. Higher scores indicate a more positive perception on this 5 point scale. The analysis reveals a highly significant main effect for time on all participants' change in attitude toward Palestine $F(1,25) = 16.37$, $p < .001$. Furthermore, descriptive statistics show that, in all conditions, participants rated Palestine more highly after the in-lab session (*M* = 3.31, *SD* = .30) than before they were exposed to the information (*M* = 2.71, *SD* = .54).

There is no significant main effect for presentation condition or interaction. However, post hoc t-tests show that participants who played the game-second (immediately before taking the final survey) had the most significant shift in political attitude towards Palestine $t(8) = 3.04$, $p = .016$. Those who played the game-first had a marginally significant shift $t(8) = 2.02$, $p = .078$. Finally, participants in the reading only condition had the least significant shift in political attitudes toward Palestine $t(8) = -1.97$, $p = .084$ The mean changes in average Stover rating of Palestine for the reading only, game-first, and game-second conditions were 0.24, 0.42, and 0.6 respectively.

We also conducted a 2 x 3 mixed model ANOVA to assess participants' change in political attitude toward Israel. The analysis revealed a highly significant main effect for time on all participants' change in attitude $F(1,25) = 12.71$, $p = .002$. Descriptive statistics show that, in all conditions, participants rated Israel as less favorable after the in-lab session (*M* = 2.67, *SD* = .49) than before they were exposed to the information (*M* = 3.11, *SD* = .39).

There is no significant main effect for presentation group or interaction. However post hoc t-tests reveal that participants who played the game-first displayed a highly significant shift in attitude $t(8) = 3.4$, $p = .009$. Those who played the game-second also had a significant shift in attitude $t(8) = 2.2$, $p = .05$. Participants who only read the information without exposure to the game did not shift in their attitude toward Israel $t(8) = .90$, $p = .39$. The mean changes in average Stover rating of Israel for the reading only, game-first, and game-second conditions were -0.15, -0.47, and -0.44 respectively.

In order to assess participants' interest in the situation, they were explicitly asked how interested they were in the Israeli/Palestinian conflict. A 2 x 3 mixed model ANOVA reveals a significant main effect for time on participants' interest in the situation $F(1,25) = 10.94$, $p = .003$. Furthermore, the analysis reveals a significant interaction effect $F(1,25) = 3.89$, $p = .034$. The largest increase in interest (*M*=1.78) was in the game-second group ($p = .009$), with a slight, but insignificant increase in interest for the game-first (*M*=0.22) and reading only groups (*M*=0.44).

At the end of the study participants were given the opportunity to anonymously donate any amount of their compensation to Gisha (2010). A one way ANOVA revealed no significant effect of $F(1,25) = 0.172$, $p = .84$. This is likely due to high variability with four people in each condition choosing to donate nothing and at least one person in each group choosing to donate the full amount ($10). The trends support our initial hypothesis. Participants who played the game-second had the highest donation amount (*M* = 4.11, *SD* = 4.70). The participants who played the game-first requested to donate the second most (*M* = 3.33, *SD* = 4.09) while participants in the read only condition donated the least (*M* = 3.00, *SD* = 3.50). The trend in our small sample pilot study (displayed in figure 1) is suggestive of a greater impact of the game, especially when it is played immediately before the request for donations.

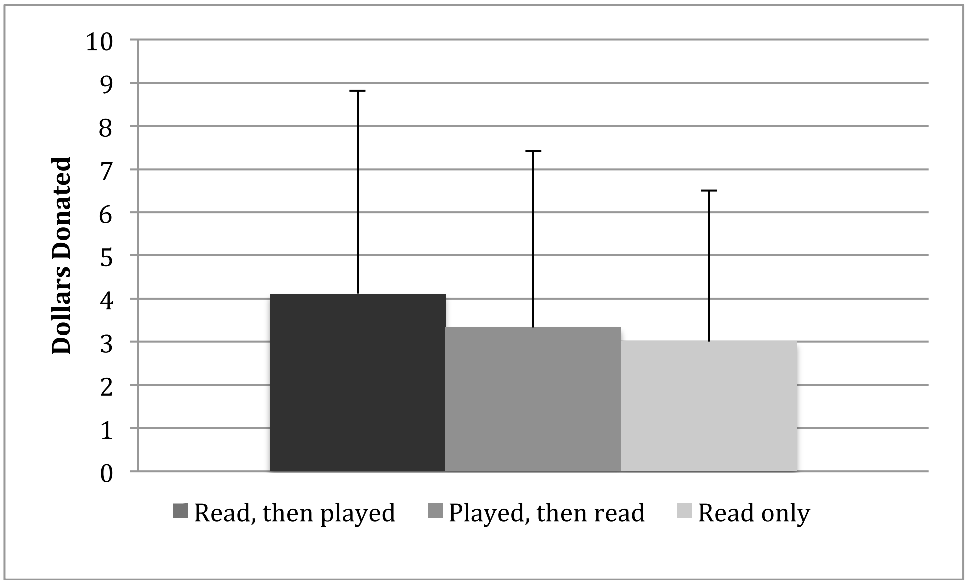


Figure 1. **A behavioral measure in which participants are given the option to donate any portion of their compensation to Gisha (2010), the creators of Safe Passage.**

Discussion

Our results provide clear evidence that reading information combined with playing Safe Passage changes political perceptions of Palestine and Israel and participants' interest more than merely reading about the humanitarian issues presented on the Gisha (2010) website. Playing the game leads to a more positive perception of Palestine, a more negative perception of Israel, and greater interest in learning about the conflict, while reading exactly the same information alone produced insignificant changes in each of these measures. There is also evidence that playing the game after reading the material may have a slightly stronger impact than playing the game-first. This advantage of recency effect of game play is shown most strongly for increasing interest in the conflict and in the increase in positive perception of Palestine. It is also suggested by the highest (though non-significant) level of donations among those who played the game just before a request for donations was made. In contrast, the negative shift in perceptions of Israel was found regardless of when the game was played.

In order to further contextualize these findings, it helps to compare these results to past work with the serious game PeaceMaker (Nilsen, 2008; Nilsen et al., 2011). After playing PeaceMaker participants displayed a significant decrease in bias between Palestine and Israel on Stover's political measure (2005, 2006). That is, in two separate studies (Nilsen, 2008; Nilsen et al., 2011) participants reported decreased positive feelings towards the nation that they initially favored (Palestine or Israel) and increased positive feelings towards the nation they initially opposed. In contrast, the present findings indicate an increase in bias as a result of playing the game Safe Passage in that they displayed consistent increase in positive attitude toward Palestine and decreased positive attitude toward Israel. This trend is most dramatic in participants who played the game (as opposed to those who read the equivalent text.) Consequentially, we propose that interaction with the serious game Safe Passage acts as a catalyst to increase political bias in the Israel/Palestine conflict. This effect can be seen in the widening attitudinal gap for the two game playing conditions displayed in figure 2 below.

Regardless of political interpretations, these findings have important implications for persuasive use of games. Serious games have been shown to effectively utilize the underlying mechanism in contact theory (Allport, 1954; Crisp & Turner, 2009; Nilsen, 2008; Nilsen et al., 2011; Wright et al., 1997). However, Safe Passage's effective increase in participants' bias demonstrates serious games' potential negative effects from a single-perspective simulated contact with another culture. Though the information is factual and crucial to humanitarian aid, Safe Passage serves as a medium through which participants witness a one-sided and imbalanced relationship between two cultures. The result is consistent with contact theory's premise (Allport, 1954; Crisp & Turner, 2009; Wright et al., 1997) in that attitudes are shifted in concordance with the cultural contact (the serious game.)

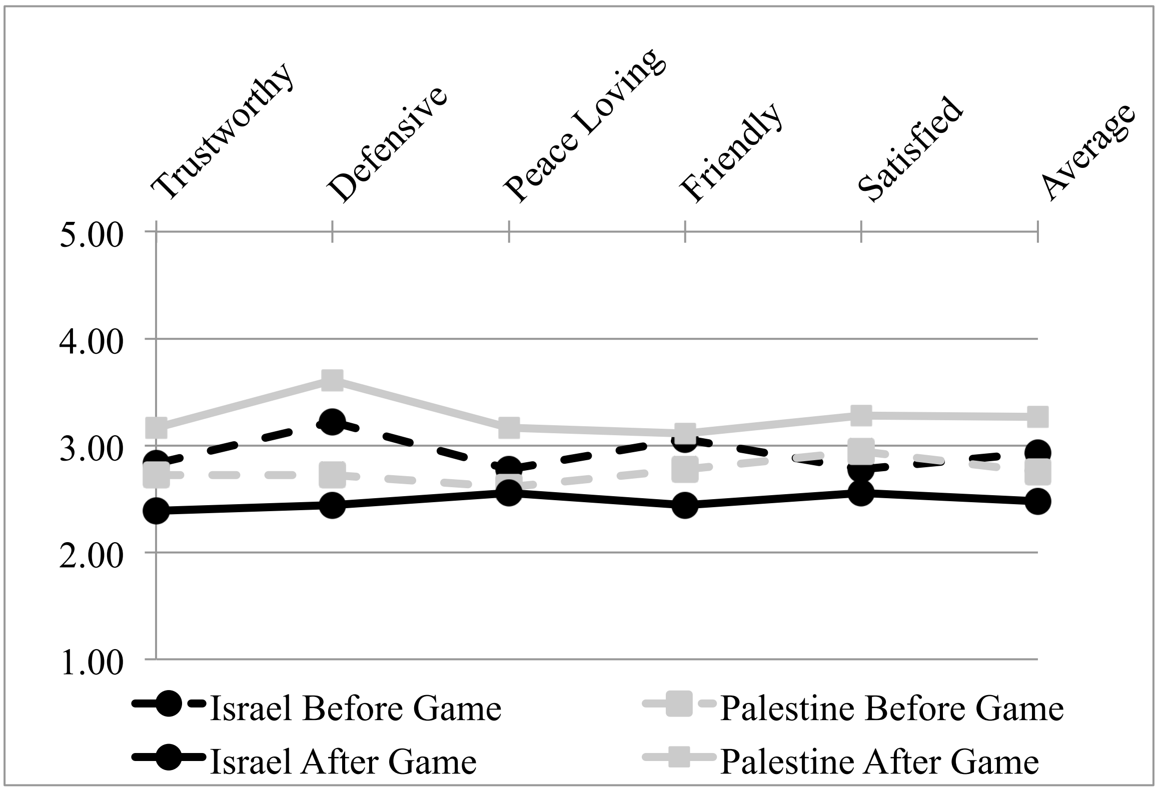


***Figure 2*. Participant reports on Stover's (2005; 2006) political measure for Safe Passage study. All items across both game play conditions are displayed although only averages were analyzed.**

Future research will try to isolate the underlying mechanisms responsible for the effectiveness of serious gaming. The Perspective taking found in Safe Passage and Peacemaker have opposite impact on changes in political perceptions. Is this difference due to the one sided, vs. balanced role playing experienced in the games? Other differences between the games include length of play, style of interaction, use of strategy in game play, performance feedback and scoring mechanisms.

In conclusion, Safe Passage demonstrates the significant persuasive effects that a simple online game may have. Information presented through an interactive medium changed attitudes significantly more than reading the information alone. Thus, though typical internet users spend relatively small quantities of time on a website (Fulloux & Gassee, 2009) viewers' interaction with a website may dictate the effects of the information far more than the information itself.

References

Allport, G.W. (1954). *The nature of prejudice.* Cambridge, MA: Perseus Books.

Breuer, J. & Bente, B. (2010). Why so serious? On the relation of serious games and learning. *Eludamos: Journal for Computer Game Culture.* 4 (1), 7-24.

Crisp, R.J. & Turner, R.N. (2009). Can imagined interaction produce positive perceptions? Reducing prejudice through simulated social contact. *American Psychologist*. 64 (4), 231- 240.

Filloux, F. & Gassee, J. (2009). Measuring time spent on a web page. CBSNEWS

Gee J. (2004). What video games have to teach us about learning and literacy. New York: Macmillan.

Gee J. (2007) Good video games and good learning: collected essays on video games, learning, and literacy. New York: Peter Lang.

Gisha, 2010. Safe passage. http://www.gisha.org/.

Nilsen, E. (2008). Promulgating Peace and Shrinking Stereotypes With a Computer Game. *Western Psychological Association Meeting*. April 2008.

Nilsen, E., LeDonne, R., Klemperer, E., & Olund, S. (2011). Conflict resolution with a serious game for peace. *Games, Learning, and Society 7.0 Conference Proceedings.*

Pettigrew, T.F., & Tropp, L.R. (2006). A meta-analytic test of intergroup contact theory. *Journal of Personality and Social Psychology,* 90, 751-783.

Prensky M. (2001). Digital game-based learning. *ACM Computers in Entertainment,* New York:McGraw-Hill, 1(1).

Schank R. (2002). Designing world-class e-learning. New York: McGraw-Hill.

Stover, W.J. (2005). Teaching and learning empathy: An interactive online diplomatic simulation of middle east conflict. *Journal of Political Science Education*. 1, 207-219.

Stover, W.J. (2006). Moral reasoning and student perceptions of the middle east: Observations on student learning from an internet dialog. *Journal of Political Science Education*. 2, 73-88.

Susi, T., Johannesson, M., & Backlund, P. (2007). Serious Games - An Overview. *Technical Report HS- IKI -TR-07-001, University of Skövde, Sweden.*

Wright, S. C., Aron, A., McLaughlin-Volpe, T., &Ropp, S.A. (1997). The extended contact effect: Knowledge of cross-group friendships and prejudice. *Journal of Personality and Social Psychology*, 73, 73-90.

Information Literacy and Online Reading Comprehension: Two Interconnected Practices

Crystle Martin, Constance Steinkuehler, University of Wisconsin – Madison, 225 N. Mills, Madison
Email: crystle.martin@gmail.com, constances@gmail.com

Abstract

Information literacy is the practices involved in finding information to fulfill an information need. Online reading comprehension outlines what skills are involved in reading online, especially those that differ from reading in print. This paper outlines the interconnectedness of information literacy and online reading comprehension both showing the overlap of the concepts and the need for information literacy in order to reach online reading comprehension.

Introduction

Literacy learning is a naturally occurring and pervasive part of massively multiplayer online games (MMO) and affinity spaces (Gee, 2003; Steinkuehler, 2007; Black & Steinkuehler, 2009; Black, 2008). Sophisticated practices using science literacy (Steinkuehler & Duncan, 2009) and advanced reading comprehension (Steinkuehler, Compton-Lilly, & King, 2009) have been documented in online discussion forums and fandom texts related to MMOs outside the context of school and other traditional learning spaces. These communities function as participatory cultures (Jenkins, 2006), with community members both producing and consuming information in equal turn. The production and consumption cycles of participants are collaborative and leverage the intellectual resources of the community in a way similar to that described by Levy's (1997) theory of collective intelligence. These communities in and around MMOs also function as communities of practice as described by Lave and Wenger (1991); they offer information to members and use apprenticing to help new members learn the standards and practices valued within the community (Steinkuehler, 2004). The collective intelligence and communities of practice aspects of these communities are seen not only in written documentation of the community of an MMO or affinity space like a wiki, in the case of *World of Warcraft* a wiki like wowhead.com, but also in in-game chat. The in-game chat produces a call-and-response pattern that employs information literacy skills, i.e. a player realizes they have an information need and seeks the information by asking the community who then respond with the answer, as well as online reading comprehension skills which are needed for the interpretation of the chat itself and when a player needs to find an outside resource. The information needs of the individual seeking information in this setting require both the collective intelligence of the community to give the individual not only an answer but to give the correct answer, as well as be willing to apprentice an individual, which is a value of communities of practice.

Information Literacy

With the vast amount of diverse information circulating and changing within the constellation of information (building on Steinkuehler's (2007) description of a constellation of literacies) surrounding an affinity space, it seems a natural place to observe and analyze the information literacy practices of naturally occurring communities online. Traditional information literacy theories and standards are designed to primarily describe the practices of information literacy used in formal learning environments like K-12 or college level education (AASL, 1998; ACRL, 2000). Many traditional models for information literacy include a five step process using various terms but basically the same concepts: 1) seeking information, 2) evaluating information, 3) interpreting information, 4) synthesizing information, and 5) disseminating information. However, these models are unable to account for some of the most basic practices found within online affinity spaces, such as *World of Warcraft* (WoW), due to the fact the spaces share very little in common with more traditional resource heavy spaces. This is because the traditional models focus on formal educational settings using institutionally created information resources being sought and found by a single person on a solitary journey, with the output of their search usually ending in a paper. The online affinity space is collaborative and the resources vary from institutionally created – like those put out by the game company, individually created resources – a player's individually created leveling guide or video, group created resources – guild websites (e.g. Elitist Jerks), and community created resources – a wiki (e.g. wowwiki.com). Because so many of the resources are user created and are constantly improved upon as the base data changes, the nature of the resources is constantly shifting, with the information they present constantly in flux. Thus, we need a more contemporary framework for information literacy skills that can better account for the collaborative nature of communities like those found in the information constellation around WoW.

Information literacy's connection to other 21st century skills has been addressed by the Partnership for 21st Century Skills in their document Framework for 21st Century Learning, who place information literacy with media and ICT (Information, Communications, and Technology) skills. We argue, however, that information literacy is more than just a skill set. It requires reasoning and critical thinking skills to be effective in designing search terms for information needs as well as for determining which sources and information best fill the need at hand. Thus, information literacy should be placed more between media and ICT skills, on the one hand, and learning and critical thinking, on the other, because it encompasses both. Using examples culled from eight months of online ethnographic data (Steinkuehler and King, 2009), Martin and Steinkuehler (2010) have examined the information literacy practices that arise in the in-game chat of WoW. The information literacy practices observed in analysis take the form of five patterns. These patterns were identified and described in Martin and Steinkuehler (2010) as "call and response", "call and refer", "call and avalanche", "simultaneous not sequential", and "fluid". These new patterns utilize the existing descriptions of the process of information literacy but crucially illustrate the actual actions and practices of people in natural information seeking spaces.

Online Reading Comprehension

The study of how people read and comprehend online reading materials, online reading comprehension is considered to be a part of literacy studies. Leu, et al., (2001) viewed online reading comprehension through the lens of new literacies, framing it as problem-based inquiry which requires the person implementing online reading comprehension to have new skills, strategies, and dispositions on the Internet. These new skills, strategies, and dispositions allowed the user to create questions that were driven by interests and information needs that occurred while reading. The reader then needs to locate, critically evaluate, synthesize, and design and communicate possible solutions to these questions. Leu and Zawilinski (2007) reaffirmed the list of skills needed for online reading comprehension by determining there were five major functions of online reading comprehension:

1. developing important questions
2. locating information
3. critically analyzing information
4. synthesizing information
5. communicating information (2)

The functions of online reading comprehension show strong similarities to information literacy; these similarities will be explored below.

The difference between studying reading comprehension of print based media and digital media was laid out by Coiro (2009). First, students needed a new and different skill set to successfully read online. These included creating search terms, sifting through sources, making evaluative choices, synthesizing the chosen sources, and responding through digital communication. The second difference focused on the disposition of the student toward the Internet, with high performing readers displaying persistence, flexibility, and skepticism. The third difference between digital and print reading was that students often looked for information in a collaborative way on the Internet, either being physically together, using synchronous online communications methods like gchat, or asynchronous online communications like forums, or collaborative sources like wikis. The fourth difference was that the process of reading should inform the instruction of reading. Coiro found that many struggling students only accessed the top link of a page of search results, often gave up if they could not find information about a websites author easily, retyped URLs because they were unaware of copy and paste, and typed in whole questions into the address bar and added .com at the end. She also determined that rewatching parts of struggling students' videos to look for these traits helped to identify the problem. The fifth difference was that the nature of online reading comprehension was constantly changing as digital tools change. The argument being made here is that online reading comprehension is different than traditional reading comprehension. Online reading comprehension requires the ability to read in a format that may not be linear: Links within in the text may be explored at any time moving the person away from the linear narrative of one page and to another, then returning to the first page when appropriate. The reading that Coiro was studying was that of non-fiction and reference like materials. Although in book settings you would also employ techniques like scanning for reference materials, the ability to switch to a related subject highlighted by a link is just one of the ways that reading online, and therefore online reading comprehension, is a more fluid, hence complicated, process.

Conclusions

Studies of information literacy and online reading comprehension rely on a similar set of constructs and are equally driven by the goal of understanding what people do in online digital spaces with information in order to ultimately help them to be better prepared and more capable of accomplishing their comprehension goals. Although there has been no direct connection in the literature between information literacy and online reading comprehension until now, they are indeed closely related. Online reading comprehension shares a process that is strikingly similar to that of many definitions of information literacy. For example the five major functions of online reading comprehension (Leu & Zawilinski, 2007) outlined above could nearly be laid over top of the traditional model of information literacy and would line up point for point.

Online Reading Comprehension	Information Literacy
developing important questions	seeking information
locating information	{locating information is assumed between seeking & evaluating information}
critically analyzing information	evaluating information & interpreting information
synthesizing information	interpreting information & synthesizing information
communicating information	disseminating information

Online reading comprehension as one of its main differences from print based reading includes practices of creating search terms, sifting through sources, making evaluative choices, synthesizing the chosen sources, and responding through digital communication. All of these traits are synonymous with information literacy. The ability for students to have flexible skills is also important in information literacy for the same reason, the changing digital environment.

Information literacy and online reading comprehension offer two bodies of literature looking at the processes of people finding information, and in the case of this comparison between the two, finding information online. The overlap of these two areas offers an interesting opportunity for research, as well as for scholars in literacy studies and in library and information science to collaborate.

References

Association of College and Research Libraries [ACRL]. (2000). *Information Literacy Competency Standards for Higher Education.* Chicago: ACRL. Retrieved from http://www.ala.org/ala/mgrps/divs/acrl/standards/standards.pdf

American Association of School Librarians [AASL] (1998). *Information literacy standards for student learning: Standards and indicators*. Chicago: American Library Association. Retrieved from http://www.ala.org/ala/mgrps/divs/aasl/guidelinesandstandards/informationpower/InformationLiteracyStandards_final.pdf

Black, R. W. (2008). *Adolescents and online fan finction.* New York: Peter Lang.

Black, R. W., & Steinkuehler, C. (2009). Literacy in virtual worlds. In L. Christenbury, R. Bomer, & P. Smagorinsky (Eds.), *Handbook of adolescent literacy research* (pp. 271–286). New York: Guilford.

Coiro, J. (2009). Rethinking online reading assessment. *Educational Leadership, 66*, 59-64.Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. *Reading Research Quarterly, 42*(2), 214-257.

Gee, J. (2003). *What Videogames have to Teach Us about Learning and Literacy.* New York: Palgrave Macmillan.

Jenkins, H. (2006). *Fans, bloggers, and gamers: Exploring participatory culture*. New York: New York University Press.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

Leu, D. J., Coiro, J., Castek, J., Hartman, D. K., Henry, L. A., & Reinking, D (2001). Research on instruction and assessment in the new literacies of online reading comprehension. In C. C. Block, S. Parris, & P. Afflerbach (Eds.), *Comprehension instruction: Research-based best practices* (pp. 321-346). New York: Guilford Press.

Leu, D. J. & Zawilinski, L. (2007). The new literacies of online reading comprehension. *Reading Online, 43*(1), 1-8.

Levy, P. (1997). *Collective intelligence: Mankind's emerging world in cyberspace.* Cambridge, Mass.: Perseus.

Partnership for 21st Century Skills. (2009). *Framework for 21st Century Learning*. Tuscon, AZ: Author. Retrieved from http://www.p21.org/documents/P21_Framework.pdf

Steinkuehler, C. A. (2004). Learning in massively multiplayer online games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), *Proceedings of the Sixth International Conference of Learning Sciences* (pp. 521-528). Mahwah, NJ: Erlbaum.

Steinkuehler, C. (2007). Massively multiplayer online games as a constellation of literacy practices. *E-Learning and Digital Media, 4*(3), 297-318.

Steinkuehler, C., Compton-Lilly, C. & King, E. (2009). Literacy practice & reading performance in the context of MMO games. To be presented at the Annual Meeting of the American Educational Research Association (AERA), Denver CO, April 30-May 4.

Steinkuehler, C. & Duncan, S. (2009). Informal scientific reasoning in online virtual worlds. *Journal of Science Education & Technology.* DOI: 10.1007/s10956-008-9120-8.

Steinkuehler, C. & King, B. (2009). Digital literacies for the disengaged: Creating after school contexts to support boys' game-based literacy skills. *On the Horizon, 17*(1), 47-59.

Acknowledgments

This work was made possible by a grant from the MacArthur Foundation, although the views expressed herein are those of the authors and do not necessarily represent the funding agency's.

Conflict Resolution with a Serious Game for Peace

Erik Nilsen, Richard LeDonne, Elias Klemperer & Seth Olund,
Lewis & Clark College, 0615 SW Palatine Hill Rd. Portland
Email: nilsen@lclark.edu, richienwl@gmail.com, elias.klemperer@gmail.com,
setholund@hotmail.com

Abstract

The current study examines the effects of playing *PeaceMaker* (an Israeli/Palestinian computer simulation game) and its relationship to *contact theory*. Thirty participants were assigned to spend one-hour in-lab either playing the game or reading/viewing media accounts of events similar in nature to those portrayed in the game. Measures of empathy and attitude were employed before and after each condition. Game-play increased hope for peace and reduced preexisting biases significantly more than media exposure. Furthermore, game-play encouraged a more constructive outlook on the major actors and actions involved in the Israeli/Palestinian conflict. Seventeen of the 32 actors and actions measured were rated significantly more positive after game play. In contrast, only 4 of the 32 actors and actions were rated more positive after media exposure. Future research will include isolation and exploration of participants' interaction with serious games as the variable responsible for the significant changes found in this study.

Introduction

In a world full of perpetual inter-group conflict rooted in history and culture, the prospect of peaceful coexistence feels incomprehensible. Moving toward solutions to these overwhelming cultural and national clashes may be the largest social issue of our time. Where do we begin? Social psychologists have long examined the relationship among segregation, social contact and inter-group relations (Crisp & Turner, 2009), illustrating conditions under which prejudice can be reduced between conflicting groups. Building upon this research, the present study examines the potential of *PeaceMaker*, a simulation-based serious computer game as a tool for conflict resolution.

The term serious games came into wide use in 2002 to describe videogames that engage the player, but also aim to achieve a defined purpose other than pure entertainment (Susi, Johannesson, & Backlund, 2007). Serious games represent a rapidly growing market in the videogame industry (Breuer & Bente, 2010) largely due to a number of researchers (Gee, 2007; Prensky, 2001; Schank, 2002) emphasizing the importance digital games may have for learning (Ritterfeld, Shen, Wang, Nocera, & Ling Wong, 2007). However, the effects of serious gaming on the player's cognition and emotion are far from understood. There is a need for guidance regarding how (when, with whom, and under what conditions) to integrate serious games to maximize their learning potential (Susi et al., 2007).

The current study examines *PeaceMaker*, an interactive Israeli/Palestinian conflict resolution simulation game developed by ImpactGames (now Hybrid Learning). *PeaceMaker* was created as a tool to promote peace, change attitudes and erode prejudice on issues surrounding the Middle East (ImpactGames, 2006). The intimate imagery, role-play, and interactivity of *PeaceMaker* provide a unique space, bringing players into contact with the complexity of the situation and relevant actors.

Research in conflict resolution shows that contact with out-group members is essential to positive outcomes. *Contact theory* postulates that, under the right conditions, direct contact with an out-group decreases inter-group hostility and leads to more positive inter-group attitudes (Allport, 1954). A meta-analysis of 515 *contact hypothesis* studies revealed a highly significant, negative relationship between contact and prejudice (Pettigrew, & Tropp, 2006). While this research is promising, it is still unclear how it translates to broader societal change (Dixon, Gurrheim, & Tredoux, 2005). In many real-world situations there are high levels of hostility, substantial distance in social and physical segregation, and little motivation to engage with out-group members (Crisp & Turner, 2009). Positive direct contact in such a situation seems unrealistic. Some transition needs to take place prior to direct interaction. Since Allport's time, researchers have demonstrated that some of the same effects of direct contact can be observed through more indirect channels. Wright and colleges (1997) found that observing or hearing about positive interactions between members of different groups can reduce prejudice. Furthermore, Crisp and Turner (2009) have shown that simply imagining a positive inter-group interaction also decreases prejudice. This research is promising in that it illustrates a method for change, but there is need for an engaging and motivating mode through which this transition can flourish. Serious games have the potential to fill such a role: serving as a captivating mechanism by which we can create indirect contact between groups and consequently shift inter-group attitudes in a transition toward closer contact.

The role of empathy in conflict resolution has also been studied in Political Science. Stover (2005) suggests that empathy development is important in international relations because it catalyzes attitude change toward opposing groups. Studies conducted by Stover (2005, 2006) found that the role participants' played within an Israeli/Palestinian conflict simulation predicted positive changes on a questionnaire focused around political values, feelings and perceptions towards Israelis and Palestinians: "participants changed their views toward the countries or ethnonational groups they represented." In this way, real-world simulation games may act as a device for empathy attainment. Stover interprets these results as evidence for a change in empathy. We suggest that Stover's results reflect a change in attitude (reduction in prejudice). Empathy can be generally defined as the ability to accurately feel or perceive the emotional or cognitive state of another (Spreng, McKinnon, Mar, & Levine, 2009). The role playing (or perspective taking) participants undertook may mediate attitude change. We will utilize Stover's questionnaire for the purpose of measuring attitude and empathy.

The current research builds on a study by Nilsen (2008) and examines the effects of playing *PeaceMaker* in comparison to viewing media coverage on the Israeli/Palestinian conflict. The study implements measures of attitude and empathy in order to better understand *PeaceMaker* through the lens of *contact theory*. We hypothesize that participants who play *PeaceMaker* (in contrast to those who view media coverage of similar information) will show a convergence of attitude (a reduction in prejudice) toward the two parties. Furthermore, we hypothesize that playing *PeaceMaker* will lead to a more hopeful attitude for conflict resolution and a more constructive view of various actors and actions relevant to the situation.

Method

Participants

The study consisted of 30 college-age students (13 women and 17 men) from the Lewis and Clark College community during the summer of 2010. Participants were acquired through Lewis and Clark e-mail list serves.

Materials

Conflict resolution is a profound process that is deeply intertwined with political perceptions, social influences, and individual experiences. *PeaceMaker* has approached this issue by creating a computer-based scenario that encompasses the historical and dynamic political situations in the Israel/Palestine region. Furthermore, the serious game sets the stage by incorporating factions from all sides of the situation in order to dissect any obdurate perspectives. The dichotomous political positions 'pro-Israel' or 'pro-Palestine' are broken down to converge into less biased and more nuanced opinions and attitudes.

We designed before and after online surveys in order to measure the changes in feelings and attitudes concerning the Israel/Palestine situation. Below we report on the measures that we used to explore the nuanced effects of *PeaceMaker*.

Dependent Variables

Hopefulness Measure. Participants are asked to choose a response on a 6-point Likert scale (1=strongly disagree, 6=strongly agree) that most closely corresponds to their opinion on a question assessing hopefulness: "In the near future there will be peace between Israel and the Palestinians".

Political Attitude. A well-established scale developed by the political scientist William Stover (2005, 2006) was used to assess changes in the perception of political behavior of Israel and Palestine. Furthermore, Stover goes on to explain the importance of these measures in understanding the effectiveness of simulating political dynamics. The scale informs participants to "consider your perceptions about the political activities of Israel/Palestine in relationship to the Palestinian-Israeli conflict. As you think about the political activities of Israel/Palestine in relationship to the Palestinian-Israeli conflict, check the response that most closely corresponds to your perception of their political behavior in international relations." Participants are then instructed to rate each country on five different 5-point Likert scales with each question anchored by negative and positive adjective pairs. The adjective pairs used are 1) Friendly/Hostile, 2) Defensive/Aggressive, 3) Peace Loving/Warlike, 4) Satisfied/Expansionist, and 5) Trustworthy/Deceitful.

Perception of "Actors" and "Actions". This 6-point Likert scale was created by Nilsen (2008) and consists of 19 "Actors" (e.g., Israeli Prime Minister, UN, Jordan) and 13 "Actions" (e.g., Economic Development, Cultural Initiatives, Speaking to World Media) relevant to the Israeli-Palestinian conflict. Participants rate each actor or action in terms of the constructive or destructive impact that each has towards achieving a peaceful two state solution (1=Very Destructive, 6=Very Constructive).

Independent Variable

Game Condition. We used *PeaceMaker*, a serious game developed by ImpactGames (now Hybrid Learning), as our experimental condition. In *PeaceMaker*, participants play the part of the Israeli Prime Minister or the Palestinian President and make diplomatic, security and economic decisions based on the progression of events. During play, the interface shows a map of Israeli and the Palestinian territories. Windows appear periodically, presenting a picture or video of a scenario (e.g., a Hamas suicide bombing or an Israeli air strike) that is likely to trigger a response from the important parties (e.g., Hamas, U.N., USA). The player must respond with an action selected from the Security, Political or Construction menus. Within each menu is a list of more specific options (e.g., give a speech to your people, to the world, to your government, etc.) After selecting an option, the player is presented with a list of more precise courses of action from which to choose (e.g., speak about security, the peace process, anti-militancy, etc.) As in reality, each move results in a reaction by one or more parties within the international community.

The primary feedback that players receive from their actions is a polling response from the various stakeholders displayed at the bottom of the screen. The player wins the game by increasing the polling score of the two main constituencies to +100. When playing as the Palestinian President, the main constituencies are National Approval and the World Approval. When playing as the Israeli Prime Minister, the main constituencies are Israeli Approval and Palestinian Approval. Each leadership role also receives ratings from the major stakeholders (e.g., Yesha (Israeli Settlers' Council), UN, USA, etc.) that influence the direction of the game and the overall polling scores of the player's constituencies.

The Player's overall goal in *PeaceMaker* is to incorporate the information provided in order to reach compromises and eventually a peace agreement leading to the establishment of a two state solution. As players advance towards peace, they reach four checkpoints that congratulate the player and give updates on the region's progress culminating in a peaceful two-state solution and presenting the player with the *PeaceMaker* award.

Media Condition

The control condition was a series of PowerPoint presentations comprised of articles and video clips from CNN, The New York Times and CBS about the Israeli-Palestinian situation between 2001 and 2007 (the period in which the game takes place). The media sources were chosen based on a survey of students to identify their major sources of world news.

In order to examine the effect of playing *PeaceMaker*, we kept the information presented in both conditions (game and media) relatively equivalent. To accomplish this, we documented all of the information in the *PeaceMaker* game that was relevant to strategy. Then we categorized the relevant information into ten basic groups (e.g., pertaining to settlements, police force). Finally, we determined the percentage of the game that each group represented and collected articles within the media sources that matched each group and its percentage. In this way we isolated the *interaction* with the content as the variable being tested.

Procedure

Each participant was randomly assigned to spend one hour of lab time in one of the two conditions of the primary independent variable (game or media). Fifteen participants were assigned to the game condition and 15 were assigned to the media condition. All participants took an online survey including questionnaires concerning hopefulness, political attitude, empathy and perception of actors and actions the day before their first in-lab session.

During the in-lab session, participants in the control group (media) read and viewed 45 minutes of Israeli/Palestinian media coverage (articles and video) and played IsoBall2 for 15 minutes. We used IsoBall2 (a relatively simple game involving building ramps to guide a ball to a target) in order to replicate a game-like experience of PeaceMaker, without interacting with relevant information. Participants then completed the second survey immediately after the media exposure.

Participants in the experimental group viewed a brief tutorial and played *PeaceMaker* for 30 minutes as the Israeli Prime Minister or the Palestinian President (order counterbalanced.) After 20 minutes of game play, participants began from a checkpoint three-quarters of the way through the game in order to get a more comprehensive experience of the game. The role was switched and the process was repeated for the final 30 minutes. Participants completed the second survey immediately following game play. Finally, after the completion of the in-lab session, all participants were debriefed and paid $20.

Results

All of the analyses presented below compare the change in scores between two online surveys. The first survey was taken at one to two days before the laboratory session and the second survey immediately after exposure to the game/media PowerPoint presentations. We report on the questions that pertain directly to our hypotheses. The primary independent variables are the condition to which the participants were assigned (Game or Media) and the time of the survey (Before and After). The dependent variables examined include 1) Perceptions of the likelihood of peace between Israel and Palestine in the near future, 2) Perceptions of political behavior in international relations of Israel and Palestine, 3) Perceptions of the constructive/destructive influence of a variety of actors and actions on moving towards a two state solution in the region.

In order to assess participants hope for peace, they were asked to respond to the following question on a 6 point Likert scale ranging from 1=Strongly Disagree to 6= Strongly agree: *In the near future there will be peace between Israel and the Palestinians*. A 2 x 2 mixed model ANOVA reveals a marginally significant main effect of survey time on participants hope for peace $F(1,28) = 2.97$, $p = .096$. In both the game and media conditions, participants were more hopeful on the survey taken after (M= 2.10, SD= 1.13) than they were on the survey taken before (M= 1.8, SD= .96). Post hoc t-tests show that this difference was stronger in the game condition, increasing 1.73 to 2.20, $t(14) = 2.43$, $p = .029$, than it was in the media condition, which had a modest increase from 1.87 to 2.0, $t(14) = .46$, $p = .65$, n.s. The main effect of condition and the interaction effects were not significant.

We used an established scale developed by Stover (2005) to assess changes in the perception of political behavior of Israel and Palestine. This scale asks participants to rate each country on five different 5-point Likert scales with each question anchored by negative and positive adjective pairs. Figure 1 shows the average ratings for Israel and Palestine on the before and after surveys for the game condition. On this figure, higher scores represent a more positive view. It can readily be seen that on the before survey, our participants had a more positive view of Palestine than they did of Israel.

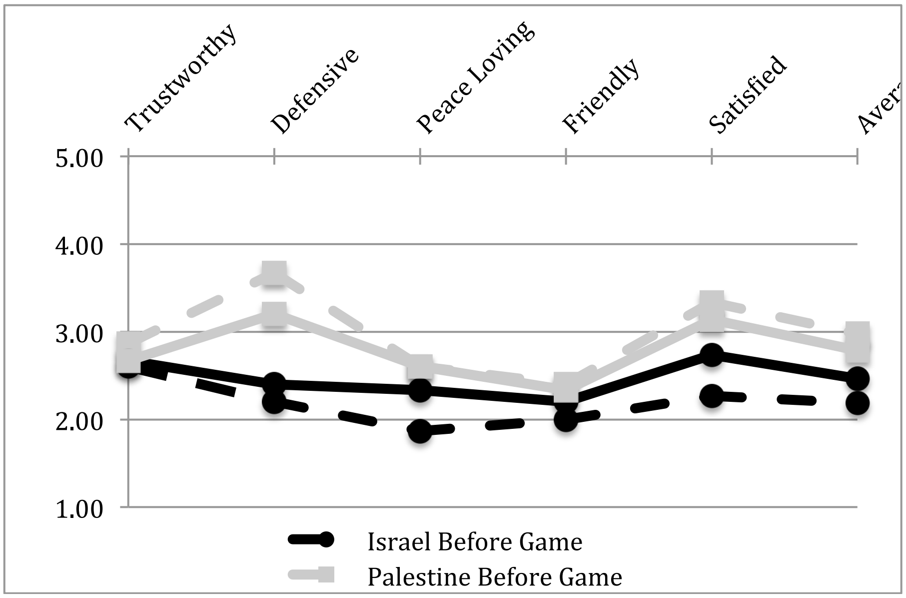


Figure 1. **Stover political perception ratings for *PeaceMaker* playing participants showing initial Pro-Palestinian bias and the significant convergence of perceptions following game play.**

The rightmost set of data points in the figure shows the mean score for the 5 questions in that particular country/survey combination. To simplify the analysis of this data in determining how perceptions changed in the study, we will only be analyzing these average scores rather than each adjective pair separately.

First, we will examine the changes in perception of each country separately by condition. A 2 x 2 mixed model ANOVA on the average political perception of Israel reveals a highly significant effect of survey time $F(1,28) = 10.07$, $p = .004$. In both the game and media conditions, participants held a more positive view of Israel on the survey taken after (M= 2.67, SD= .75) than they were on the survey taken before (M= 2.33, SD= .95). Post hoc t-tests show that this difference was significant in both the game condition, increasing 2.19 to 2.47, $t(14) = 2.63$, $p = .02$, and the media condition, which had an increase from 2.47 to 2.88, $t(14) = 2.17$, $p = .048$. The main effect of condition and the interaction effects were not significant. An identical analysis for changes in perceptions of Palestine revealed a small, non-significant decrease average attitude towards Palestine (from 2.83 to 2.73) but no significant main effects, interaction effects, or post-hoc t-tests were found.

We also explored whether the *gap* in attitudes between Israel and Palestine changed after game play or media exposure. Converging attitudes indicated a more balanced view of the countries, while diverging attitudes would indicate a strengthening of pre-existing biases. To look for evidence of convergence or divergence of attitudes we transformed the average perception data into difference scores between Palestine and Israel at each survey time and separately for the game and media conditions. This score was derived by taking the nationality with the highest mean at a given survey time/condition combination and subtracting the lower scoring nationality from it. The resulting number represents the difference between the perception of the two nationalities with lower numbers meaning greater convergence and thus reduction in pre-existing bias. For three combinations (Game/Before, Game/After, and

Media/Before) we subtracted the lower Israel score from the higher Palestine score. For Media/After, we subtracted the lower Palestine score from the higher Israeli score.

Evidence for convergence of political perceptions with this new transformed variable, called the Stover Difference Score, is a significant reduction in difference scores from the before survey to the after survey. T-tests show that this difference was significant in the game condition, decreasing from 0.79 to 0.05, $t(14) = 2.98$, $p = .01$, but not for the media condition, which had a small decrease from 0.227 to 0.213, $t(14) = .032$, $p = .98$, n.s.

In order to look more deeply into what particular attitudes changed, we also asked participants to rate the impact of 19 actors (e.g. United Nations, Israeli Prime Minister, Palestinian Police) and 13 actions (e.g. Economic Development, Cultural Initiatives, Speaking to World Media) in terms of the constructive or destructive impact that each has towards achieving a peaceful two state solution. Participants were asked to rate each of the 32 questions before and after the lab session on a 6-point Likert scale. Figures 2-3 display the ratings for the game condition. The figures are split into actors and actions. The individual actors and actions are sorted left to right by how much change the condition produced. Significant changes between pre and post surveys are marked with an asterisk. The patterns of significant t-tests indicate a stronger change in attitude in the game condition with 17 of 32 comparisons yielding a significant positive change compared to only 4 of 32 resulting in a significant change in the media condition. Of particular note in the game condition, the three actors showing the greatest positive shift are all Israeli (Israeli Prime Minister, Israeli Government, and Israeli Army, all p's <.001). The only actor in the media condition to show even a marginally significant change was the Palestinian Police, $p = .09$.

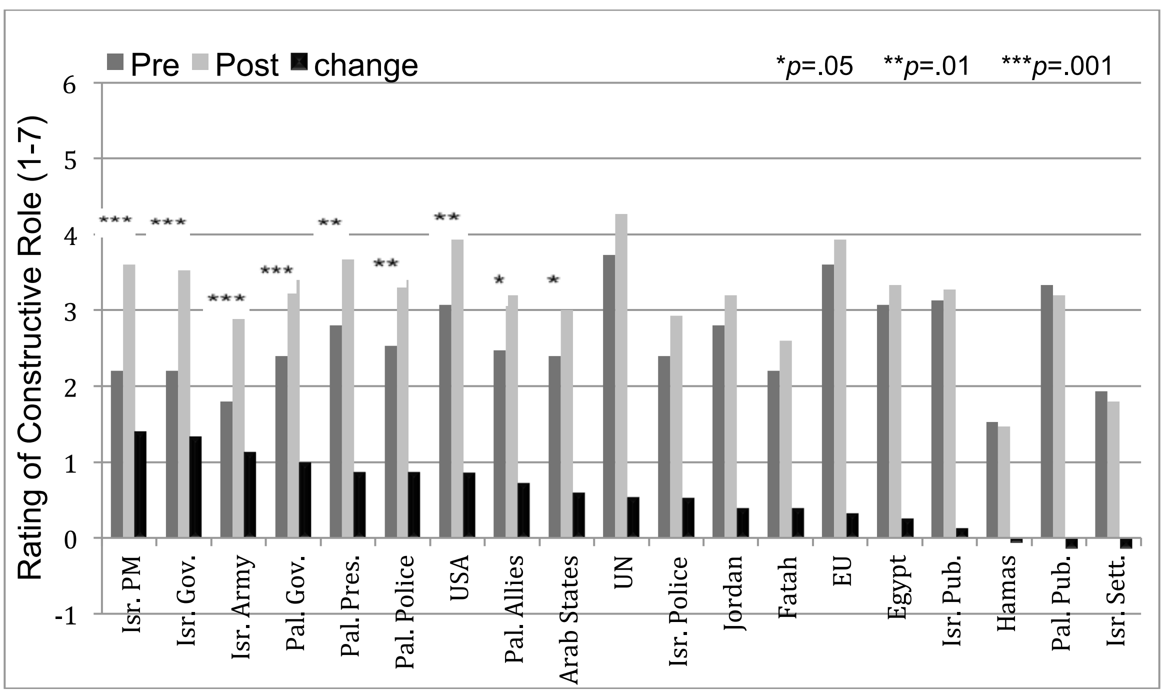


***Figure 2*. Perception of constructive role of various actors in *PeaceMaker* game playing condition ordered from greatest positive change to greatest negative change. No actors showed a significant change in the media condition.**

For both the game and media conditions the general trend was for participants to rate most actors and actions as more constructive at the end of the study. In order to isolate which actors and actions were impacted differentially more by the game we ran independent mean t-tests for each actor and action using the change in rating for the game and media conditions as the independent variables. Of the 19 actors, the following 4 showed a significantly greater positive change for the game compared to the media condition: Israeli Prime Minister (p = .01), Israeli Government (p = .02), Palestinian Government (p = .03), Israeli Army (p = .04). Of the 13 actions, only the action of Cross-cultural Initiatives (p = .04), showed a significantly greater change in rating for the game condition compared to the media condition.

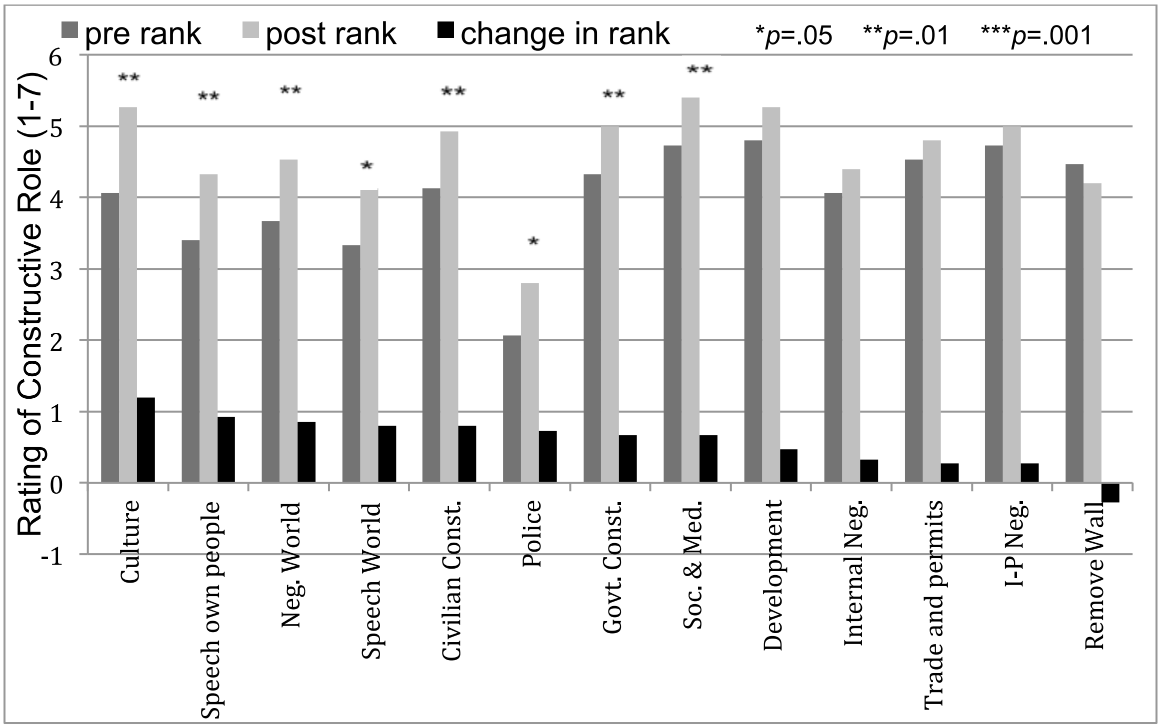


Figure 3. **Perception of constructive role of various actions in *PeaceMaker* game playing condition. Eight significant changes marked with asterisk.**

Discussion

Our results provide converging evidence that playing one hour of the *PeaceMaker* game results in positive changes in attitudes concerning the Israeli-Palestinian conflict that equivalent exposure to popular media sources does not. *PeaceMaker* players are more hopeful about a near-term solution to the conflict than people who read and view mainstream media accounts of events in the region. Playing the game from both perspectives reduces pre-existing biases about the political behavior of the Israelis and Palestinians. Finally, game play results in an expanded view of actors and actions that have a constructive role in achieving a two state solution, while exposure to media has a minimal effect.

There is one alternative hypothesis to our results that needs to be addressed. The changes in political perceptions reflected in the Stover scale might reflect a pro-Israeli bias in the game itself. This would explain the convergence in the Stover scale seen in figure 1 and the tendency towards a greater positive shift in the constructive role of actors associated with the Israeli state as seen in figures 2 and 3. Fortunately, we have some data that speaks to this alternative explanation. An earlier study conducted by Nilsen (2008), had 24 students in a human-computer interaction class play the *PeaceMaker* game for a total of 6 hours, 3 hours in each role. While this class-based lab did not have a control group to compare with, participants did fill out the Stover scale before and after game play. These college students displayed a clear pro-Israeli bias prior to game play, the mirror image of the participants in the current study. After playing the *PeaceMaker* game for 6 hours, this bias disappeared and, as in the current study, the political perceptions of Israelis and Palestinians converged. This demonstrates that playing *PeaceMaker* leads to a more balanced perception of Palestinians and Israelis political behavior regardless of the direction of the initial bias. This pattern is not seen in the media exposure condition which produced very little change in perception.

Our findings support the predictions of contact theory (Allport, 1954; Crisp & Turner, 2009). Our results indicate that playing a computer game that involves adopting the role of the two leaders (perspective taking) can move people toward a shift in inter-group attitudes and a reduction in biased political perception. Meta analyses of the contact theory literature suggest that perspective taking and empathy play a critical role in prejudice reduction (Pettigrew, & Tropp, 2006). More work is needed to look at how role-playing may be linked to perspective taking.

The next step in this line of research is to explore the mechanisms underlying the observed changes in attitude. Specifically, we suggest that future research conduct a more detailed investigation of the effects of participants' *interaction* with the information. Possible candidates for mediating factors include the use of realistic situations, the mechanisms for scoring and feedback, the strategic level of decision-making. Furthermore, research should explore the extent to which variations in role-play (status, similarity, control, etc) have an effect on participants' emotion, attitude and empathy.

The current study serves as a demonstration that *PeaceMaker*, taken as a whole, increases hopefulness, decreases prejudice and promotes an appreciation for constructive actors and actions in resolving the Israeli/Palestinian conflict. As such, *PeaceMaker* serves as an effective medium through which opposing groups may move toward closer contact. More generally, our research serves to display the beneficial effects of serious games. We hope our findings regarding the positive aspects of digital simulations will serve to provide new resources for the study of conflict resolution.

References

Allport, G.W. (1954). *The nature of prejudice.* Cambridge, MA: Perseus Books.

Breuer, J. & Bente, B. (2010). Why so serious? On the relation of serious games and learning. *Eludamos: Journal for Computer Game Culture.* 4 (1), 7-24.

Crisp, R.J. & Turner, R.N. (2009). Can imagined interaction produce positive perceptions? Reducing prejudice through simulated social contact. *American Psychologist*. 64 (4), 231-240.

Dixon, J., Gurrheim, K., & Tredoux, C. (2005). Beyond the optimal strategy: A reality check for the contact hypothesis. *American Psychologist, 60, 697-711.*

Gee J. (2007) Good video games and good learning: collected essays on video games, learning, and literacy. New York: Peter Lang.

ImpactGames. (2006) PeaceMaker [Software]. Pittsburgh, PA (http://www.peacemakergame.com).

Martin, J.M. & Gonzalez, C. (2010). The cultural determinants of strategic bias: A study of conflict resolution in an interactive computer game. *International Conference on Intercultural Collaborations, 3,* 151-160.

Nilsen, E. (2008). Promulgating Peace and Shrinking Stereotypes With a Computer Game. *Western Psychological Association Meeting*. April 2008.

Pettigrew, T.F., & Tropp, L.R. (2006). A meta-analytic test of intergroup contact theory. *Journal of Personality and Social Psychology,* 90, 751-783.

Prensky M. (2001). Digital game-based learning. *ACM Computers in Entertainment,* New York: McGraw-Hill, 1(1).

Rieber L. (2005). Multimedia learning with games, simulations, and microworlds. In Mayer R, (Ed.) Cambridge handbook of multimedia learning. New York: Cambridge University Press, pp. 549–67.

Ritterfeld, U., Shen, C., Wang, H., Nocera, L. & Ling Wong, W. (2007). Multimodality and interactivity: Connecting properties of serious games with educational outcomes. *CyberPsychology & Behavior*. 12(6), 691-697.

Schank R. (2002). Designing world-class e-learning. New York: McGraw-Hill.

Spreng, R.N., McKinnon, M.C., Mar, R.A., & Levine, B (2009). The Toronto empathy questionnaire: Scale development and initial validation of a factor-analytic solution to multiple empathy measure. *J Pers Assess*. 91(1), 62-71.

Stover, W.J. (2005). Teaching and learning empathy: An interactive online diplomatic simulation of middle east conflict. *Journal of Political Science Education*. 1, 207-219.

Stover, W.J. (2006). Moral reasoning and student perceptions of the Middle East: Observations on student learning from an internet dialog. *Journal of Political Science Education*. 2, 73-88.

Susi, T., Johannesson, M., & Backlund, P. (2007). Serious games - An overview. *Technical Report HS- IKI -TR-07-001, University of Skövde, Sweden.*

Wright, S. C., Aron, A., McLaughlin-Volpe, T., & Ropp, S.A. (1997). The extended contact effect: Knowledge of cross-group friendships and prejudice. *Journal of Personality and Social Psychology*, 73, 73-90.

Acknowledgements

We thank Howard Hughes Medical Institute, The Rogers Program and The Fairchild Foundation for their grants through Lewis and Clark College

A Data-Driven Taxonomy of Undergraduate Student Videogame Enjoyment

John M. Quick, Robert K. Atkinson, Arizona State University, Tempe, AZ, USA
Email: John.M.Quick@asu.edu, Robert.Atkinson@asu.edu

Abstract

Understanding the design elements that lead to player enjoyment is critical to the creation of effective game experiences. An exploratory factor analytic approach was taken to discover the underlying characteristics of videogames that influence player enjoyment. Using questionnaire data from 219 undergraduate students, a taxonomy of six design features (fantasy, exploration, companionship, competition, realism, and challenge) that influence player enjoyment of video games was derived. In this paper, ten recent and well-known game design taxonomies are compared to the derived taxonomy. The abundance of similarities between the taxonomies provides evidence of universal game design features. This lends support to the belief that the influential aspects of videogame design can be scientifically identified and manipulated to beneficent ends.

Introduction

Understanding the design elements that lead to player enjoyment is critical to the creation of effective game experiences. The fields of education, training, health, and serious games can especially benefit from identifying the manipulable design characteristics that affect player perception of videogames.

An exploratory factor analytic approach was taken to discover the underlying characteristics of video games that influence player enjoyment. This paper will focus on describing the resulting taxonomy and comparing it to past game design taxonomies. A detailed discussion of the statistical analyses employed in this study will be provided in a future manuscript, which is currently being developed.

Several past taxonomies have categorized video game features and players. Some were born primarily out of expert practice and theory (Bartle, 1996; Heeter, 2007; Hunicke, LeBlanc, & Zubeck, 2004; Schell, 2008; Winn, 2008), whereas others were generated through empirical research (Fu, Su, & Yu, 2009; Hong et al., 2009; King, Delfabbro, & Griffiths, 2010; Ryan, Rigby, & Przybylski, 2006; Wilson et al., 2009; Yee, 2006). Some taxonomies focus on enjoyment (Fu et al., 2009; Hunicke, LeBlanc, & Zubeck, 2004; Schell, 2008; Winn, 2008), whereas others are more concerned with player motivation (Ryan et al., 2006; Yee, 2006), learning (Hong et al., 2009; Heeter, 2007; Wilson et al., 2009), or generally identifying game characteristics and players (Bartle, 1996; King et al., 2010). In this paper, ten recent and well-known game design taxonomies are compared to the data-driven taxonomy of undergraduate student videogame enjoyment found in this study. This comparison will demonstrate the universality of certain design elements and lend support to the belief that the influential features of videogame design can be scientifically identified and manipulated to beneficent ends.

Taxonomy of Undergraduate Student Videogame Enjoyment

To gauge student perceptions of manipulable game design features, an attitudinal questionnaire was employed. This questionnaire asked participants to rate how important 37 features are to their enjoyment of video games on a scale from one (*Not at all important*) to five (*A must-have feature*). The included features were largely derived from a previous study on the structural characteristics of videogames (Wood, Griffiths, Chappell, & Davies, 2004). Three sample questionnaire items are provided.

- The game is set in a fantasy world.
- The game allows me to search for hidden things.
- The game features 3D graphics.

The questionnaire was administered to 219 undergraduate students from a large public university in the southwestern United States. The students held a wide variety of majors and earned course credit for participation. Their median age was 21, while 67% were female and 33% were male. An exploratory factor yielded six categories that accounted for 57% of the total variance in videogame enjoyment. Ordered from most to least variance accounted for, each factor underlying undergraduate videogame enjoyment is described.

1. Fantasy: the enjoyment of fantasy-world settings and roleplaying as different species, races, and genders (13%)
2. Exploration: the enjoyment of searching for hidden things, collecting things, and exploring unfamiliar places (10%)
3. Companionship: the enjoyment of multiplayer games and playing with friends (9%)
4. Competition: the enjoyment of playing with others online, meeting new people, and displaying one's skills in public (9%)
5. Realism: the enjoyment of realistic 3D graphics and real-world settings (8%)
6. Challenge: the enjoyment of mastering difficult games, overcoming obstacles, and achieving high scores (8%)

This exploratory, data-driven taxonomy sets a foundation for investigating the critical game design elements that influence player and learner enjoyment. This taxonomy can be further validated through its robust similarities to past game design taxonomies.

Comparison to Past Game Design Taxonomies

Ten recent and well-known game design taxonomies were selected from the literature for comparison with the taxonomy of undergraduate student video game enjoyment derived from this study. The individual components of each taxonomy were examined for similarities and determined to have either no substantial relationship, a weak or partial relationship, or a strong relationship with one or more categories in the proposed taxonomy. The comparison of each past taxonomy with the taxonomy of undergraduate student videogame enjoyment is described here and visualized in Figure 1.

One of the earliest and most well-known video game taxonomies is Bartle's (1996) classification of players found in Multi-User Dungeons (MUDs). MUDs were early, text-based versions of today's expansive massively multiplayer online role-playing games (MMORPG) and virtual worlds, such as *World of Warcraft* and *Second Life*. In playing and designing MUDs, Bartle encountered four common player types, which he named Explorers, Socializers, Killers, and Achievers (Bartle, 1996). All four player types relate strongly to components of the videogame enjoyment taxonomy. Explorers, Socializers, Killers, and Achievers respectively correspond to the Exploration, Companionship, Competition, and Challenge dimensions.

Building upon Bartle's (1996) work and a review of learning style and motivation theory, Heeter (2008) expanded the number of MMO player types to 13. These players' motivations and behaviors fall into four primary categories: Intrinsic, Extrinsic, Antisocial, and Prosocial. Player types centered around Heeter's Intrinsic category relate strongly to the Fantasy and Exploration dimensions, and partially to Challenge. The gamers in the Extrinsic category correspond strongly to Competition and Challenge, and partially to Exploration. Prosocial players relate strongly to Companionship, while Antisocial players relate strongly to Competition.

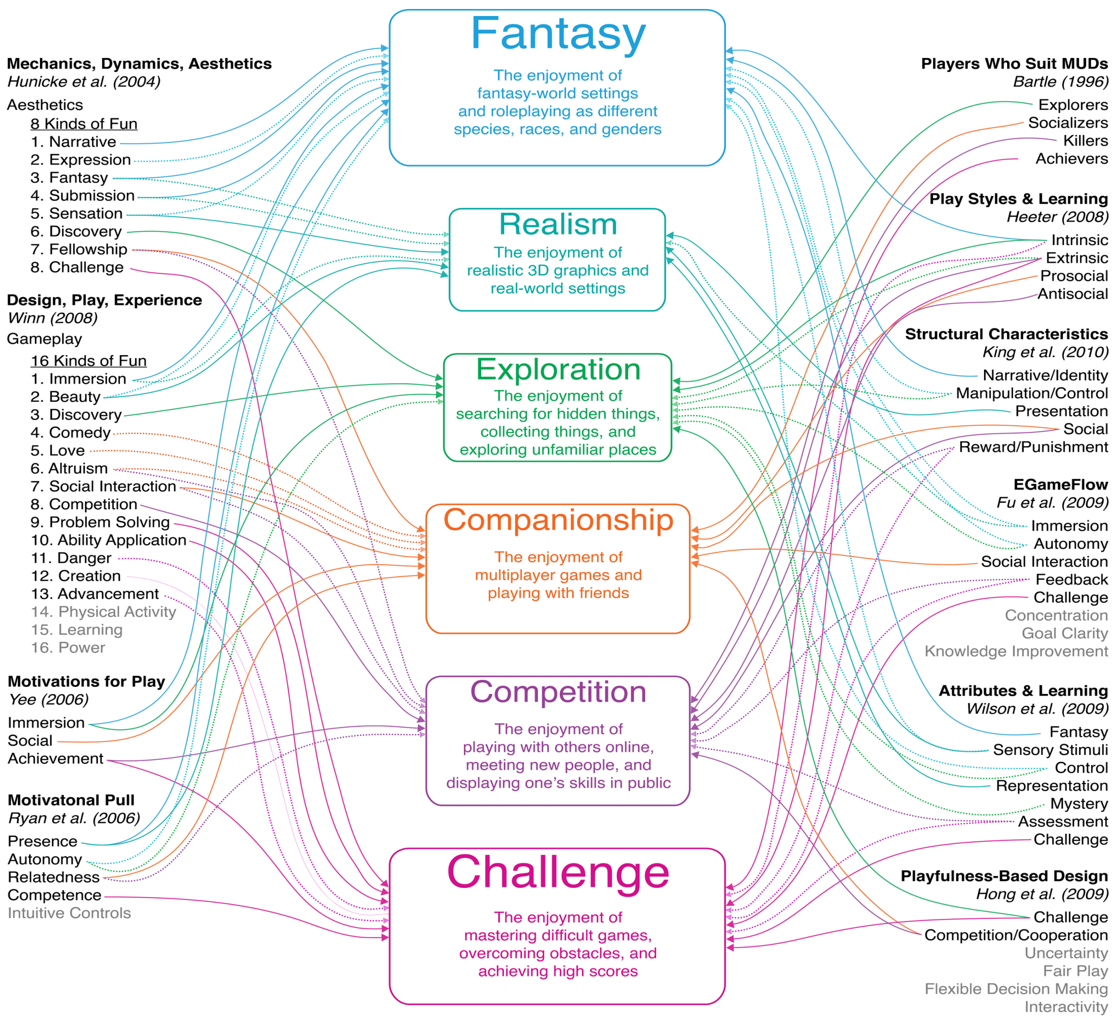


***Figure 1*. Comparison of past game design taxonomies to the taxonomy of undergraduate student videogame enjoyment. Solid lines indicate complete or strong relationships, while dotted lines indicate partial or weak relationships. No line indicates that no substantial relationship exists. Larger category sizes indicate a greater total number of relationships.**

Yee (2006) was also concerned with MMORPG players and motivation. He proposed a taxonomy of three main components (Immersion, Social, and Achievement), all of which relate strongly to aspects of the videogame enjoyment taxonomy found in this study. Immersion corresponds to Fantasy and Exploration, Social matches Companionship, and Achievement reflects Competition and Challenge. Additionally, Ryan et al. (2006) studied the motivational pull of a variety games along the five dimensions of Presence, Autonomy, Relatedness, Competence, and Intuitive Controls. Presence pairs with Fantasy and Realism, while Competence matches Challenge. Relatedness showed a strong connection to Companionship and a weak one to Relatedness. Meanwhile, Autonomy was weakly linked to Fantasy and Exploration. Only Intuitive Controls fails to substantially relate to a component of the taxonomy proposed in this study.

Three taxonomies focused specifically on learning games. EGameFlow (Fu et al., 2009) proposed a scale with eight factors, within which Social Interaction strongly relates to Companionship and EGameFlow's Challenge corresponds to Challenge in the in the videogame enjoyment taxonomy. Multiple partial links are found in EGameFlow's Immersion, Autonomy, and Feeback dimensions, whereas no substantial relationships are present in the Concentration, Goal Clarity, and Knowledge Improvement factors. Continuing, while the Playfulness-Based Design model (Hong et al., 2009) contains six dimensions, only two correspond to the videogame enjoyment taxonomy. Its Level of Challenge component relates strongly to Exploration and Challenge, while Its Opportunities for Competition and Cooperation component relates to Companionship and Competition. Lastly, Wilson et al. (2009) reviewed the literature and suggested seven components of games that impact learning outcomes. Their Fantasy, Representation, and Challenge components respectively relate strongly to Fantasy, Realism, and Challenge. Sensory Stimulation relates strongly to Realism and partially to Fantasy. Meanwhile, Control relates weakly to Fantasy and Exploration, Mystery relates weakly to Exploration, and Assessment relates weakly to Competition and Challenge.

Both the Mechanics, Dynamics, and Aesthetics (MDA) (Hunicke et al., 2004; Schell, 2008) and Design, Play, and Experience (DPE) (Winn, 2008) frameworks are extensive and holistic in nature. Therefore, the component of each that deals specifically with player enjoyment was analyzed. In the case of MDA, the Aesthetics component reveals eight kinds of fun in games, all of which relate to elements of the videogame enjoyment taxonomy. Similarly, DPE's Gameplay component suggests 16 forms of fun. Of these, 13 relate to the videogame enjoyment taxonomy, while three lack a substantial relationship.

Finally, in 2010, King et al. published a psychological taxonomy based on their ongoing study of the structural characteristics of videogames. This taxonomy presents five groups of game design features, titled Social, Manipulation and Control, Narrative and Identity, Reward and Punishment, and Presentation. Here, strong links are found between Narrative and Identity and Fantasy, Presentation and Realism, and Social and Companionship and Competition. Weak links occur between Manipulation and Control, Fantasy, and Exploration, and Reward and Punishment and Competition and Challenge.

Overall, the past game design taxonomies and the taxonomy of undergraduate student videogame enjoyment show very strong similarities. Of the 66 elements that compose the 10 past taxonomies, 55 (83%) have either a partial or complete relationship with one or more components in the videogame enjoyment taxonomy, while 39 (59%) have a strong relationship.

Of the 11 (17%) remaining components that exhibit no substantial relationships, it appears that these describe conditions surrounding gameplay rather than manipulable design characteristics, which were the focus of the videogame enjoyment taxonomy. For instance, Concentration, Goal Clarity, and Knowledge Improvement (Fu et al., 2009), Intuitive Controls (Ryan et al., 2006), and Fair Play (Hong et al., 2009) reflect player attributes and environmental circumstances to a greater extent than manipulable game design features.

Conclusion

In spite of their development for different purposes, with distinct populations, and using dissimilar methods, the past and present game design taxonomies show stark similarities. This suggests that research and practice in the field of game design has begun to identify genuine aspects of videogames that influence player perception. The provided taxonomy describes six key design features that affect undergraduate student videogame enjoyment. Continued research will refine and expand this taxonomy.

It is believed that there is an identifiable science that underlies the design of videogames. Future research in this area aims to distinguish the influential, manipulable design characteristics of videogames that affect player perception. In addition, it will identify the attributes of players that predict their reactions to game experiences. Ultimately, frameworks will be developed and tools will be provided to assist designers and educators in the creation of effective game experiences.

References

Bartle, R. A. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. Retrieved from http://www.mud.co.uk/richard/hcds.htm

Fu F. L., Su, R. C., & Yu, S. C. (2009). Egameflow: A scale to measure learners' enjoyment of e-learning games. *Computers and Education, 52*(1), 101-112.

Heeter, C. (2008). Play styles and learning. In R. Ferdig (Ed.), *Handbook of Research on Effective Electronic Gaming in Education* (pp. 826-846). Hershey, PA: IGI Global.

Hong, J. C., Hwang, M. Y., Lu, C. H., Cheng, C. L., Lee, Y. C., & Lin, C. L. (2009). Playfulness-based design in educational games: A perspective on an evolutionary contest game. *Interactive Learning Environments, 17*(1), 15-35.

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI-04 workshop on challenges in game AI.*

King, D., Delfabbro, P., & Griffiths, M. D. (2010). Video game structural characteristics: A new psychological taxonomy. *International Journal of Mental Health and Addiction, 8(1), 90-106.*

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion, 30*(4), 344-60.

Schell, J. (2008). *The art of game design: A book of lenses*. Burlington, MA: Morgan Kaufmann Publishers.

Wilson, K. A., Bedwell, W. L., Lazzara, E., Salas, E., Burke, C. S., Estock, J. L., Conkey, C. (2009). Relationships between game attributes and learning outcomes: Review and research proposals. *Simulation and Gaming, 40*(2), 217-66.

Winn, B. (2008). The design, play, and experience framework. In R. Ferdig (Ed.), *Handbook of Research on Effective Electronic Gaming in Education* (pp. 1010-24). Hershey, PA: IGI Global.

Wood, R. T., Griffiths, M. D., Chappell, D., & Davies, M. N. (2004). The structural characteristics of video games: A psycho-structural analysis. *CyberPsychology & Behavior, 7*(1), 1-10.

Yee, N. (2006). Motivations for play in online games. *CyberPsychology & Behavior, 9*(6), 772-5.

Acknowledgements

This research was supported by the Office of Naval Research (ONR) under grant 141010143 awarded to Robert K. Atkinson.

Simulating Failure: Why Simulations Don't Always Work

Carlton Reeve, Play with Learning Ltd, Sheffield, UK, Email: carlton@playwithlearning.com

Abstract

This paper assesses the circumstance and environment that makes game-based simulations effective learning tools for educational leadership training. It examines why a simulation produced for a large UK training organization failed to meet its objectives within a larger blended-learning program.

Despite extensive user testing during development more than half of participants regarded the simulation as "Not much use" as a learning resource.

The production failed to take into account a number of important user and use characteristics such as: integration with the wider programme of study, system scaffolding and peer support.

However, when used as a catalyst for group activity, the simulation proved far more effective. Its failure to work as an individual exercise but its success as a group tool offer valuable lessons about program design as well as insights into user behavior associated with games used in formal professional development.

Introduction

The use of simulations within educational contexts is well explored (Pratchett, 2005; Sandford & Williamson, 2005; Ellis, et al., 2006) but there have been relatively few sims aimed at educational professionals. In contrast the published successes of Ben Sawyer's *VirtualU* (Sawyer, 2002) and David Gibson's *simSchool* (Zibit, 2005), *Virtual School*, a sandpit for UK teachers failed to meet expectations.

Virtual School was one of the components for a leadership program developed by the UK's National College for School Leadership. The College was established by Prime Minister Tony Blair in 2000 to help develop leadership skills within English schools. Although the College inherited a number of existing programs, there was a need to develop new courses to fill perceived gaps in provision. Leading from the Middle was the first original program.

Leading from the Middle is a blended learning program that combines face-to-face activity, a school-based project and coaching with online materials. The College collaborated with Manchester Metropolitan University and a specialist media production unit from the BBC (where the author was lead producer) to make the simulation.

Leading from the Middle is aimed at emergent leaders, that is, Heads of Department, subject specialists or teachers with whole school responsibility. The program has five areas of focus:

- Leadership of innovation and change
- Knowledge and understanding of their role in leading teaching and learning

- Enhancing self-confidence and skills as team leaders
- Building team capacity through the efficient use of staff and resources
- Active engagement in self-directed change in a blended learning environment

The objective of *Virtual School* was to help address these areas by providing a semiotic domain (Gee, 2003) and practicum (Shaffer, 2008) in which teachers could experiment and build confidence in leadership scenarios. Specifically, *Virtual School* intended to:

- Raise awareness of ongoing issues
- Provide a 'sand-pit' for experimentation
- Stimulate discussion in online forums
- Provide scenarios to develop key skills, particularly communications
- Offer users the chance to role-play
- Illustrate key points from within the program modules

An implicit goal for the College was the improvement of teachers' confidence and competence when using information and communication technologies (ICT). As a consequence, like many other organizations (Simmons, 2002), the College put the majority of the Leading from the Middle materials on the institution's learning management system in a deliberate ploy to compel online engagement.

Use Context

Individual teachers playing *Virtual School* would start by setting up their own custom environment. This included choosing the phase of the school, that is, a primary, secondary or special educational needs school. They then chose an avatar. With the environment set up, teachers could choose which of five program areas or 'development strands' they wanted to practice.

Teachers could explore their virtual school, walk around corridors, click on doors and enter the various rooms. There were classrooms (Figure 1), the teacher's own office, the senior management base and the communal staff room. By looking inside these rooms teachers could get an immediate impression of the situation. Teachers could interrogate characters by clicking on them, revealing both graphic and text information regarding their current state.

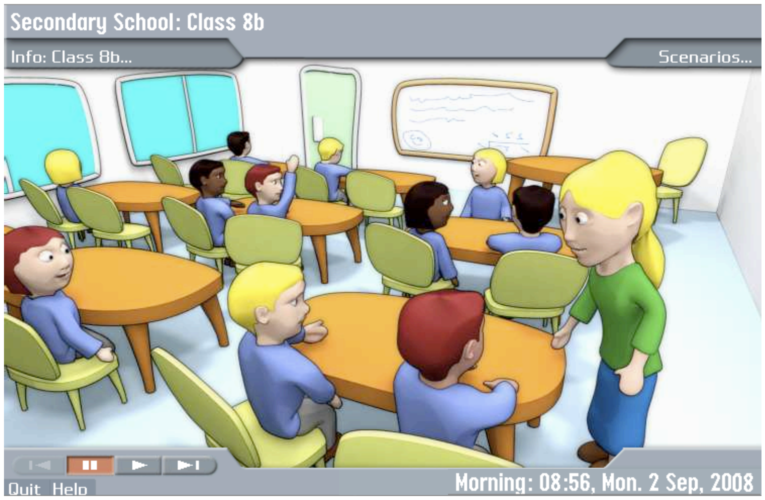


***Figure 1*. One of the classrooms in *Virtual School*.**

At regular intervals, scenarios from the chosen development strands would appear. The scenarios in *Virtual School* were the backbone of the learning. They were developed over a number of weeks with educational experts coordinated by Manchester Metropolitan University. Great attention was paid to making these scenarios authentic and credible. Each one had levels of detail associated with it offering teachers as much information as they required to make an educated decision. Each scenario had three plausible and equally valid responses to choose from.

The teacher had the option of finding out more information about the context of each scenario by referring to the other online resources (called Learn2Lead) or by posing a question to be online communities (Middle Ground). There was also the option to propose an alternative solution.

Teachers would choose the option they considered the most viable before proceeding back into the school.

In order to increase the degree of believability, the effects of each decision were split into short and long-term consequences as they would be in reality. The short-term consequences revealed themselves over the course of a number of *Virtual School* weeks and longer term ones manifested themselves after a term or so.

Feedback appeared in three different forms. Most immediately the graphics within the simulation would change. For example, teachers would see a difference in the disposition of characters within the school or, on entering the classroom, see an entirely new scene (Figure 2). Feedback was also delivered quantitatively through key performance indicators such as graphs measuring morale, levels of confidence, hours' worked, etc., and qualitatively in the form of text feedback describing the influence of the teacher's decisions on the characters within the school.

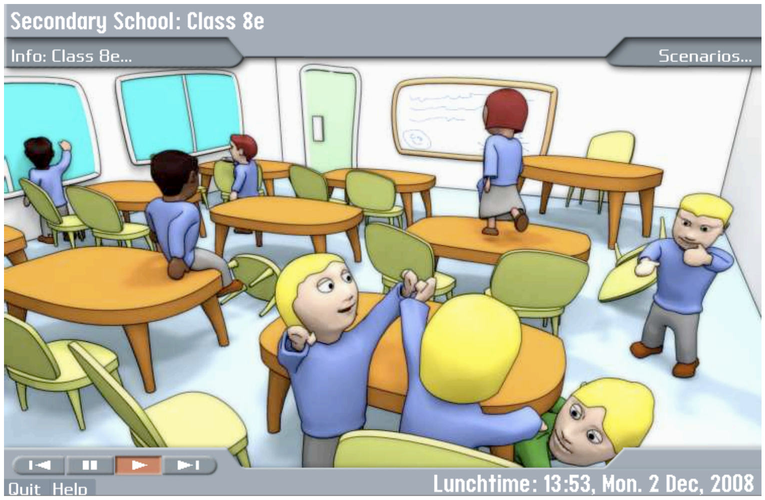


***Figure 2*. A transformed classroom within *Virtual School*.**

However, despite numerous rounds of development testing and evaluation (Reed et al, 2003), *Virtual School* did not meet its learning objectives. In an evaluation conducted after the end of the first cohort, 51% of the participants stated that *Virtual School* have been of little use (Table 1) (Simkins, et al., 2004).

Table 1: Usefulness of online materials according to participants.

Which parts of the program did you find most useful?	very useful (%)	of some use (%)	not much use (%)
Virtual School simulation	11	38	51
Learn2Lead materials	41	47	12
Middle Ground online communities	7	39	54

What is more, there is no evidence to suggest that any participants completed the entire game. In fact usage dropped off dramatically after the first (mandatory) session (Figure 3).

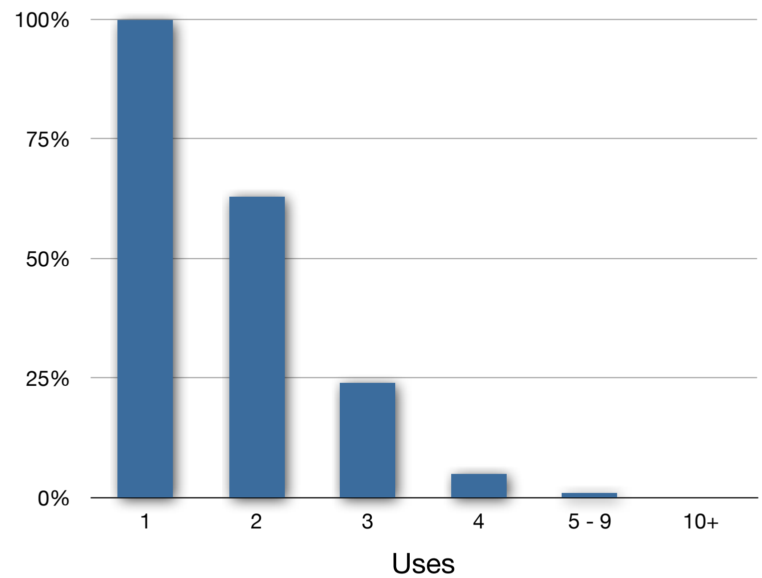


***Figure 3*. Participant usage of *Virtual School*.**

Areas of failure

The failure of *Virtual School* can be categorized into five areas:

- Engagement
- Feedback
- Integration
- Collaboration
- Culture

Engagement

Garris, et al. (2002) describes the cyclical relationship between the enjoyment of gameplay, the user's intrinsic motivation and the decision to keep playing, however, this simulation fundamentally failed to engage its users. It demonstrated a lack of variety, ability to fail and reward for participation. In use, there was little variation in the experience with participants witnessing a stream of scenarios that looked and felt very similar. Although each scenario affected whole school parameters, they remained discrete events within the narrative, that is, one decision did not trigger any subsequent situations, they merely compounded effects.

Worse still, unlike in ordinary games, players of the school could not fail. For political reasons none of the options in each scenario was allowed to have negative outcomes. This meant that it was impossible to transgress, break the school or even fall softly. This lack of failure prevented the participants from learning from mistakes, experimenting with risky behavior or developing remedial actions.

The other key flaw in engagement was the lack of obvious reward for participation. Although users received feedback throughout play, there were no rewards before the end of year completion certificate. This lack of 'texture' and recognition fatally undermined participants' motivation for what was an optional activity.

Feedback

The feedback mechanisms within *Virtual School* failed to deliver or promote clear understanding. The scenarios mixed quantitative and qualitative feedback but because it was staggered it was often difficult to associate the consequences with decisions made earlier. This messy feedback system was a deliberate decision and an attempt to recreate the chaotic environment of schools where cause and effect are rarely clear-cut. Indeed the implicit relationship between actions and events was intended to promote enquiry and discussion among participants (Figure 4).

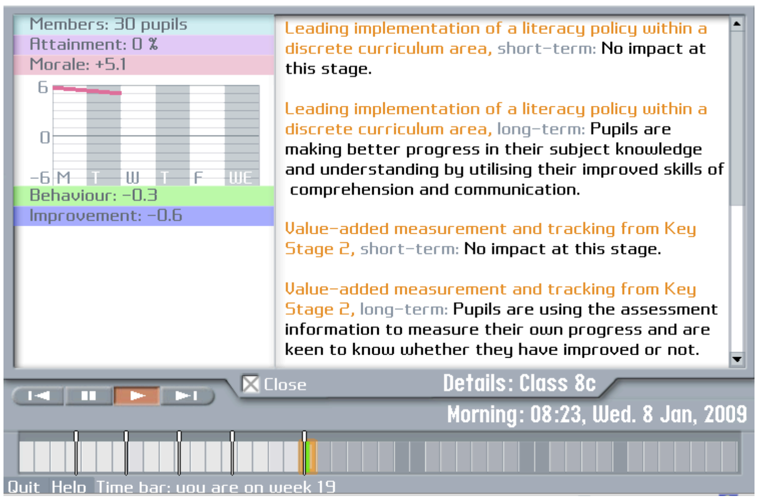


***Figure 4*. Feedback.**

However the lack of connection between two events caused participants much frustration and prevented them from being able to see how actions and consequences were tied together.

At the same time, the mixture of quantitative and qualitative data proved contentious. For simplicity, the simulation attempted to quantify intangible characteristics such as levels of confidence but did not offer more familiar metrics such as exam results.

What was needed in terms of feedback was clarity—more obvious associations between action and consequence, both in timing and substance. The risk of users attempting to subvert the model by manipulating these rules would have illustrated a commitment to winning (Salen & Zimmerman, 2004, p275) and a deeper desire to understand the simulation enough to control it.

Integration

Notionally, *Virtual School* had numerous links to the other online program content but in reality, using these connections meant leaving one system and joining another— a clumsy and time-consuming process. These token attempts at connecting the simulation to the other elements resulted in it being an isolated and optional activity. This lack of integration sent a powerful message to dubious participants about the value of and faith in the simulation exercise.

Rather than forming a complementary part of the user's dynamic narrative (Reeve, 2009) by offering participants the chance to experiment with approaches discussed previously or providing catalyst material for post-play discussion, *Virtual School* became an apparently unnecessary task.

To appreciate the value of the simulation it must be embedded within the overall course design as a structured activity and with a clear position in the learning narrative. Its inclusion must demonstrate a pedagogic rationale and include integrated links to other resources that create opportunities for reflection and complementary experiences that collectively build deeper knowledge and understanding.

As well as the carefully considered arrangement of components across the program, the simulation itself warrants a logical flow of internal events. Scenarios need meaningful sequencing that reinforces the learning and offers users the opportunity to test developing ideas in new contexts. The order and timing of the scenarios must form a central part of the learning design to provide opportunities to analyze situations, test and retest approaches and solutions and reflect on the process in such a way that users can clearly articulate and refine their thinking.

Collaboration

Virtual school was designed as a single player game with opportunities to collaborate in online communities. However because of the technical difficulties of combining two different technology platforms this collaboration with peers rarely, if ever, occurred. One participant noted, "In *Virtual School*, no-one can hear you scream." Even if unrecorded discussion occurred, there was little common ground in gameplay. The randomized sequencing of scenarios resulted in participants who had chosen identical options having entirely different experiences (or at least until they had played the whole *Virtual School* year).

Not only were players isolated from the real world, they received little support from characters within the game itself. Although the game included a school secretary, Margaret, she only appeared in the introductory tutorial and then disappeared from proceedings. She was the obvious candidate to provide feedback throughout the game and a little bit of scaffolding and moral support.

Culture

The final failure of *Virtual School* was the lack of appreciation of the participants' professional sensitivities and the prevailing political culture. Both the commissioners and the users inhabit a world under extreme scrutiny. As a consequence it is generally risk-averse. Investing in a 'game' as part of its first new program was a very risky strategy for the College and one that various stakeholders remained dubious about throughout production. This atmosphere profoundly affected the presentation and content of the sim.

Although apparently of only superficial value to professional users learning in their working environment, the look and feel of the resource not only creates a crucial first impression, it provides ongoing feedback and is the user's most immediate and intimate connection to the game. *Virtual School* demonstrated the characteristics described by Allen, Hays and Buffardi (1986) in that the visual accuracy of the environment is less important than the content to users. However, rather than providing a transparent window on the workings of the model, the look and feel became an issue for commissioners if not for users.

Response and revisions

Based on the evaluation, *Virtual School* was revised in a number of crucial ways stripping it of most of its game-like characteristics (Figure 5). Critically, the simulation was shattered into component parts: the scenarios were disaggregated so that participants could focus on one event at a time.

The design was also revised to be less cartoon-like and use photographs of real schools instead of graphics.

Crucially *Virtual School* became a more integrated part of the overall program meaning that there was a coherent narrative between components and a purpose for participating.

Perhaps the most significant change was the revision to use context. Rather than being a solitary activity, *Virtual School* became a group endeavor. Participants now look at a scenario together and discuss the most appropriate action before deciding on a response. Because of the disaggregated nature of the new version they can immediately see the consequences of their actions and debate the validity of the computer outcomes.

Figure 5. Revised Virtual School.

Conclusions

In her meta-analysis of the effectiveness of simulations, Sitzmann declares that:

Post-training self-efficacy was 20% higher, declarative knowledge was 11% higher, procedural knowledge was 14% higher, and retention was 9% higher for trainees taught with simulation games. (Sitzmann, 2011, p489)

However, she goes on to say:

Trainees learned less from simulation games than comparison instructional methods when the instruction the comparison group received as a substitute for the simulation game actively engaged them in the learning experience. (ibid)

For the Leading from the Middle audience, the effectiveness of substituted material proved entirely accurate. There are three key lessons that we can take away from this experience.

Authenticity is a double-edged sword. Whilst seeking to be credible, we run the risk of our games becoming too lifelike and dull. As Tennyson and Jorczak (2008) note, although simulations are distinguished by being based on reality they incorporate game mechanics to increase engagement. Yet for professionals, fun activities can appear suspicious, at risk trivializing or being perceived to trivialize important issues. As Sitzmann (2011) identifies, the entertainment value of simulations does not affect the amount users learn but it clearly influences motivation.

Games remain a contentious addition to the suite of learning formats in professional settings so users benefit from knowing why a game has been included in the resource list. A simulation needs a clear purpose within any blended program, that is, plainly identified objectives for its use and a specific role within the wider learning ecology. This clarity of intention is essential if users are to gain a sense of progress and meaning from a multitude of activities, particularly those not to the user's traditional taste or more usually associated with "unproductive fun".

Finally, peers are everything in adult learning. Just as games have the most impact when they become shared experiences (Caillois, 2001 p39) we know that adults learn most effectively through 'conversation' based on experience (Pask, 1975; Laurillard, 1993). Making the most of social interactions is central to these resources being effective. Greater involvement by the community in each user's experience would allow increased shared skill development. In these circumstances it is not the explicit transfer of information from more skilled participants but the evolved social understanding of the context that improves understanding (Lave & Wenger, 1991). Lave and Wenger characterized these 'communities of practice' by "joint enterprise", "mutual engagement" and a "shared repertoire of community resources." Furthermore, the ongoing nature of these communities encourages continuing professional development: learners remain current in their field through the connections formed (Siemens, 2004).

References

Allen, J. A., Hays, R. T., & Buffardi, L. C. (1986), Maintenance training simulator fidelity and individual differences in transfer of training, Human Factors, 28(5), pp497-509

Caillois, R., (2001), *Man, Play and Games* [Les jeux et les hommes, 1958], University of Illinois Press, Urbana & Chicago.

Ellis, H., Heppell, S., Kirriemuir, J, Krotoski, A., & McFarlane, A. (2006), Unlimited Learning: the role of computer and video games in the learning landscape, ELSPA, Available at http://www.elspa.com/assets/files/u/unlimitedlearningtheroleofcomputerandvideogamesint_344.pdf. Accessed 29 November 2010

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. Simulation & Gaming, 33, 441-467.

Gee, J. P. (2003), What Video Games have to teach us about Learning and Literacy. New York: Palgrave Macmillan

Lave, J. E., & Wenger, E. (1991), *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press,

Laurillard, D., (1993), *Rethinking University Education: a framework for effective use of educational technology*, London: Routledge

Pask, G. (1975), *Conversation, Cognition, and Learning,* Elsevier, New York

Pratchett, R. (2005). Gamers in the UK: Digital play, digital lifestyles. London: BBC New Media & Technology, Creative Research and Development. Available online at http://crystaltips.typepad.com/wonderland/files/bbc_uk_games_research_2005.pdf. Accessed 11 March 2011

Reed, J., McCallum, B., Askew, S. & Evan, P. (2003), Interim Report of the Evaluation of the Pilot of "Leading from the Middle", International School Effectiveness and Improvement Centre, Institute of Education, London

Reeve, C. (2009), Narrative-based Serious Games, In Petrovic, O & Brand A. (eds) *Serious Games on the Move*. Vienna: Springer

Salen, K. & Zimmerman, E., (2004), *Rules of Play: Game Design Fundamentals*. Cambridge, Massachusetts: MIT Press,

Sandford, R. & Williamson B. (2005), Games and Learning, NESTA Futurelab, Available at http://www.nestafuturelab.org/download/pdfs/research/handbooks/games_and_learning.pdf. Accessed 11 March 2011

Sawyer, B. (2002), Serious Games: Improving Public Policy through Game-based Learning and Simulation, Foresight & Governance Project, Woodrow Wilson Center, Available at http://wwics.si.edu/foresight/index.htm. Accessed 11 November 2009

Shaffer, D. W. (2008), *How computer games help children learn*. New York: Palgrave Macmillan.

Siemens, G., (2004), Connectivism: A Learning Theory for the Digital Age, http://www.elearningspace.org/Articles/connectivism.htm. Accessed 18 March 2011

Simkins, T., Coldwell, M., Caillau, I., Finlayson, H. & Williams, J. (2004), Leading from the Middle - Evaluation of Cohort 1, Sheffield Hallam University

Simmons, J. (1992). The forum report: E-learning adoption rates and barriers. In A. Rossett (Ed.), *The ASTD e-learning handbook*, New York: McGraw-Hill.

Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personal Psychology* (64), 2, 489-528.

Tennyson, R. D., & Jorczak, R. L. (2008). A conceptual framework for the empirical study of instructional games. In H. F. O'Neil & R. S. Perez (Eds.), *Computer games and team and individual learning* (pp. 39-54). Oxford, UK: Elsevier.

Zibit, M., & D. Gibson. (2005), simSchool: The game of teaching, Innovate 1 (6), http://www.innovateonline.info/index.php?view=article&id=173. Accessed 24 April 2008

The Challenge of Assessing Learning in Open Games: HORTUS as a Case Study

Dr. Franziska Spring, Dr. James W. Pellegrino,
Learning Sciences Research Institute, University of Illinois at Chicago, United States,
Email: franspring@gmail.com , pellegjw@uic.edu

Abstract

Educational designers and researchers are faced with new challenges when it comes to the design of open games for learning that allow players to choose their own solution path through the game. The goal of this empirical study with 70 university students was to be able to tell at any point in the game what the player knows and whether a specific learning goal has been attained. The analysis of learning success considered two performance categories: continuous improvement and learning by failure. An in-game assessment and an external posttest served as verification of a player's hypothesized state of learning. Behavioral patterns extracted from game playing provided evidence of a player's learning success or failure and were shown to have predictive accuracy.

Introduction

Researchers agree that games often provide deep conceptual and meaningful learning (Gee, 2003; Shaffer, 2006; Squire, 2008). However, little is known of how original games provide effective learning and how they effect learners (Squire, 2008). This paper concentrates on so-called open games for learning and begins by considering what they are and how players learn in such games. This is followed by a discussion of the state of the art regarding assessment of learning in games. The majority of the paper presents a case study of learning in the game *Hortus*. The game's learning goals are described, as well as how they are assessed, followed by a discussion of empirical results. We conclude with an outlook regarding future prospects and challenges in this area.

Open Games and Learning

Open games are similar to simulations, as they provide an open environment where learners are loosely guided and can choose among multiple pathways. The most popular examples of this genre applied to an educational context are commercial games like *Civilization* or *Sim City*. There are a variety of goals that have to be attained in order to win the game. Learning is regarded as the understanding of systems and their dynamics. Learners are encouraged to experiment and to experience causalities of a virtual world. The strengths of open games are that they feature layers of complexity that promote curiosity, discovery, and replayability—important characteristics for intrinsic motivation (Malone, 1987).

There are only a few studies that investigate how people learn in open games and simulations. Usually, the nature of the game dictates learning goals to a certain degree and open games cover a variety of such goals. They include conceptual understanding, science process skills, or scientific discourse (Honey and Hilton, 2011). The most popular learning goal is conceptual learning (Honey and Hilton, 2011; Gee, 2005; Squire, 2008). Conceptual learning involves gaining an understanding and applying rules and concepts of a system, such as the functioning of machines, the human body, or horticultural systems. Learning within games involves many processes such as learning through failure, learning by practice, and learning through competition (Gee, 2003, 2005; Squire, 2008, 2011). Learning by failure and the practice principle are our focus because they are applicable to learning in *Hortus*.

Failure takes on a different meaning in a playful learning environment. If players fail in a game, the worst that could happen is the death of their character or the destruction of their city. But after resurrecting the character or rebuilding the city, they can try again. Learning in games tolerates failure without real punishment. This allows trying out different solution paths and going to the limit of the system while remaining on the safe side without any real-world consequences.

Practice is very important in games. Games provide situations and opportunities where players have the chance to practice their recently learned skills. Other than in drill and practice games, these situations are embedded into the story of the game. Suddenly, practicing skills until they become routine is not boring anymore, but rather meaningful in a situated context. Players can achieve a mastery level for certain skills and new skills have to be learned or combined with old ones to meet the next challenge.

Assessment of Game-Based Learning

Assessment of learning from games is usually conducted apart from the game using traditional methods such as multiple choice questions (Burgos, 2008; Tan & Biswas, 2007; Wang, 2008) or qualitative interviews (Galarneau, 2005; Squire, 2008; Squire & Durga, in press). Shaffer (2009) assesses epistemic games with so-called epistemic frame inventories (EFI). In epistemic games, players take over the role of professionals in the respective field. This rather new assessment concept deals with a variety of methods to assess players in a specific knowledge domain. For instance, players have to create concept maps or they are asked to use their learned skills to solve designed tasks. Those methods, however, are not integrated in the game environment. This can be contrasted with the assessment approach in the project "SimScientists" (Quellmalz et al., 2009a, 2009b) which has the goal of encouraging model-based reasoning in science. Students learn about food chains in simulation environments with embedded interactive tasks. In the context of the simulation, students have to categorize fish in the hierarchy of the food chain and their decisions are immediately assessed.

There are few cases of knowledge assessments seamlessly integrated into a game. Furthermore, such assessments are usually highly structured so that learners have to take the same paths as other learners. In open games, learners are not restricted by given paths. Learning progress in open games is defined as a change in a learner's reaction to a certain event or situation in the game and it is difficult to monitor or to control. This reaction is manifest as either an increase or decrease in performance. The challenge is to develop approaches to assessment that respect the characteristics of open games and do not interrupt play flow. We next describe a case study of attempting to do so in the open game *Hortus.*

Figure 1. Hortus – Level 2.

Hortus – A Case Study

Hortus is an online strategy game specifically designed for research on open games and assessments. It is turn-based which means that most of the progress in the game is only visible after the player actively clicks a 'Next Day' button. The player takes over the role of an herbalist who has to create a potion to heal the sick people in the village. Therefore, players have to plant herbs in their garden plot, grow them, and harvest leaves for the potion. The game consists of four levels. The first level is a tutorial where players learn the basic skills of herb growth such as planting, watering, and harvesting. In levels 2 and 3, new herbs are introduced (see Figure 1). Those herbs interact with each other either positively (symbiotic) or negatively (competitive). Level 4 provides a starting situation and serves as an in-game assessment. Each player has the same goals and the same number of days in which to finish a given level and it is up to the player how quickly and efficiently they reach the game goal.

Learning Goals

The player has to learn six different plant interactions that are produced when placing different kinds of herbs next to each other (see Figure 2). The visual display indicates how well the player is using those relations and feedback occurs in various ways. An overall score rates how well a player takes advantage of those interactions. Within each turn, the rating changes and indicates an improvement or decrease in the performance of the player. The score is only kept for one level and restarts when moving to the next level. When herbs are placed next to each other on the plot, the player receives immediate visual feedback in the form of tiles that represent the nature of the interaction. Players have to build up their own hypotheses from this information as to the quality of the interaction. Another source of information is the number of leaves growing on each herb. A positive plant interaction accelerates leaf growth drastically while a negative interaction stops or even removes leaves from the herbs.

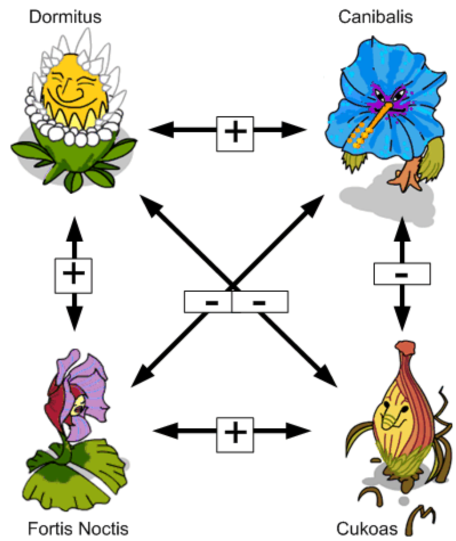


***Figure 2*. Four plants with six different interactions**

Verification of Learning Goals

A player's learning, i.e., was a specific plant interaction understood?, can only be assessed in an indirect way by analyzing performance patterns. It is assumed that players with good strategies, meaning a short number of turns and a high number of positive interactions, have understood most of the plant interactions because they are able to apply their knowledge in the form of a strategy. For a more detailed assessment of specific learning goals, they are divided into two categories: improving performance (positive interactions) and learning by failure (negative interactions). It is assumed that a player has to experience all plant interactions in order to learn them. This is also true for negative interactions. The more positive interactions a player has, the more likely it is that he understood each interaction and is able to use that knowledge in developing a play strategy. Improving a player's performance is a modified version of Gee's practice principle. For negative interactions, the player has to experience each at least once but then has to avoid them. There were two kinds of assessments designed to verify the assumptions above. First, there is an in-game test scenario (Level 4). Figure 3 shows the starting situation the player has to modify. It is a particularly problematic situation and the assessment is whether all the negative interactions (dotted tiles) disappear and the positive tiles (wavy tiles) increase in number in the first turn. As a second verification, there is an external posttest in which players have to solve different tasks that are related to the learning goals in the game.

***Figure 3*. Level 4 – Test scenario with a bad starting situation**

The Participants

153 college students were recruited for the online study: 22 from the United States, 117 from Austria, and the remainder from other countries. Their ages ranged from 18 years to 61 years. For analysis purposes, a valid data set required that each player finish Level 4 in his or her first attempt. 70 participants met this criterion and their data contributed to the analysis corpus. The online experiment included playing the game—approximately 45 minutes—and taking the posttest—approximately 5 minutes.

Results and Discussion

The player's overall game score, summarized across all negative and positive interactions, increased as the player used more positive interactions. However, the score did not reveal how many times a player used particular plant relations—only how many were used in total. Thus, the information derived from the overall game score could only indicate an increase or decrease in the use of positive and negative relations in general, and is only a gross indication of the progress of learning. Therefore, to more precisely assess learning, the categories of positive and negative interactions were analyzed separately to determine if a specific interaction was "known" and being used in game play.

Analysis of Positive Interactions

Players need to learn about plant interactions that are symbiotic and cause plant leaves to grow faster. The leaves are necessary for the potions to heal the sick villagers in the game, which is the desired end state. The more symbiotic relations a player has in their garden plot the faster the game goal is achieved. As mentioned before, players have to experience specific positive interactions in order to understand them. However, the challenge was to find out how many experiences of this kind were necessary so that a “hypothesis” could be generated that a relation was learned. Eventually, for every player, a so-called ‘breakthrough moment’ was identified. This moment is detected by searching for the current maximum of positive interactions on the field. The maximum has to be equal to or higher than the median value over all players’ maximum of positive interactions for the current level.

For example, the plant relation Dormitus – Canibalis had to be learned in level 2. The median value for this relation was 4 for a learning breakthrough. Table 1 shows a player (ID 62) with a breakthrough moment at Turn 6, with 8 positive interactions—well above the median value. The same player showed a similar strong pattern throughout for all plant interactions. However, not every player had such a clear behavior pattern. Some players put a strong emphasis on only specific plant interactions while neglecting others. It is assumed that a player’s strategy plays an important role in this behavior.

Table1: Player ID 62 shows a learning breakthrough from turn 5 to 6.

Can_Dorm	Level	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4
	NoOfTimesReplayLevel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Turn	0	1	2	3	4	5	6	7	8	9	10	11	12	0	1	2	3	4	0	1	2
	NoOfPosInteractPerTurn	0	0	0	0	0	0	8	8	8	8	8	8	8	5	4	4	5	5	5	5	5

In Level 4, players had to re-organize a given situation that contained many negative plant relations (see also Figure 3). In our example, the criterion to pass level 4 for the relation Dormitus – Canibalis required that there be at least 3 positive interactions in the first turn (median value for this plant relation). Thus, player ID 62 passed this test with 5 such interactions in the first turn. The small number of turns in level 4 (3 turns out of 10 possible) also shows use of a good strategy overall.

When analyzing all the positive interactions over all players, there was a 70% match between the game results (met/not met the criterion) and the Level 4 test scenario results (passed/failed). This means that learning success or failure at Level 4 for a given learning goal can be predicted with a 70% probability based on play information from level 2 or 3. The predominant tendency was over-prediction of learning. While this is an adequate level of prediction, one would ultimately like a higher degree of match.

Negative Interactions

The negative plant interactions were learned through experiencing them and then showing avoidance. A player was assumed to have understood a negative interaction when there was a breakthrough moment followed by no further negative interactions—called the ‘flat phase’. The breakthrough moment in this context is defined as a temporary increase in the number of negative interactions. In the best case, a player only has one breakthrough moment followed by a flat phase until the end of the game. However, this kind of behavior has to be assessed in each level of the game. Someone with several breakthroughs and hardly any flat phases in between is not likely to have achieved the learning goal. Therefore, the criterion for passing the Level 4 test scenario is quite strict. The player was not allowed to have any negative interactions in the first two turns. It is expected that if a player acquired this knowledge, he would remove all the existing negative interactions and also try to avoid them in the future. The example in Table 2 shows a player who had a successful negative breakthrough followed by a flat phase until Level 4.

Table 2: Player ID 62 reduced the five negative interactions to zero.

Dorm_Cuk	Level	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4
	NoOfTimesReplayLevel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Turn	0	1	2	3	4	5	6	7	8	9	10	11	12	0	1	2	3	4	0	1	2
	NoOfNegInteractPerTurn	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3 shows a player who did not meet the learning goal. He had several peaks with a high number of negative interactions but no real flat phase. From the eight given negative interactions in the starting scenario of Level 4, he left half of them on the field. When analyzing all the negative interactions, the data revealed a 83% match between the game results (met/not met) and the test scenario results (passed/failed). This means that a learning success or failure can be predicted with 83% probability based on performance in level 2 or 3. Clearly, prediction in this case was superior to positive interactions.

Table 3: Player ID 156 had continuously negative relations.**Error! Not a valid link.**

Dorm_Cuk	Level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4
	NoOfTimesReplayLevel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0
	Turn	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	0	1	2	0	1	2	3	4	5	6	7	0	1	2
	NoOfNegInteractPerTurn	1	1	1	1	2	2	1	3	3	4	3	3	3	2	2	4	4	2	2	2	2	0	2	1	1	1	4	4	1

Posttest

Initially, a knowledge posttest was developed, designed to verify learning results from the game. Although the test questions seemed to be a fair assessment of the learning goals, the results were not promising when compared with the game data. Only 50% of the cases matched the game results. Players who used many positive plant interactions still gave incorrect answers in the posttest. The opposite also occurred—weak game players answered the posttest questions correctly. An explanation for this incompatibility may be that questions in the posttest require a different kind of knowledge than that learned in the game. In the game, players receive immediate feedback when they place plants on the field. In the test, players had to actively associate interaction type with the plants. While players might be aware of the different interactions and plant associations as part of sophisticated game playing strategies, they might not be able to apply or transfer this knowledge to a more abstract environment as represented by problems presented in the posttest. Thus, their knowledge may be highly situated in the game that circumscribes transfer. This clearly is a matter that needs further investigation.

Conclusions and Future Directions

The game score reflected how well a player took advantage of the plant interactions, but not if each relation was understood. By categorizing the negative and positive interactions into classes of learning goals such as ‘learning by failure’ and ‘learning by improving performance’, respectively, it was possible to abstract behavioral patterns that indicated successful learning of specific information. In addition, it was easier to detect if a player learned the negative interactions by avoidance than analyzing a continuously improving strategy based on positive interactions. When analyzing all the positive interactions, the data revealed a 70% match between the game results (met/not met) and the test scenario results (passed/failed). In contrast, the negative plant interactions revealed an 83% match.

Educational designers and researchers are confronted with many issues when it comes to designing open games for learning. The chasm between 'learning' and 'fun and motivating' is difficult to bridge. First, there is the challenge to walking a fine line between developing an exciting game and designing learning goals that do not compete with the game goals. For instance, a player's strategy in *Hortus* might result in a weak and unclear behavioral pattern where it is not possible to see if the learning goals were attained. Second, there is the dilemma of setting restrictions on choices in the game to enable the assessment of learning. A game with confined choices makes it easier to assess learning than one where players are free to explore but it also runs counter to the nature of open games. These two issues require further investigation and analysis.

Simulations and complex game-like learning environments are growing in use and importance in our society (e.g., Honey & Hilton, 2011). With the improvement of technology and increasing experience with these kinds of learning environments, more complex learning scenarios should be possible that can enhance the nature and quality of learning. However, assessment methods have to be aligned with the learning environment to support the effectiveness of such learning environments.

References

Burgos, D., Moreno-Ger, P., Sierra, J., Fernandez-Manjon, B., Specht, M., & Koper, R. (2008). Building adaptive game-based learning resources: The integration of ims learning design and <e- adventure>. *Simulation Gaming*. 39(3), 414-431.

Galarneau, L. (2005). Authentic learning experiences through play: Games, simulations and the construction of knowledge. Paper presented at the DiGRA, Vancouver, Canada.

Gee, J. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

Honey, M. A. & Hilton, M. H. (2011) Learning Science: Computer Games, Simulations, and Education. National Research Council. Washington, DC: The National Academies Press.

Malone, T. W. & Lepper, M. R. (1987) Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.). *Aptitude, learning, and instruction. III: Conative and affective process analysis*. Hillsdale, NJ: Lawrence Erlbaum Associates, pp. 223-253.

Quellmalz, E. S., Timms, M., & Buckley, B. (2009a) Using science simulations to support powerful formative assessments of complex science learning. *WestEd*.

Quellmalz, E. S., Davenport, J., Timms, M., & Buckley, B. (2009b) Quality science simulations for formative and summative assessment. *WestEd*.

Shaffer, D. W., Hatfield, D., Svarovsky, G. N., Nash, P., Nulty, A., Bagley, E., et al. (2009) Epistemic network analysis: A prototype for 21st century assessment of learning. *International Journal of Learning and Media*, 1(2), 33-53.

Shaffer, D. (2006). *How computer games help children learn*. New York: Palgrave Macmillan.

Squire, K. (2011). *Video games and learning: Teaching and participatory culture in the digital age*. New York: Teachers College Press.

Squire, K., & Durga, S. (in press). Productive gaming: The case for historiographic game play. To appear in R. Ferdig (Ed.) *The handbook of educational gaming*. Hershey, PA: Information Science Reference.

Squire, K. (2008). Open-ended video games: A model for developing learning for the interactive age. In K. Salen (Ed.) *The ecology of games: Connecting youth, games, and learning*. (167-198) Cambridge, MA: The MIT Press.

Tan, J. & Biswas, G. (2007) Simulation-based game learning environments: Building and sustaining a fish tank. In: *Proceedings of the First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning*, Jhongli, Taiwan, pp. 73–70.

Wang, T. H. (2008) Web-based quiz-game-like formative assessment: Development and evaluation. *Computers and Education*. 51, 1247–1263.

Let Me Know When She Stops Talking: Using Games for Learning Without Colonizing Play

Constance Steinkuehler, Elizabeth King, Esra Alagoz, Gabriella Anton, Sarah Chu, Jonathan Elmergreen, Danielle Fahser-Herro, Shannon Harris, Crystle Martin, Amanda Ochsner, Yoonsin Oh, V. Elizabeth Owen, David Simkins, Caroline Williams, & Bei Zhang, University of Wisconsin–Madison, 225 N. Mills, Madison
Email: constances@gmail.com, emking29@gmail.com, esraalagoz@gmail.com, gabby.anton@gmail.com, gabby.anton@gmail.com, jelmergreen@gmail.com, daniherro@gmail.com, shannon.linehanharris@gmail.com, crystle.martin@gmail.com, amanda.ochsner@gmail.com, yoonsinoh@gmail.com, v.elizabeth.owen@gmail.com, dwsimkins@gmail.com, caro.williams@gmail.com, bzhang17@gmail.com

Abstract

This paper describes the original designed lab structure for the Games+Learning+Society Casual Learning Lab, an afterschool program for teenage males who were struggling or chronically disengaged with school. In it, we detail the lab's intended design and how it proved to be entirely wrong-headed. The paper then goes on to describe in situ changes we made to the program, as well as lessons learned from the failure of its original design.

Original Intentions

The Games+Learning+Society Casual Learning Lab was an afterschool lab run at the University of Wisconsin–Madison. The idea behind the lab was to use *World of Warcraft* (*WoW*) as a gateway activity to revitalize young people's intellectual interest in intellectual or "smart" practices affiliated with K-12 education and college. Our hope was that we would create a means for developing *WoW*-related pro-academic practices and dispositions identified in prior research, such as digital and print literacy, problem solving, and model-based reasoning. From this view, the game was seen as a vehicle for doing intellectual practices and the lab an "incubator" of those practices. Not all participants were *World of Warcraft* players, but all were initially interested in playing games, so the idea of using a game as a way to reinvigorate the academic and general interests of participants seemed obvious given our previous studies demonstrating the game's merit as an intellectually rich space (Steinkuehler, 2007; Steinkuehler, 2006a; Steinkuehler, 2006b, Steinkuehler, 2006c; Squire & Steinkuehler, 2006; Steinkuehler, Black, & Clinton, 2005).

As initially conceived, the lab was to use a quasi-structured format as a way to create a "bridging third place" (Steinkuehler & Williams, 2006) between school and home, with games as our bridging component. The formal research question for this lab was, "Can we create a bridging third place based on online games to incubate key norms & and practices?" We wanted this especially for boys. Why boys? Only 65 percent of boys graduate from high school compared to 72 percent of girls (Greene and Winters, 2006). Boys score lower on NAEP tests and other basic literacy assessments than girls (Lee at al., 2007). They also consistently underperform in and opt out of literacy related courses (Gilbert and Gilbert, 1998; Rowan et al., 2002). Boys have been statistically shown to do less well in school than girls—however, boys are also traditionally the main players of videogames and the majority of inhabitants of virtual worlds like *World of Warcraft.* Thus, the idea of creating an environment that might reconnect boys, with school with their gameplay function as the bridge, was compelling.

The participants in the lab were males ages 13-18 from urban and rural areas near the university. The project was run over the course of two years: The pilot program was run in 2008 and had a total of 9 participants; the formal study was run in 2009 and had 22 participants. One principal investigator (PI), along with 8 doctoral students, and 6 undergraduate students, ran the lab and provided mentorship and resources for the participants. The original idea of this lab was to "seed" intellectual practices through activities that were related to or based on the content of the game (Steinkuehler & King, 2009). Specifically, in the first semester we planned to collectively design, write, and implement a guild website as a means for fostering digital and print literacy. The participants were to be mentored through the process of creating a guild website. This would position the participants to learn website development skills, like basic coding, and also graphic design skills that would be used in web layout and the aesthetics of the site. In the second semester, we arranged to write graphic novels based on *WoW* gameplay using in-game screenshots and with the helpful inspiration of a professional graphic novelist's mentoring. The graphic novelist would come in and work with the participants to teach them the art and design fundamentals of creating a graphic novel, as well as how to integrate key literary elements (especially overarching narrative and character development). With this plan in place, the formal year of the program began.

Figure 1. **Participants at a Saturday session.**

Failure and Redesign

Within the first month of our program, our plan showed itself to be a real failure. The moment the projects were first introduced into the Saturday face-to-face sessions, the teenage participating guys totally turned off and tuned us out. In fact, anything and everything that we did that looked or smelled like school to the guys in our lab was met with utter disengagement or worse, muttered ridicule. Anytime we tried to implement a structured activity, we would run into what we have termed the "Let-me-know-when-she-stops-talking Problem". This problem entails the complete disengagement of participants until the staff stopped talking. This response was a complete surprise. As conceived, the planned activities did not appear to us as being school-like on any level. Instead, we viewed them as fun, un-school-like opportunities to expand skills. Our participants clearly disagreed. The level of disengagement was such that guys in the lab would pull their hoodies up over their heads, fold their arms, and stare at the table anytime the PI started to talk about an activity or introduce content.

One approach to this problem would have been to solider on, trying to reengage them with content that they viewed as resembling school (an institution that they already found thoroughly disengaging), and try to either change their minds about the scholastic nature of the task or convince them that school was fun. However, this threatened to be a strenuous uphill battle unlikely to yield any positive buy-in to the program from the participants. So instead of taking this path, which seemed unnecessarily difficult and almost adversarial, we revised our strategy completely.

The negative reception of our originally conceived program forced us to completely recreate the structure, function, and justification of the casual learning lab in order to evade complete loss of engagement, which we saw as an anathema of games and learning of any form. The new strategy focused on *following the interest of the boys*. This shifted the organization of the lab from a structured, activity-centered design to a design that focused on observation of the participants' interests and habits and the staff resourcing these participant-driven directions in whatever way possible. When two participants showed an emerging interest in fiction based on the "world" of *World of Warcraft*, staff scrambled to locate and then provide graphic and textual novels to make readily available to them to take home.

Figure 2. **Saturday Structured Activity**

The revised "structure" of the lab shifted from designed pedagogy to something much more akin to a typical Montessori classroom. Participants themselves decided what content they cared to dive in to and when. The lab met monthly in a face-to-face setting in an on-campus game lab, as well as meeting within the game to collaborate in gameplay whenever the participants were playing. The researchers set up a schedule of "lifeguarding" times, where they were online and playing with them, so if a participant needed anything they were available. Participants and researchers alike joined a guild so that they could participate in in-game activities together more easily. Many of the participants were higher-level players than the researchers, so mentoring happened in both directions—from researcher to participant, and participant to researcher. The lifeguarding sessions included the researchers recording the in-game chat for later analysis and taking screenshots of interesting moments. The participants also posted asynchronously on forums created on their guild website. Throughout all interactions, staff played alongside participants and functioned as resources for them only when they identified a need for such. We observed their needs and interests, resourced the environment to support their work, and stuck to the Montessori mantra of "Follow the needs of the child."

Figure 3. **Participants in-game.**

Revised Research Agenda

Overall, the lab collected 8 months of ethnographic data as well as data from 5 studies that focused on comparison between knowledge, skills and dispositions related to games versus school. These studies included reading, online reading comprehension, social reasoning, and epistemological beliefs. Our revised main objective was not to measure changes over time due to "intervention" as originally conceived but rather to resource and trace individual learning trajectories and interests throughout the duration of participation and later attempt to describe and analyze what happened and why. The data set consists of 454 photos, 66 forum posts, 100+ hours of video, and 2506 pages of in-game chatlogs. The data was collected in the qualitative data analysis software NVivo and coded with a broad content coding scheme based on previous games literature that, we felt, would provide a broad enough net to catch most (although not all) emerging intellectual practices and skills. The analytic framework included 11 themes and 48 codes, shown in Figure 4. The entire corpus was coded by 8 analysts with a pairwise interrater agreement of 98%.

ARGUMENT
Claim. A statement about the (real or virtual) world that begins some form of oppositional conversation or debate. (Erduran, Simon, & Osborne, 2004)
Evidence. Reasons, data, or evidence to warrant one's claims. (Kuhn, 1992)
Counter Claim. A refutation or statement that contradicts the original claim initiating the given conversation topic. (Erduran, Simon, & Osborne, 2004)
Counter Evidence. Reasons, data, or evidence to warrant one's refutation of the initial claim. (Erduran, Simon, & Osborne, 2004)
Rebuttal. Refutation of a counter claim (imagined or stated) in support of the original claim. (Kuhn, 1992)
Other. A move in an argument not included in above codes, including: agree/disagree, concession/dismissal, compromise, qualification, request for clarification.
PROBLEM-SOLVING
Finding a solution to a problem where the solution is not given or looked up in a resource. (i.e., NOT Info. Seeking). (Halpern, 1992).
READING (Study 1)
Reference to reading something in the game (e.g. quest text, an in-game book) or outside the game (e.g., thotbot, fan fiction, guild site, book, graphic novel, etc). (Steinkuehler, Compton-Lilly, & King, 2010)
INFORMATION LITERACY (Study 2)
Seeking Info. To locate relevant information for the task at hand. (AASL, 1998 ACRL, 2000)
Evaluating Info. To evaluate the reliability and credibility of different information resources. (AASL, 1998 ACRL, 2000)
Interpreting Info. To identify significant information from less significant information, determine or infer its meaning, and draw appropriate and meaningful conclusions from it. (AASL, 1998 ACRL, 2000)

Synthesizing Info. To combine information from multiple resources into a coherent whole. (AASL, 1998 ACRL, 2000)
Disseminating Info. To seek out and use appropriate distribution channels for one's own info production. (AASL, 1998 ACRL, 2000)
DIGITAL MEDIA LITERACY
Visualization. The ability to create visual representations of information for problem-solving purposes (for teaching/communicative purposes, see "sociocultural theory/tool & artifact creation").
Remixing. The ability to meaningfully sample and remix media content.
Transmedia Navigation. The ability to follow the flow of stories and information across multiple modalities.
Multitasking. Engaging in other activities outside the game (while gaming) in ways that evidence the ability to scan one's environment and shift focus as needed to salient details.
Pop Culture Reference. Any reference within the game to pop culture outside the game (e.g. discussion of movies, cartoons, Paris Hilton, etc). This is a form of convergence, with multiple "narrative arcs" intersecting in one media context.
DESIGN THINKING (from consumption to production)
Appraise Design. Critical Consumption – Stating an opinion or stance toward a particular designed object or design choice (e.g., "X is a stupid design"). (Steinkuehler & Johnson, 2009)
Argument (for Appraisal). Reasoned Critical Consumption – A rationale for an opinion or stance toward some given design that functions to justify the critique in some way. (e.g. "X is a stupid design because…"). (Steinkuehler & Johnson, 2009)
Alt Design/Fix. Offering an alternative design or a fix to some existing designed object or design choice (e.g., "They should have done Y instead of X because…"). (Steinkuehler & Johnson, 2009)
Prediction (for Alt Design/Fix). Forward-Thinking Alternative Design – A justification of some alternative design or fix in the form of a prediction or thought experiment of what would happen if you designed it differently. (e.g., "If you did Y instead of X, you'd find …"). (Steinkuehler & Johnson, 2009)
Design. The development (even if only in the abstract) of an original design or an entirely new redesign that is justified on its own terms. (e.g., "We should make an X that…"_). (Steinkuehler & Johnson, 2009)

MODEL BASED REASONING
Working with a Model. Any interaction with a model – A principle-based mechanism with interacting components that represents the operation of system within the natural (virtual) world. A model may concretize phenomena that are not directly observable. (AAAS, 1993; Steinkuehler & Duncan, 2009)
Judging Model Based on Prediction. Judging the usefulness of a model by comparing its predictions to actual observations in the real world. (AAAS, 1993; Steinkuehler & Duncan, 2009)
ATTITUDES (Study 3)
Nature of Knowledge. Epistemology – Any overt comment about the nature of knowledge (e.g., knowledge is certain, subjective, or something in-between). (AAAS, 1993; Steinkuehler & Duncan, 2009)
Nature of Learning. Epistemology – Any overt comment about the nature of learning (e.g., learning is ability is innate or you can learn how to learn, success is hard work or “all or nothing”).
Attitudes Toward School. Any overt comment conveying their attitudes, opinions, and/or positioning toward school, their teachers, etc. (e.g., why they like or do not like a particular class).
Attitudes Toward Games. Any overt comment conveying their attitudes, opinions, and/or positioning toward either this game or gaming in general (e.g., why they like gaming).
Attitudes Toward Program. Any overt comment conveying their attitudes, opinions, and/or positioning toward the (pop cosmo / global kids) program, the staff, etc. (e.g., why they like or do not like a particular activity, etc).
Attitudes Toward Civic Empowerment. Any overt comment conveying feelings about their ability to make a difference in their community or in the world.
SOCIOCULTURAL LEARNING (Study 4)
Collaborative Problem Solving. The ability to collaborate within a small, bounded group to develop solutions to a given problem employing the sources at hand while considering divergent points of view and negotiating mutual benefit. (Steinkuehler & Duncan, 2009)
Collective Problem-Solving. The capacity to work in large-scale knowledge-working communities in which each member makes an incremental contribution to shared knowledge and understanding under development. (Steinkuehler & Duncan, 2009)

Tool & Artifact Creation. Creation of tools or artifacts to pass knowledge or skills on to other individuals (to teach or support learning in some way).
Didactic Teaching. Explicit teaching in which the "teacher" presents information to the learner (e.g., lecturing, giving step-by-step procedures).
Apprenticeship. Teaching through engagement in joint activity between a mentor and learner. (Steinkuehler, 2004)
Modeling. Demonstration of how to do something as a form of teaching.
CROSS CULTURAL FLUENCY
Adopt Alternative Perspective. The ability to adopt alternative perspectives or opinions for the purpose of understanding another viewpoint, discovery, and improvisation. (Kuhn, 1992; Steinkuehler, 2006c)
Connect Global to Local. The ability to understand what's happening around the world globally and the ways it relates to one's local communities.
Politics & Current Affairs. Discussion of politics, current events, world affairs, etc. happening in the "real world".
Ethical Reasoning. Thinking about issues of social equity, rights & responsibilities, right & wrong behavior toward one another, or codes of interpersonal behavior. (Simkins & Steinkuehler, 2008)
Social Norms & Rules. Negotiation or discussion of social norms and/or rules such what is or is not acceptable behavior in the game or various chat channels (e.g., spamming, reporting to GM).
Conflict Resolution. Helping to resolve a dispute or disagreement.
WORKPLACE LITERACY
Goal Setting. Setting specific objectives or targets for oneself as a way to make and/or mark (track) progress.
Time Management. Monitoring and management of time in order to make the most out of it (e.g. explicit attention toward efficiency, time spent gaming versus other activities, etc).
IT Skills. Using or otherwise demonstrating understanding of technology (systems, applications operations, etc) beyond the gaming platform itself. (ISTE, 2007).
Financial Literacy. Students think about money management, economics (e.g. auction house), financial value of items, or how to make money in the game.

Job Knowledge. To have knowledge of post-graduation options and/or what a specific profession entails.
Public Speaking. Students are capable of and comfortable speaking in public (formally).

Figure 4. **Analytic Framework**

As shown in Figure 5, Information Literacy, Sociocultural Learning, and Workplace Literacy were the most prevalent of practices engaged in by the participants. However, the graph also demonstrates that the participants engaged in a whole host of other pro-academic practices like model-based reasoning and argumentation.

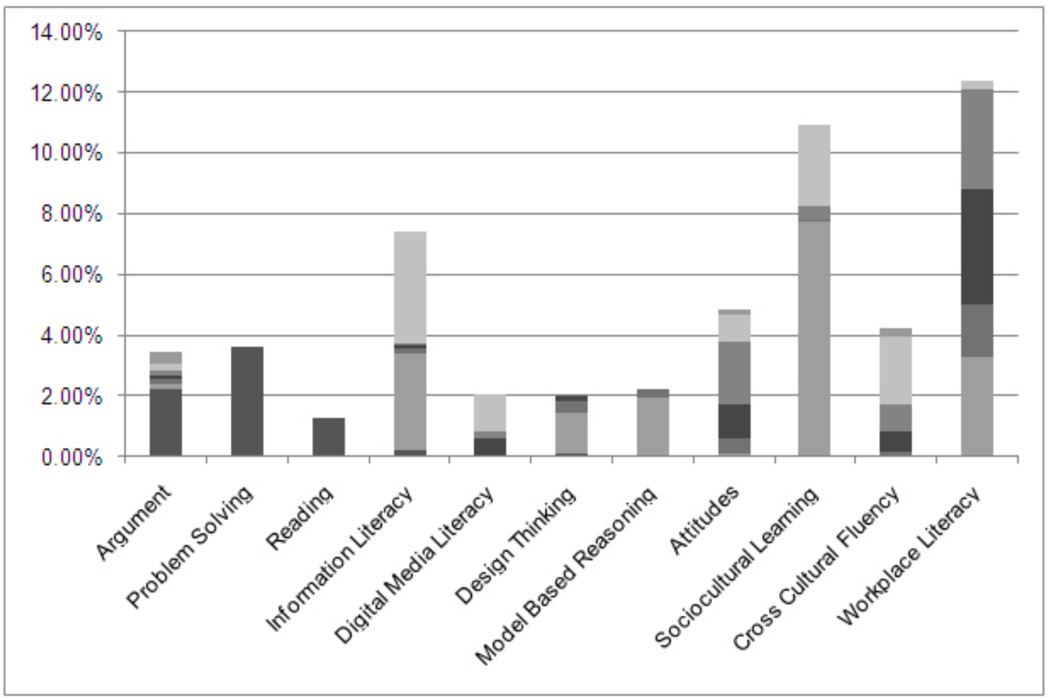


Figure 5. **Themes with codes (subcodes denofunding agency's.**

Generative Failure

What do these results tell us? Our dilemma (and design challenge) led to the creation of an entirely open structure of interest-driven learning that shifted from handing out agendas to catering to interests as they emerged. From the results given above, we can see that the pro-academic practices that we were hoping to foster in our participants were practices that they were already prone toward naturally participating in. Because our initial design was met with resistance, we were forced to shift our model for learning from "games as means for accomplishing *our* educational goals" back to "education as a means for accomplishing *their* goals." We had to revise the way we think of the role and function of education from a traditional model of "instruction as norming" to a very different model much more akin to "education as community organizing." It is seductive to think of games as a means for doing what we already (try to) do in school. The lesson we learned stands in contrast but is surely onto a new one: "Education is a natural process carried out by the child and is not acquired by listening to words but by experiences in the environment." (Montessori, 1959, p. 3)

References

Association of College and Research Libraries [ACRL] (2000). Information literacy competency standards for higher education. Chicago, IL: Association of College and Research Libraries.

American Association for the Advancement of Science [AAAS]. (1993). *Benchmarks for science literacy*. New York: Oxford University Press.

American Association of School Librarians [AASL] (1998). *Information literacy standards for student learning: Standards and indicators*. American Library Association.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education, 88*, 915–933.

Gilbert, R. & Gilbert, P. (1998). *Masculinity goes to school.* London: Routledge.

Greene, J. P. & Winters, M. A. (2006). Leaving boys behind: Public high school graduation rates. *Civic Report, 48*(April).

Halpern, D. (2002). *Thought and knowledge: An introduction to critical thinking*. Mahwah NJ: Erlbaum, Lawrence & Associates.

International Society for Technology in Education [ISTE] (2007). National educational technology standards (NETS•S) and performance indicators for students. Retrieved August 19, 2009 from http://cnets.iste.org/

Kuhn, D. (1992). Thinking as argument. *Harvard Educational Review, 62*(2), 155-179.

Lee, J., Grigg, W. S. & Donahue, P. L. (2007). *The nation's report card: Reading 2007.* Publication No. NCES 20007496. Washington, DC: National Center for Education Statistics.

Montessori, M. (1959). *Education for a new world.* Adyar, India: Kalakshetra Publications.

Rowan, L. Knobel, M., Bigum, C. & Lankshear, C. (2002). *Boys, literacies and schooling.* Buckingham: Open Court Press.

Simkins, D. & Steinkuehler, C. (2008). Critical ethical reasoning & role play. *Games & Culture, 3*, 333-355.

Squire, K. D. & Steinkuehler, C. A. (2006). Generating CyberCulture/s: The case of Star Wars Galaxies. In D. Gibbs & K. L. Krause (Eds.), *Cyberlines 2.0: Language and cultures of the Internet* (pp. 177-198). Albert Park, Australia: James Nicholas Publishers.

Steinkuehler, C. A. (2004). Learning in massively multiplayer online games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), *Proceedings of the Sixth International Conference of the Learning Sciences* (pp.521–528). Mahwah, NJ: Erlbaum.

Steinkuehler, C. (2006a). The mangle of play. *Games & Culture, 1*(3), 1-14.

Steinkuehler, C. A. (2006b). Massively multiplayer online videogaming as participation in a Discourse. *Mind, Culture, & Activity, 13*(1), 38-52.

Steinkuehler, C. (2006c, November 17). Virtual worlds, learning, & the new pop cosmopolitanism. *Teachers College Record,* 12843. Retrieved from: http://www.tcrecord.org/Content.asp?ContentID=12843

Steinkuehler, C. (2007). Massively multiplayer online gaming as a constellation of literacy practices. *eLearning, 4*(3), 297-318.

Steinkuehler, C. A., Black, R. W., & Clinton, K. A. (2005). Researching literacy as tool, place, and way of being. *Reading Research Quarterly, 40*(1), 7-12.

Steinkuehler, C., Compton-Lilly, C., & King, E. (2010). Reading in the context of online games. In K. Gomez, L. Lyons, J. Radinsky (Eds.) *Learning in the disciplines: Proceedings of the 9th International Conference of the Learning Sciences (ICLS 2010) Volume 1, Full Papers* (pp. 222-230). Chicago, IL: International Society of the Learning Sciences.

Steinkuehler, C. & Duncan, S. (2009). Informal scientific reasoning in online virtual worlds. *Journal of Science Education & Technology*. DOI: 10.1007/s10956-008-9120-8.

Steinkuehler, C. & Johnson, B. Z. (2009). Computational literacy in online games: The social life of a mod. *The International Journal of Gaming and Computer Mediated Simulations, 1*(1), 53-65.

Steinkuehler, C. & King, E. (2009). Digital literacies for the disengaged: creating after school contexts to support boys' game-based literacy skills. *On the Horizon, 17*(1), 47-59.

Steinkuehler, C., & Williams, D. (2006). Where everybody knows your (screen) name: Online games as "third places." *Journal of Computer-Mediated Communication*, *11*(4), 885-909. doi:10.1111/j.1083-6101.2006.00300.x

Acknowledgments

This work was made possible by a grant from the MacArthur Foundation, although the views expressed herein are those of the authors' and do not necessarily represent the funding agency's.

Mixed Methods to Study Games and Learning

Constance Steinkuehler, Elizabeth King, Crystle Martin, Yoonsin Oh, Sarah Chu, Caroline Williams, Amanda Ochsner, Shannon Harris, V. Elizabeth Owen, Gabriella Anton, & Jonathan Elmergreen
University of Wisconsin – Madison, 225 N. Mills, Madison, WI
Email: constancies@gmail.com, emking29@gmail.com, crystle.martin@gmail.com, yoonsinoh@gmail.com, sarahnchu@gmail.com, caro.williams@gmail.com, amanda.ochsner@gmail.com, shannon.linehanharris@gmail.com, v.elizabeth.owen@gmail.com, gabby.anton@gmail.com, jelmergreen@gmail.com

Abstract

This paper outlines a mixed methods workshop describing how the methods of quantifying qualitative codes, repertory grid analysis, matched sample comparison, triangulation, and discourse analysis can be used in various combinations to create a more detailed analysis. These methods are presented in the context of researching online games.

Introduction

For the last six years, the Pop.Cosmo research team lead by Constance Steinkuehler at the University of Wisconsin-Madison has been conducting mixed methods research to examine learning in the context of online gameplay. To date, this work has included data collection across multiple *contexts* (from naturalistic studies of gameplay by anonymous fans within the virtual game world to controlled studies conducted within institutionally-affiliated lab environments), drawing on a variety of *modal data types* (video data, multimodal fieldnotes, in-game chatlogs, structured and unstructured interviews, forum data, web pages, structured lab activities, and even surveys), and has used a range of *analytic means* (content coding, discourse analysis, pre-post comparisons, longitudinal analyses, quantitative data mining, and comparisons of means).

In this workshop, we explored the use of mixed methods research in game-related studies of learning as a means for reaching broad audiences. Using our own data corpus as fodder for discussion, we explored a range of methods for studying learning and how those methods can be used in combination to build a persuasive case for (or against) learning related to games. The workshop began with an introduction to mixed methods and a description of the dataset from which the examples presented in the workshop were drawn. Mixed methods are a combination of qualitative and quantitative research techniques. It is a "third wave" research movement building on the idea of pragmatism (Johnson & Onwuegbuzie, 2004). The logic of inquiry that underlies mixed methods research includes the use of induction (discovering patterns), deduction (hypothesis testing), and abduction (uncovering best explanations for results). Using mixed methods offers a variety of benefits as an approach to research (Greene & Caracelli, 1997; Johnson & Onwuegbuzie, 2004). Triangulation of data through the corroboration of results increases the validity of findings. Mixed methods data gives completeness to an analysis, resulting in a more comprehensive account of phenomena. It can offer development of a research trajectory illuminating the next steps in the line of inquiry or offset the weaknesses of a single method through the use of several analytic strategies. While one method specifies the outcomes of the study, a second can make clear the process behind those outcomes. A mixed methods approach can answer related questions as well as the ones asked of the study. Or, while one method provides context for findings, another might enable generalizability. One method might allow illustration of the data while another provides depth. In sum, by combining methods, you can enhance analysis of your data by augmenting that analysis with other approaches.

The context for the data used as examples in this workshop originated from the Games+Learning+Society (GLS) Casual Learning Lab. The lab ran for two years; 2008 was the pilot year with 9 participants, and in 2009, the formal program ran, which had 22 participants. The participants of the lab were males age 13-18 from nearby rural areas. The lab had one PI, 8 doctoral students, and 6 undergraduates in terms of staff, allowing for a very high ratio of participants to researchers. The lab met monthly in a face-to-face setting in a game lab on campus, as well as online during regular collaborative gaming within *World of Warcraft.* The participants and researchers all joined one guild so that they could easily interact and "lifeguard," that is, take participant observations and function as a resource in the game. Communication also took place asynchronously on forums created on their guild website. In total, the lab collected 8 months of ethnographic data as well as data from 4 studies that focused on games vs. school targeting: reading, information literacy, social reasoning, and epistemological beliefs. The main objective of the lab was to resource and trace individual learning trajectories and interests throughout the duration of participation. The dataset consisted of 454 photos, 66 forum posts, 100+ hours of video, and 2,506 pages of in-game chatlogs. This corpus was then coded by 8 analysts with an a priori content coding scheme consisting of 11 themes and 48 codes. Interrater agreement was 98%.

The workshop was structured so that participants divided into groups. Each group was given a card with a game context (see Figure 1) and a phenomenon; for example: "apprenticeship." With the context and phenomenon in mind, the group created a research question. Then each group member chose to go to two of five hands-on mini-workshops focusing on one method per workshop. The methods that were available to choose from included: quantifying qualitative codes, repertory grid analysis, triangulation, discourse analysis, and matched samples comparison (each is described below). After the mini-workshops, the groups reconvened and discussed which combination of methods they felt were best suited to help them answer their research question, what data sources that combination of methods would require, and assessed its feasibility and drawbacks. The workshop ended with the groups sharing their research question, mixed methods, data collection strategy, and anticipated challenges with the group at large.

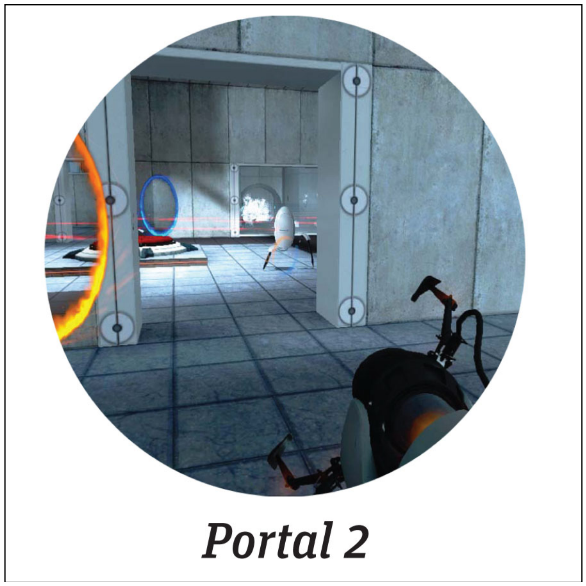


Figure 1: **Example of a game card**

Quantifying Qualitative Codes

Quantifying qualitative data is a method used to analyze coded data (Chi, 1997). During the coding process, an a priori scheme is applied to a set of data to illuminate patterns of themes. Schemes may be generated from the ground up to capture unique occurrences within the data. Codes are counted and examined to find patterns. Graphical representations of the data can be created from these findings. While this method allows for the examination of aggregated patterns of qualitative data, events or items that occur only once can be missed even though they might be significant.

Researchers in the Pop.Cosmo lab frequently utilize this method to understand general patterns occurring within the ethnography as well as specific patterns within a smaller study. Researchers begin by looking for general codes that apply to the data. Quantifying qualitative codes was utilized in the lab data to understand participants' "information literacy" or how adolescents use the web to find information in one of the smaller studies within the lab. The data set, containing audio and video of the guys' progress, is transcribed with actions and speech. Researchers then collaboratively coded one small excerpt of the video corpus with the scheme in order to understand the nuances of the application of codes. During this initial process, generated codes can be easily added to the scheme to more fully represent the events and behaviors occurring within the data. While missing uncommon but important events remain an issue for this method, it can be checked by a general "emergent" code used to highlight any seemingly significant occurrence for post hoc review. After collaborative coding for "calibration" is completed, each researcher individually codes a portion of the data set (our norm is 10%) in order to obtain an inter-rater reliability score of (typically 90% or better is required). If reached, the researchers may then carve up the remaining corpus and code individually with the assumption that they are each coding consistently. The patterns obtained from counting codes allow the understanding and quantification of the general processes occurring within qualitative data. These patterns can then be compared across variables of interest within the study to determine differences of events and behaviors. While there are pitfalls to using this method, it provides a vital picture into the aggregated patterns within data.

Repertory Grid Analysis

The repertory grid method is a form of structured interview that helps elicit the constructs an individual uses to make sense of their world. Generally, the interview focuses on the interviewee's constructs or views around a particular topic. To begin, the researcher sets the topic of the interview, which is some general category. Next, she asks the interviewee to think of as many "elements" as possible within that category that seem relevant to the conversation. Once the interviewee is finished listing or simply repeating elements, the researcher then presents those elements back to the interviewee in random sets of triads asking which of the three elements is the least like the other two and why. The descriptive words used to explain what makes one element distinct from the remaining two are recorded and later become the "constructs" of meaning that represent the participant's world of meaning. Since these are provided in terms of one thing being unlike another, they are always expressed as contrasting concepts or terms. After the researcher is satisfied with the number of constructs provided by the participant (either all triads are used or the participant reaches the point of repetition), s/he has the participant rate each of the initial elements in terms of the entire set of elicited constructs. This rating is typically done on a 5 or 7-point scale, from which the researcher can create a matrix to which can be applied various statistical analyses that cluster the elements and constructs (e.g., RepGrid).

The primary strength of the repertory grid analysis method is that it allows the researcher to elicit the participant's constructs of meaning without supplying them terms or priming certain kinds of responses or language. Additionally, though the data collected by this method are qualitative in nature, the fact that participants rate the elements on a numerical scale makes it possible for the researcher to run various statistical tests to examine clustering patterns. However, since each interviewee provides their own unique set of constructs, this method is less readily used to examine aggregated patterns across entire groups of research subjects. Thus, the strength of this method is to enable the researcher to discern subtle differences between individual meaning making rather than to generalize across populations.

As part of the Pop.Cosmo research team, we used the repertory grid analysis method to elicit the constructs that *World of Warcraft* players form about other players and their interests. Toward this end, we selected six participants and staff from our casual learning lab and had them recall other participants in the lab ("elements") and discern what their play styles (Bartle, 1996) and interests were ("constructs"). In the coming months, we will be using these "interest" constructs to mine the ethnographic data to see if specific play styles and interest led to differentiated learning outcomes.

Matched Sample Comparisons

Matched pair comparisons such as *t*-tests on pre-/posttest performance tasks or attitudes surveys allow comparison of the means (averages) of the two sets of related scores (Trochim, 2006). When analyzing data from isomorphic tasks situated across two points in time or two contexts, *t*-test results gave us a sense of direction for how to differences in the two measures. Such differences can then be compared to related qualitative data through a process called "triangulation" (see discussion below).

The guiding research question for our matched sample comparison study was related to a social reasoning task: How do our participants reason about social/ethical dilemmas within versus outside of online games like *World of Warcraft*? First we borrowed an out-of-game instrument called the Defining Issues Test, or DIT-2 (Rest, Narvaez, Bebeau & Thoma, 1999) to measure reasoning in one context. Next, we adapted the DIT-2 scenario to create an in-game version with the same core ethical and social issues at stake (yet set in the online game's virtual world). Participants completed both measures with order of instrument counterbalanced to mitigate any ordering effects (i.e. one random half of the participants took the games measure first, the other random half took the out-of-game measure first) so we could compare the two matched samples of performance scores to examine similarities and differences based on contrasting contexts. Based on the statistical results, participants were more willing to abdicate to an authority and suspend personal rights in the context of the virtual world than the real one. We then triangulated these findings with our observational data (see next section).

Triangulation

Another mixed methods technique is the triangulation of quantitative (e.g., survey or performance test) and qualitative (e.g., observation) data (Jick, 1979). One strength of this approach is that it helps ensure that the aggregate quantitative patterns you find are understood in sufficient depth (qualitative data). One potential complication of this strategy is that surveys and their analyses typically assume that people have stable attitudes or dispositions or beliefs (factors) that endure across time and context, which may not always be true.

For example, in the Pop.Cosmo lab, quantitative data to measure individuals' attitudes, dispositions, and beliefs is first analyzed using statistical procedures (e.g., comparison of means, cluster analysis) to group together items in order to identify any latent constructs that might explain patterns in the survey item responses. We then use qualitative data taken from everyday activities involving the same participants (e.g. game transcripts) to triangulate, explain, or otherwise augment the quantitative data analysis to build a more complete and valid picture of what's going on. Data used for the workshop is an excellent case on point: Here, we gave participants two isomorphic surveys (63 items each) designed to measure their epistemological beliefs specific to game versus school contexts. Based on this comparison, we found that participants were significantly more likely to hold naïve beliefs about the nature of knowledge and learning in the context of school versus games. Specifically, they were more likely to believe that "success is unrelated to hard work" and "you cannot learn how to learn" in relation to school than to games. We then searched our coded ethnographic data related to these two themes for both confirming and disconfirming evidence. Once these significant differences were found, we then searched for confirming and disconfirming evidence within our longitudinal ethnographic data where we indeed found the same pattern, corroborating and strengthening our final claims.

Discourse Analysis

Discourse analysis (Gee, 1996) is a method of closely examining language in order to connect the micro-dynamics of language-in-use with the macro-dynamics of culture and society. Discourse analysis approaches language as action and affiliation, attending to both the content of what is said as well as its form (i.e. the way in which it's said, which is also part of its content). Thus, by unveiling the work that is done tacitly through language in social interaction, discourse analysis functions as a particularly powerful means for examining issues the actual activities that participants are involved in, the value structures in play, and the identities that are being performed – all work that social interaction accomplishes covertly more often than overtly. The primary drawback to discourse analysis is the complexity of the analysis (it can sometimes take quite a bit of study to become adept at analyzing language in this way) and its limitations to only smaller excerpts of language-in-use given its practical constraints. As we say in the lab, analyzing long tracts of data with discourse analysis is like attempting to paint Texas with a fine, camel's hair brush: Not advisable.

Discourse analysis techniques are used in multiple ways within the Pop.Cosmo lab to better understand the nature of social engagement among participants, the forms of collaboration (and competition) that emerged among the adolescents involved, and ways in which the "culture" of gaming is taken up and handed down. This latter issue, cultural apprenticeship, was the example used for the purposes of this workshop. Using transcripts excerpted from the ethnographic data culled over the eight month lab, we had participants in the workshop observe and then apply discourse analytic strategies to a partially analyzed one-page transcript of in-game talk between a master and an apprentice in order to answer two related questions: (a) What moves does the expert make to apprentice the novice into the activity captured in the transcript? and (b) What values are in play throughout their interaction? Responses to these two questions were then used as fodder for reflection on a third and final question: What evidence do we have for the inferences drawn?

Final Reflections on Mixed Methods Research

Mixed methods as a research approach offers multiple avenues for strengthening one's empirical argument and speaking to a range of diverse research communities at once. The right combination of appropriate methods can create a more complete understanding of one's data corpus, increasing the reliability of one's findings and painting a more complete portrait of the phenomenon at hand. Some hold an "incompatibility thesis" and argue that methods with competing or conflicting premises about the nature of the world and of our truth claims about it cannot, in good faith, be used in combination. After all, if your t-test assumes that aggregated averages are useful representations of groups of people while your "repertory grid analysis" assumes that meaning is individual and not usefully aggregated across groups, then there's a way in which your two selected methods are in conflict about not just the best way to make sense of humans but, indeed, the very nature of the world itself. Such conflict can and do arise. We argue, however, that many of these seeming philosophical quandaries can be easily avoided altogether by understanding the different scales at which various methods operate. In the above example, t-tests assume that populations are of central interest while repertory grid analyses assume that individuals are. But surely groups are composed of individuals whose individual meaning-making shapes and is shaped by the groups of which they are a part. Understanding how individuals become group members and how group characteristics reflect their individual membership is surely part of the enterprise of social sciences and educational research. In thinking carefully through the scale or "unit of analysis" on which various methodologies operate, the researcher can thoughtfully combine methods to create robust, analytic, descriptive and predictive analyses of human beings in all their myriad contexts. Resolving conflicts and incompatibilities between methods is a central charge of the mixed methodologist, a process to be explored and explained, not avoided, in one's research proposal, presentations, and publications. We hope this workshop description illustrates, at least in part, some of that heady work.

Endnotes

(1) For materials from the workshop go to: http://therealca.ro/GLSmixedmethods.html

References

Bartle, R. (1996). *Hearts, clubs, diamonds, spades: Players who suit MUDs.* Retrieved from: http://www.mud.co.uk/richard/hcds.htm

Chi, M. T. H. (1997). Quantifying qualitative analysis of verbal data: A practical guide. *Journal of Learning Sciences, 6*(3), 271-315.

Gee, J. P. (1999). An introduction to discourse analysis: Theory and method. New York: Routledge.

Steinkuehler, C. A. (2004). Learning in massively multiplayer online games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), *Proceedings of the sixth International Conference of the Learning Sciences* (pp. 521–528). Mahwah, NJ: Erlbaum.

Greene, J. C. & Caracelli, V. J. (Eds.). (1997). *Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms.* New Directions for Program Evaluation, No. 74, San Francisco: Jossey-Bass.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, *24*(4), 602-611.

Johnson, R. B. & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Rest, J., Narvaez, D., Bebeau, M., & Thoma, S. (1999). DIT-2: Devising and testing a new instrument of moral judgment. *Journal of Educational Psychology*, *91*(4), 644-659.

Trochim, W. M. K. (2006). The t-test. *Research Methods Knowledge Base*. Available from http://www.socialresearchmethods.net/kb/stat_t.php.

Acknowledgments

This work was made possible by a grant from the MacArthur Foundation; although the views expressed herein are those of the authors' and do not necessarily represent the funding agencies.

Enabling Educators to Customize the Game Environment

Mark Stenerson, William Schneller, Eve Syrkin Wurtele
Iowa State University VRAC, 1620 Howe Hall, Ames, IA 50014
msteners@iastate.edu, willschneller@gmail.com, evewurtele@gmail.com

Abstract

In the field of educational gaming, a lot of attention has been given to the delivery of educational content and how content is integrated into interactive and entertaining game play. For instance, Gee (2007) concludes that "…in video games, unlike in novels and films, content has to be separated from game play…"

With this in mind, we, the developers of the biology game *Meta!Blast*, have begun integrating a series of features into our game that will enable educators to customize the in-game experience and tailor it to their lesson plans. It is our belief that these features will not only enable teachers to optimally utilize our game in their classrooms, but also allow students to become more engaged in the game.

Most research involving educational games and the classroom focuses on the design of games and how students benefit from and accept games as a part of their educational development. While this is an important hurdle in integrating games with the classroom, a teacher's acceptance of the game can be an even bigger problem (Egenfeldt-Nielsen, 2004). If a teacher is unable to efficiently and effectively use the game in their classroom, what incentive is there for them to use the game at all? Why should they shape their curriculum around a game that doesn't allow them to teach the way they want to teach?

In truth, a teacher shouldn't have to shape their curriculum around an educational game. It would be better if the game could be augmented and shaped in order to fit into the curriculum. Since it is unrealistic to expect an educator to learn how to modify game code and art assets, the responsibility falls to the game developers to make this possible. But is this really feasible? The educational gaming world is full of papers that go into great detail about the careful planning required for the development of games targeted for use in the classroom (Dondlinger, 2007). Arguably, the biggest problem that educational game developers face is how to integrate content into game play so that the student is not only engaged in play but is also learning the content.

Such considerations lead to the question: *can game play and game content be separated in such a way that allows educators to modify game content without having to modify game play?* To address this challenge, we explore the differences between game play and game content. A clear understanding of these two key aspects of game development will enable an approach to the design of a system that will not only meet the needs of educators, but will also allow them to easily achieve their goals.

Game Content versus Game Play

There are some scholars that make the claim that "one feature of all good educational games is a marriage of form (game play) and content" (Fortugno & Zimmerman, 2005). Others conclude that "…in video games, unlike in novels and films, content has to be separated by game play…" (Gee, 2007). If we are going to allow educators to modify game content, we need to first look at the differences between game play and game content to understand if it is possible to change one without changing the other.

The term game play has many different definitions and interpretations. For instance, Björk and Holopainen (2005), define game play as "the structures of player interaction with the game system and with other players in the game" whereas Lindley et al. (2008) defines game play as "the experience of interacting with a game design in the performance of cognitive tasks, with a variety of emotions arising from or associated with different elements of motivation, task performance and completion." As the list of definitions for game play grows, one unifying theme seems to arise: interaction. Almost all of the definitions of game play either mention a player's interactions with the game or allude to game play being tied to what the player experiences in the game. Therefore, we could create a short definition of game play as being "the interactions that the player has with the game".

The website Dictionary.com defines content as "something that is to be expressed through some medium, as speech, writing, or any of the various arts." Simply put, content, in regards to an educational game, can be considered "what the developers of the game are trying to teach to their audience via their game".

Thus, if we view game play as the interactions that the player of a video game has with the system and we view the game content as the information that we are trying to convey to our player, then we can hypothesize that game play and game content should be independent of each other. In fact, Gee (2007) contends that "content in a game sets up, but does not fully determine, game play." The example that Gee gives involves the controversial game *Grand Theft Auto: San Andreas*. While it is not viewed as an educational game in the traditional sense, Gee points out that the content of *Grand Theft Auto: San Andreas* involves concepts like poverty and crime and the game play involves problem solving situations like evading cars as you ride a bicycle through town in order to get somewhere safely. He concludes that if one were to change the game play by taking pictures of people rather than killing them, the problem solving aspects and difficulty of the game would be relatively unchanged.

Meta!Blast – From Preaching to Practice

Meta!Blast (www.metablast.org) is a real-time 3D action-adventure game designed for high school and college level students that puts a player inside a virtual plant cell. By immersing players into such an environment, the developers of Meta!Blast hope that players will come to a greater understanding of the cell than they could learn from traditional diagrams and textbooks (see Figure 1). The current demonstration version of Meta!Blast allows players to travel around the cell in their "bioship" and answer an assortment of thought provoking questions stored in data capsules that have been scattered throughout the cell (see Figure 2).

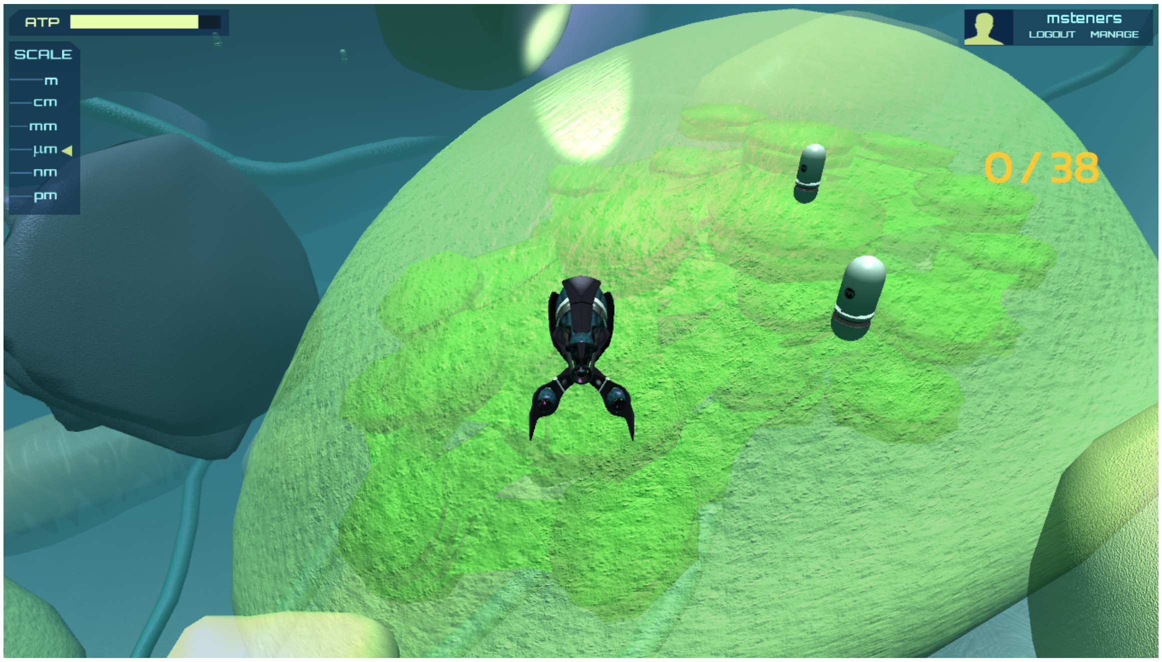


***Figure 1:* A snapshot of Meta!Blast at the cell level. Players can shrink down to smaller sizes to see more complex processes.**

When reflecting on our definition of game content, we can clearly see that the content of Meta!Blast is primarily centered around plant cell biology. One consideration for the demonstration version of Meta!Blast was how to deliver more complex and vocabulary-rich content than what would be provided to the player by simply flying through the cell. One possibility was to design Meta!Blast to be paired with a textbook that players could reference when they wanted more in-depth information about a specific biological concept. However, this would require creating and providing the students with such a textbook. In addition, the "flow" of the game would be disrupted if a student had to continuously reference a textbook while playing. Flow, as defined by Csikszentmihalyi (1990), is "the state in which people are so involved in an activity that nothing else seems to matter." As developers of an educational game, we felt that it was more important for our players to be involved in the interactivity of our game without the reminder that they are, in fact, learning. Therefore, we decided to create the BioLog, a virtual in-game database that would allow students to click on objects in the cell and find more detailed information about their environment without taking their focus off of the game (see Figure 3).

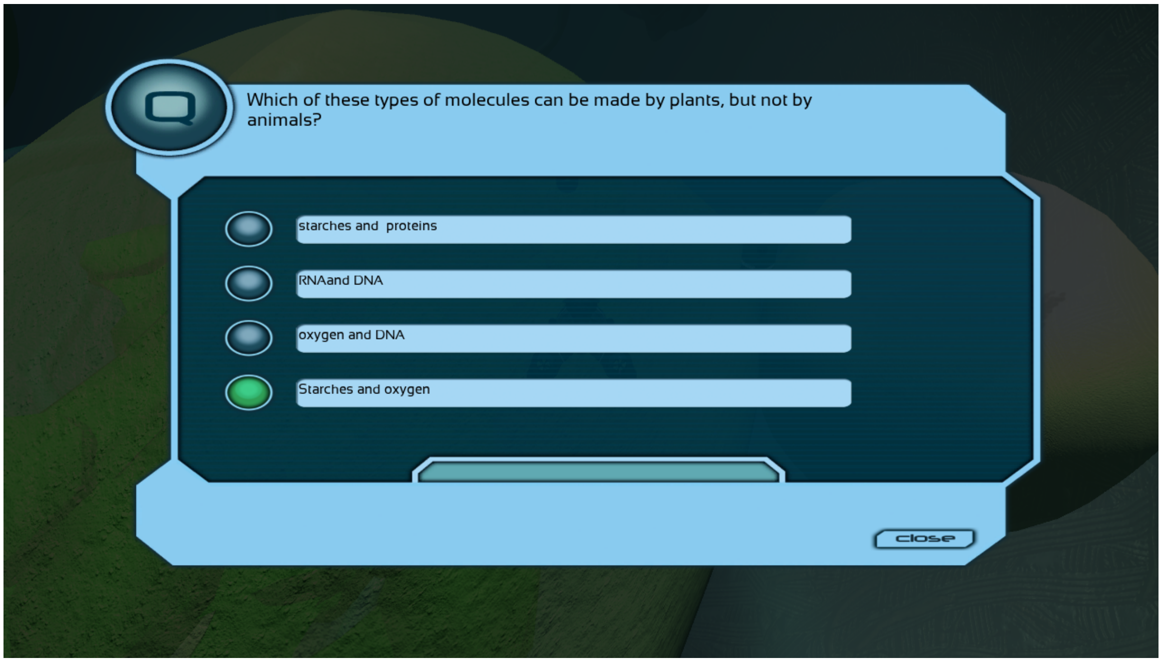


Figure 2: **An example of an in-game question**

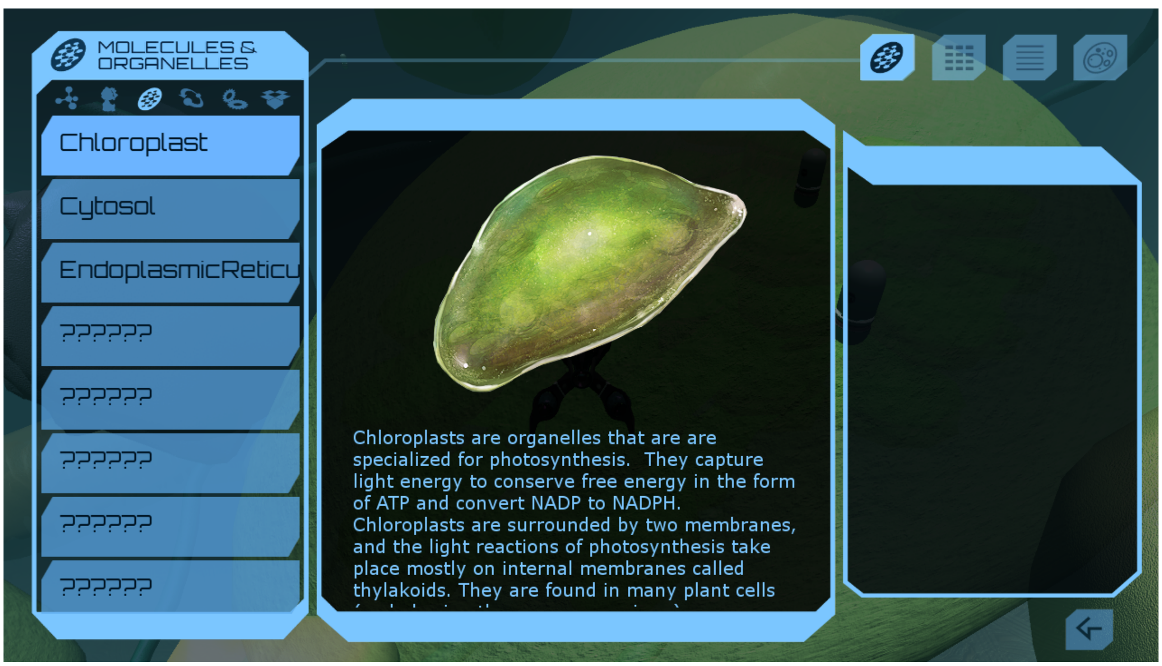


Figure 3: **This player has just clicked on a chloroplast and has received information about its function.**

Since we didn't want our players to be dependent on a working internet connection, the contents of the BioLog are stored on each player's computer in a text file and loaded into the game when the game begins. Through a prototype, custom editor that is included with the game (see Figure 4), teachers are given the ability to create, edit, and in some cases, delete BioLog entries, thereby allowing the incorporation of curriculum-specific information into the game.

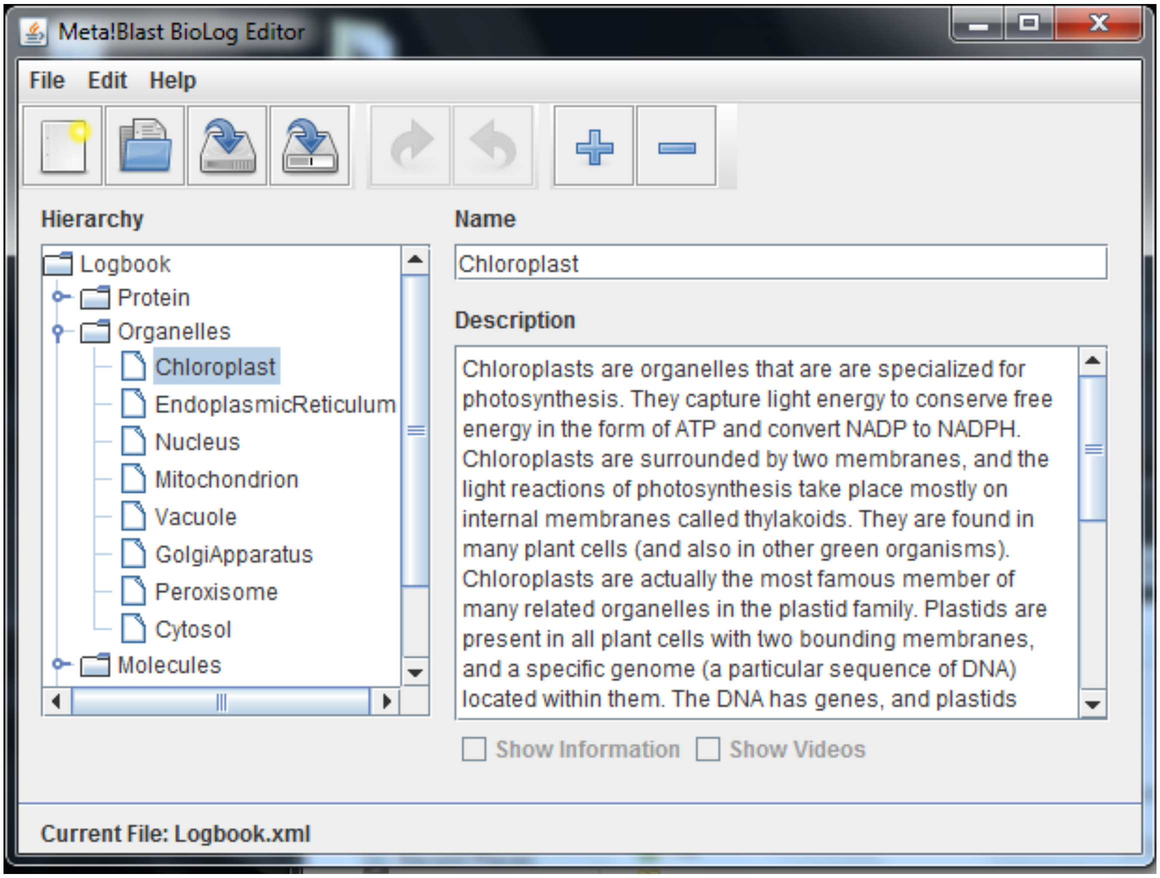


Figure 4: The BioLog editor allows educators to modify the contents of the in-game BioLog.

While further classroom testing and additional interface design needs to be done, initial reactions to the BioLog editor have been encouraging. Not only does it allow teachers to add more information to our game in an effort to provide information on more complex concepts of biology, it also allows teachers to simplify the information in order to use Meta!Blast with students that are younger than our target demographic.

Looking Forward – Teacher-Centered Design

It is clear that, without teacher approval and support, it is going to be difficult for games to thrive in the classroom (Egenfeldt-Nielsen, 2004). Teachers bridge the gap between educational game developers and students, our target audience. While they don't necessarily need to be good at playing the game, educators do need to be able to use the software in such a way that it augments their curriculum without being too complicated and cumbersome.

The growing field of human-computer interaction provides an approach to the design of software that has been dubbed *user-centered design* (Usability Professionals' Association, 2011). User-centered design is an iterative process of designing a software interface in which the target audience plays an active part in the design process. The goal is to create an interface that will allow the target audience to optimally use the software with as little training as possible (see Figure 5).

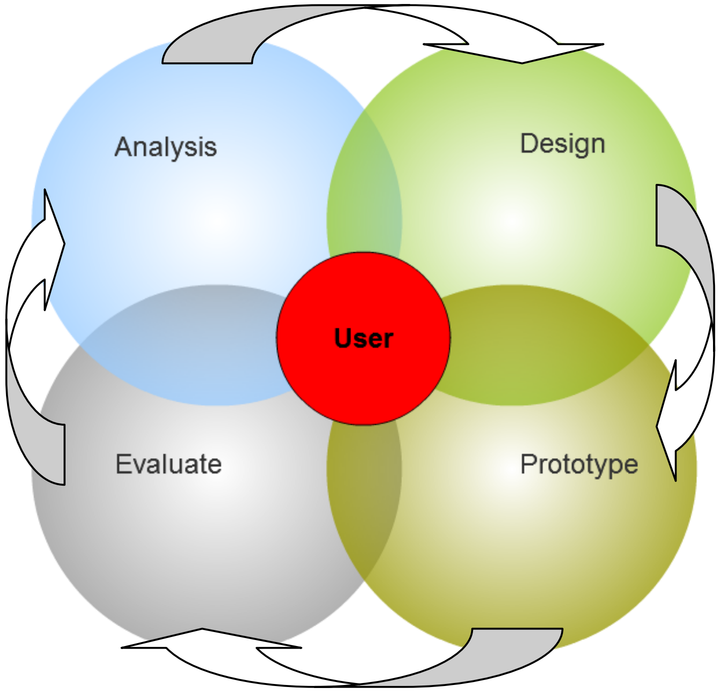


Figure 5: **A simple diagram outlining the four key steps of user-centered design. The user of the software plays an active role from task analysis to the evaluation of the prototype. The cycle continues until the user can efficiently use the software to complete their task.**

As educational game developers, we should explore the concepts and benefits of teacher-centered design in features of our games that teachers will interact with. Additionally, we need to further pursue the idea of separating some of the game content so that teachers can have the ability to modify the game through a well designed, teacher oriented interface. By doing this, we will eliminate a key obstacle in the integration of games into classrooms.

References

Björk, S. & Holopainen, J. (2005). *Patterns in game design*. Cengage Learning.

Csikszentmihalyi, M. (1990) Flow: The Psychology of Optimal Performance. New York: Cambridge University Press.

Dictionary.com. *Definition of content*. Retrieved from http://dictionary.reference.com/browse/content

Dondlinger, M. J. (2007). Educational Video Game Design : A Review of the Literature. *Journal of Applied Educational Technology*, *4*(1), 21-31. Citeseer. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.83.4710&rep=rep1&type=pdf

Egenfeldt-Nielsen, S. (2004). Practical barriers in using educational computer games. *On The Horizon*, *12*(1), Retrieved from http://www.emeraldinsight.com/journals.htm?issn=1074-8121&volume=12&issue=1&articleid=839885&show=html

Gee, J.P. (2007). *Good video games + good learning: collected essays on video games, learning, and literacy*. Peter Lang Pub Inc.

Lindley, C. A., Nacke, L., & Sennersten, C. C. (2008). *Dissecting play: Investigating the cognitive and emotional motivations and effects of computer game play*. Proceedings of Cgames'2008: 13th International Conference on Computer Games: AI, Animation, Mobile, Educational and Serious Games, 9-16.

Usability Professionals' Association (2011). *What is User-Centered Design?*. Retrieved from http://www.upassoc.org/usability_resources/about_usability/what_is_ucd.html

Zimmerman, E., & Fortungo, N. (2005). Soapbox: learning to play to learn - lessons in educational game design. *Gamasutra*, Retrieved from http://www.gamasutra.com/view/feature/2273/soapbox_learning_to_play_to_learn

Acknowledgments

We thank National Institutes of Health, Science Education Partnership Award 1R25RR025147 for support of Meta!Blast game development. We thank the outreach components of National Science Foundation awards DBI-0520267, EEC-0813570, BIO-IIS0612240, and MCB-0951170 for support of interdisciplinary education for undergraduate students in computer science, design, and biology, and for educational content. We are grateful for encouragement and support from the Department of Genetics, Development and Biology, the College of Liberal Arts and Science, the Virtual Reality Applications Center, and the Plant Sciences Institute, at Iowa State University.

High-Resolution Feedback using Tactile Semaphores

Reza Taghavi, Tactile Image, Inc., 401, the Empire Building, 360 Robert Street North, Saint Paul, MN 55101. USA, Email: taghavi@tactileimage.com

Abstract

In this paper, a novel tactile communication device for the neck is presented. This device relies on a one-dimensional array of actuators and uses tactile semaphores to convey information received wirelessly from a mobile device, computer, or game console to the subject wearing the device. Tactile semaphores are tactile patterns generated by multiple actuators on the neck. The neck is unique in that it offers an intuitive one-to-one tactile correspondence between directions in the horizontal plane and locations on its periphery. This device is capable of conveying bearings with an angular resolution better than 20° and ranges with nearly 10 levels of distance, making it accurate enough for most gaming and navigation applications. Tactile semaphores may be used to mimic real-world experiences and to enhance immersion in a gaming or simulation environment. In-world experiences such as acceleration, fall, impact, or game-related sensation such as boost, gradual loss of health, win, and loss may also be conveyed through the use of dynamic semaphores called marquee patterns. Other applications of this device are also presented.

Background

The five senses provide an individual with cues about distance, location, velocity, and properties of surrounding items. In simulated or virtual worlds such as electronic videogames, the senses are restricted by the size of the video screen, limited speaker sound quality, and the very limited tactile feedback provided by the vibration of a hand-held controller.

Vibrating game controllers have been devised (Nishiumi, Koshima and Ohta, 2006) and used to create in the player a sense of interaction with the physical world. For instance, in a racing game, as the vehicle leaves the pavement, the hand-held game controller vibrates. In first-person shooter games, the player is informed of having been hit through the vibration of the game controller. With the advent of controller-less game systems that enable interaction with a game without the use of controllers, such as Microsoft's Kinect system, even this basic tactile feedback is no longer available.

Tactile communication methods, systems, and devices have been devised to provide an individual with the ability to understand text and commands, or to augment his or her situational awareness. These methods primarily relate to artificial vision for the blind (MIT Touchlab, 2005) and to remote communication with individuals (Gilson & Christopher, 2007; Rupert & Kolev, 2008; Zelek & Holbein, 2008). Tactile communication devices have also been proposed to transmit parameters describing the state of a remote unmanned vehicle to various areas of a human controller's skin (King, 2009).

The Tactile Situation Awareness System (TSAS) is a wearable tactile display intended to provide spatial orientation cues (Zelek & Holbein, 2008; Rupert & Kolev, 2008). A belt equipped with transducers and worn around the waist (Gilson & Christopher, 2007) was devised to provide orientation cues to soldiers. This approach uses tactile stimulus at various positions around the torso and the belt area to pass on information on the location of an incoming threat to the subject.

Tactile displays, as the visual-to-tactile information translation devices are often called, have been investigated by research organizations such as the MIT Touch Lab (MIT Touchlab, 2005). Work on tactile displays is generally concentrated around passing tactile information to the skin and investigating the mechanical and physiological parameters that govern the complexity and bandwidth of transmitted information; this, with no particular attention paid to the neck skin.

In general, it can be noted that tactile devices designed to convey complex information utilize a relatively large area of the body and do not offer an intuitive or accurate relationship between the information conveyed and the tactile feeling sensed by the subject.

A novel tactile feedback device

The proposed device is built around an exoskeleton in the form of a pair of headphones (Figure 3) connected by flexible and spring-loaded metal strips resting around the neck of a user. The exoskeleton maintains an extensible holster that carries a number of tactile actuators taught and snug around the neck of the subject. This design (Figure 4) ensures that the device is always properly oriented (front facing to the front of the subject) and that the tactile actuators remain always in contact with the neck. Furthermore, the device may be combined with a pair of speaker/headphones and a microphone, thus providing a complete sensory audio-visual and tactile environment to the user.

An electronic controller located in the back of the device and powered by a small rechargeable battery pack operates the device based on signals received form an external source through a wireless receiver.

Based on signals received from a mobile communication device, computer, or game console, the device impresses sequences of tactile stimuli at specified locations around the subject's neck, thereby providing the subject with intelligible information.

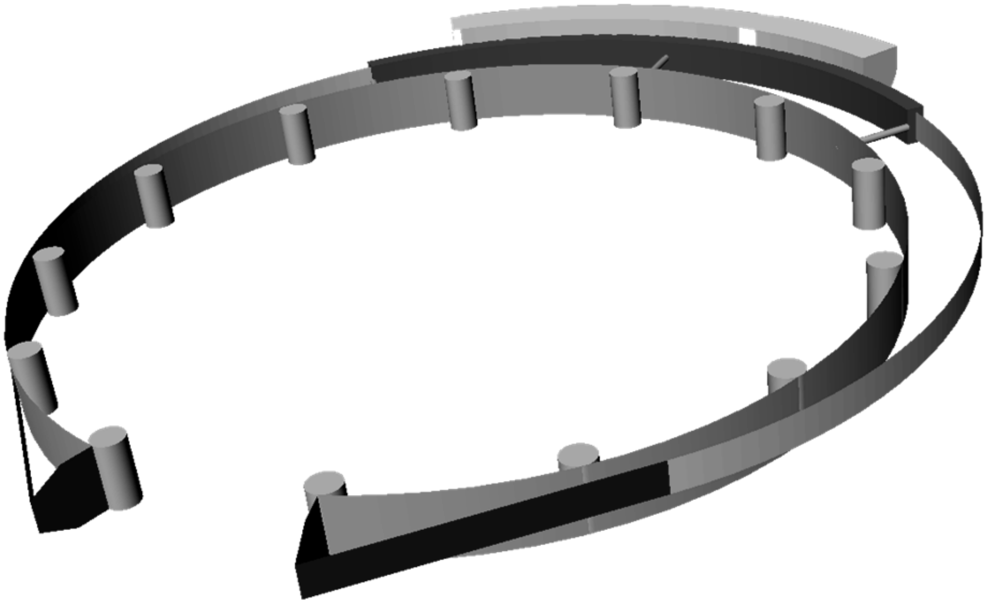


Figure 3. **The device shown with 12 actuators equally spaced and held by a holster**

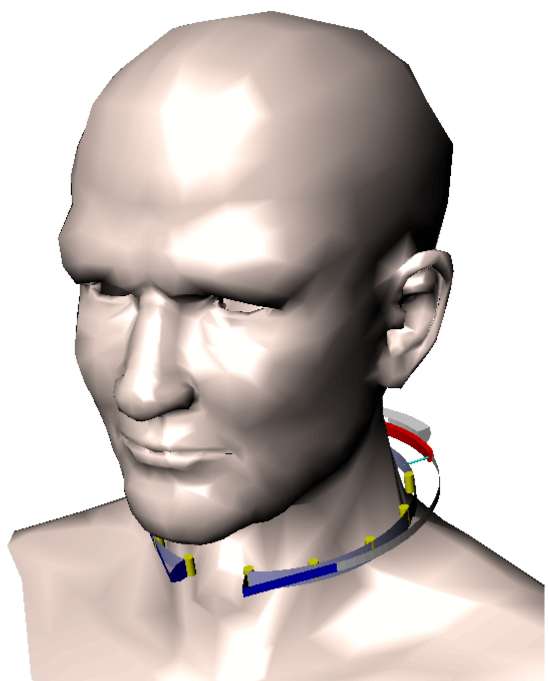


Figure 4. Subject wearing the device

The Neck Skin As A High-Resolution Sensory Organ

One measure of the effectiveness of a form of communication is how fast complex information can be transmitted to an individual using that form of communication. The speed of communication or bandwidth may be measured by how many characters are involved and the rate at which these characters are conveyed and comprehended by the individual.

In general, the skin is an imprecise sensory organ. While a person can discriminate between tactile stimuli applied to individual fingers, toes, other body parts or wide expanses of skin, the ability to discriminate tactile stimuli applied to neighboring skin locations is limited. However, the neck skin has a unique property that enables a person to accurately discriminate tactile stimuli applied from various directions onto its surface. Tactile stimuli applied at various angles around the neck can be discerned despite the closeness of the application points. An untrained individual is often capable of discriminating as many as 12 different peripheral locations around his or her neck. With some training, an individual may be trained to distinguish the location of tactile stimuli applied to many more angular locations around the neck.

With such a resolution, an individual is also able to distinguish between combinations of directions. By simultaneously stimulating several locations around the neck it is possible to communicate complex information to an individual. This approach may also be used to communicate with the blind, the autistic, and those unable to communicate verbally or visually.

Tactile semaphores

Tactile semaphores are created by turning individual actuators on or off at various frequencies and with various intensities thus generating various tactile patterns on the subjects neck. Figure 5 shows two examples of tactile semaphores where the back and white circles indicate "on" and "off" actuators.

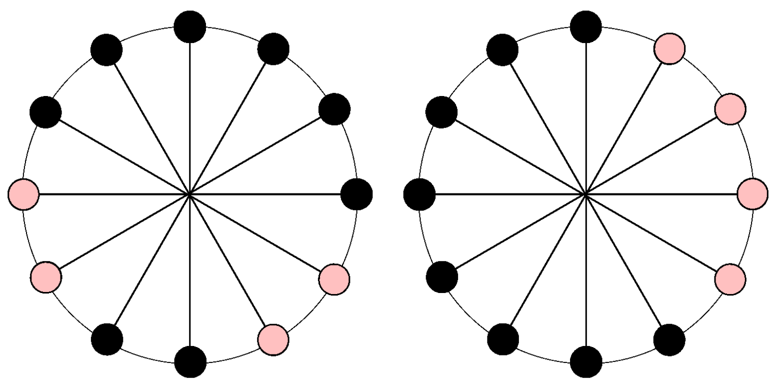


Figure 5. **Two examples of semaphores generated by 12 "on" (shown in black) and "off" (shown in gray) actuators**

Semaphores for representing distance to a target

Because of the one-to-one relationship between directions and locations around the neck, bearings can be intuitively conveyed using this device, but in order to represent distances, certain analogies or paradigms need to be used. Each analogy has its applications and limitations.

The approaching cruiser analogy

As the target approaches (Figure 6), the patch of active actuators expands, with the average direction of the patch of active actuators pointing towards the approaching target.

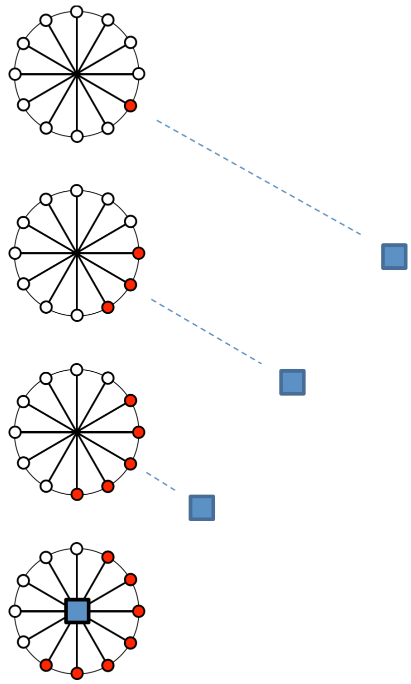


***Figure 6.* The approaching cruiser analogy: as the square object approaches, the patch of active actuators expands**

The radar analogy

Instead of representing the location of an object with several contiguous and continuously active actuators, a single actuator pointing in the direction of the object may be turned on and off at a frequency depending on the distance of the object to the subject. As the object approaches, the on/off frequency increases. When the object is very close to the subject, the frequency is maximal. As the object recedes, the frequency diminishes.

By linking the distance of an object (to the subject) to the on/off frequency of actuators, multiple objects located at various distances from the subject may be tracked, each represented by a single actuator pointing in that direction and turning on and off at a frequency representing the distance of that object to the subject.

The approaching noise source analogy

As an object approaches, the intensity of the stimulation on the skin may be increased. As the object recedes, the intensity is reduced. The intensity of the stimulation may be controlled with the intensity of the electrical current fed to each actuator. In this fashion, multiple objects located at various distances from the subject may be tracked, each represented by a single actuator pointing to that object and operating at an intensity based representing the distance of that object to the subject.

Semaphores used to indicate departure from the vertical axis

One application of this device is as an aid to pilots in preventing loss of horizon: a dangerous condition caused by bad weather and low visibility and resulting in disorientation and accidents. Loss of horizon occurs when all visual cues about the "up" and "down" directions are lost. Most aircraft are equipped with electronic navigational systems, including gyroscopes. A gyroscope keeps track of the horizon and the current attitude of the aircraft and, with the help of the onboard navigational systems, displays the horizon through an instrument called artificial horizon. However, in certain emergencies, a visual display of the horizon may be confusing to a pilot who must scan multiple instruments under extreme workloads.

The electronic navigational system of the aircraft calculates the angle between the acceleration vector experienced by the pilot—which points along the pilot's neck axis—and the vertical axis OZ associated with the horizon.

Figure 7 shows the neck axis, represented by the vector $\vec{n}$, and the vertical axis OZ. As the "up" direction (perceived by the pilot, vector $\vec{n}$) drifts away from the real "up" direction (axis OZ calculated by the instruments), the actuator located at P is activated to indicate the direction in which the neck should be tilted to realign it with the vertical axis. Point P may be calculated as the intersection between two planes: plane ∑ and the plane containing the axes OZ and the vector $\vec{n}$.

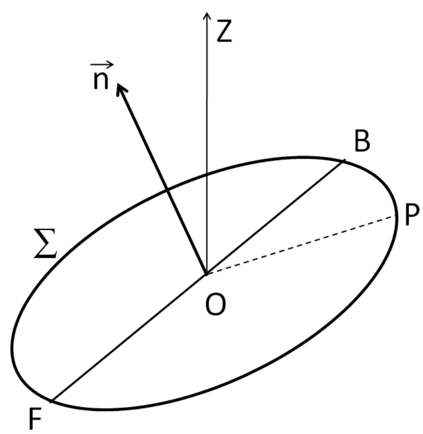


Figure 7. **Vertical axis OZ associated with the artificial horizon provided by an aircraft's navigation instrument, and the vertical perceived by the pilot (vector $\vec{n}$) associated with the plane of the device, ∑**

Semaphores for representing acceleration

In racing games this device may be used to convey the direction and intensity of the acceleration vector experienced in a virtual environment such as a videogame or a simulation. Figure 8 shows that as the acceleration experienced by the user increases in intensity and changes directions, the patch of active actuators increases in size as a function of the intensity of acceleration, and the average direction of the patch of active actuators points in the opposite direction of the acceleration vector. Thus, the player experiences accelerations as if a yoke placed around his/her neck drags him in various directions, with the size and direction of the patch of active actuators causing a variable pressure on the neck skin.

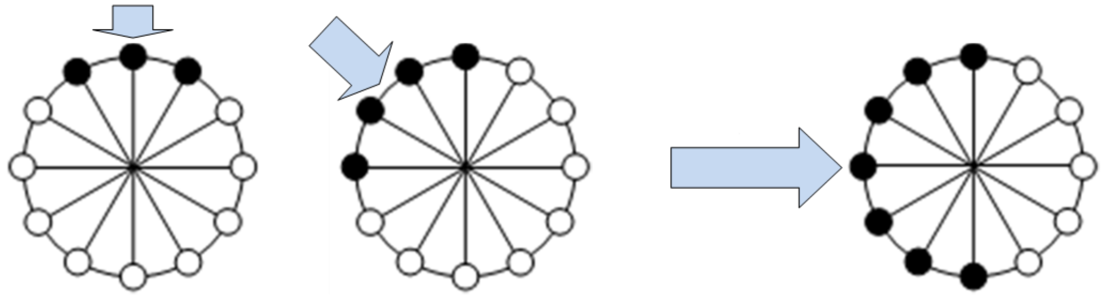


Figure 8. **As the direction and intensity of acceleration experienced by the user changes, the average direction and extent of the patch of active actuators is modified.**

In an alternate and more realistic method of conveying acceleration, at lower accelerations, the extent of the patch of active actuators increases with increasing acceleration up to a certain value of acceleration; then, the intensity of tactile stimulation increases with increasing acceleration while the extent of the patch remains constant. This method mimics the car headrest paradigm in which initially, the contact surface between the neck and the headrest foam material increases as a function of the acceleration module—the constant pressure phase. Once the maximum contact surface is reached, the pressure applied on the neck increases with the acceleration module—the constant contact area phase.

Marquee patterns as dynamic tactile semaphores

Marquee patterns are dynamic tactile patterns. Table 1 shows an example of a marquee pattern making the subject feel as if a point of contact is turning around his/her neck. The numbers indicate the sequence in which the actuators are activated.

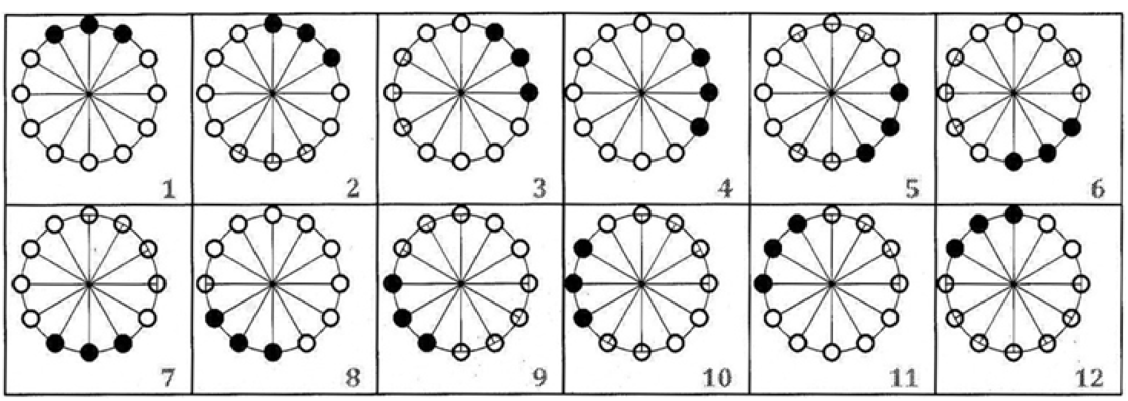


Table 1**: Example of marquee patterns causing a rotating point of contact around the neck**

Table 2 shows another example of marquee pattern causing a sensation of back and forth movement of a pressure point on the left and right sides of the neck. Dark circles represent active actuators and clear circles are inactive. The numbers indicate the sequence in which the actuators are activated.

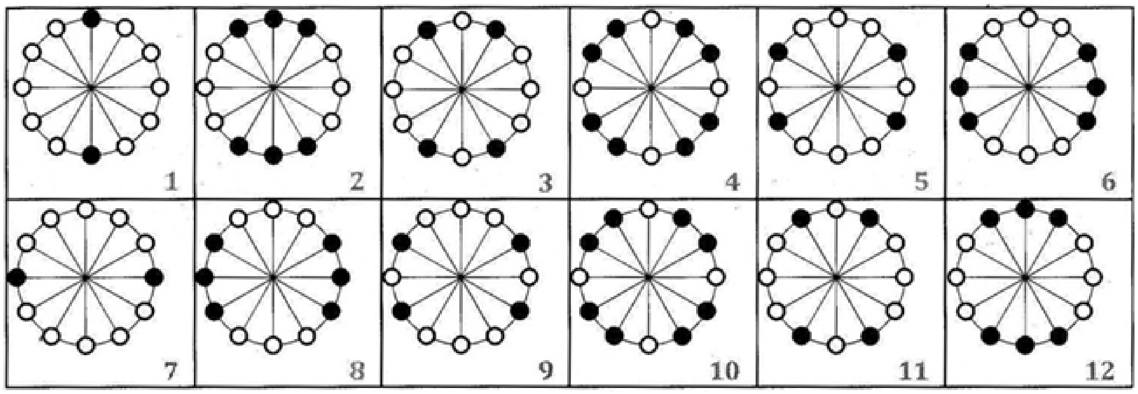


Table 2: **Example of marquee patterns causing a back and forth movement of a point of contact on the neck**

Table 3 shows yet another example of marquee pattern causing a repetitive constriction around the neck of the subject. Such patterns and the sensations they provoke may be used to convey certain game conditions such as ‘diminishing health’, ‘about to be shot’, ‘ball at reach’, ‘falling’, or ‘dying’.

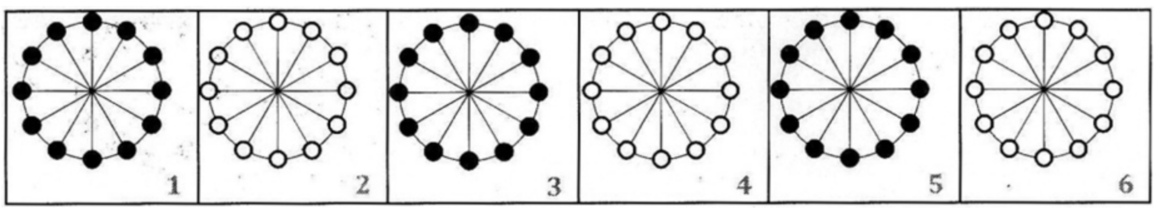


Table 3: **Example of marquee pattern causing a repetitive constriction around the neck of the subject**

Table 4 shows an example of a tactile alphabet based on the static tactile patterns generated by 12 actuators around the neck.

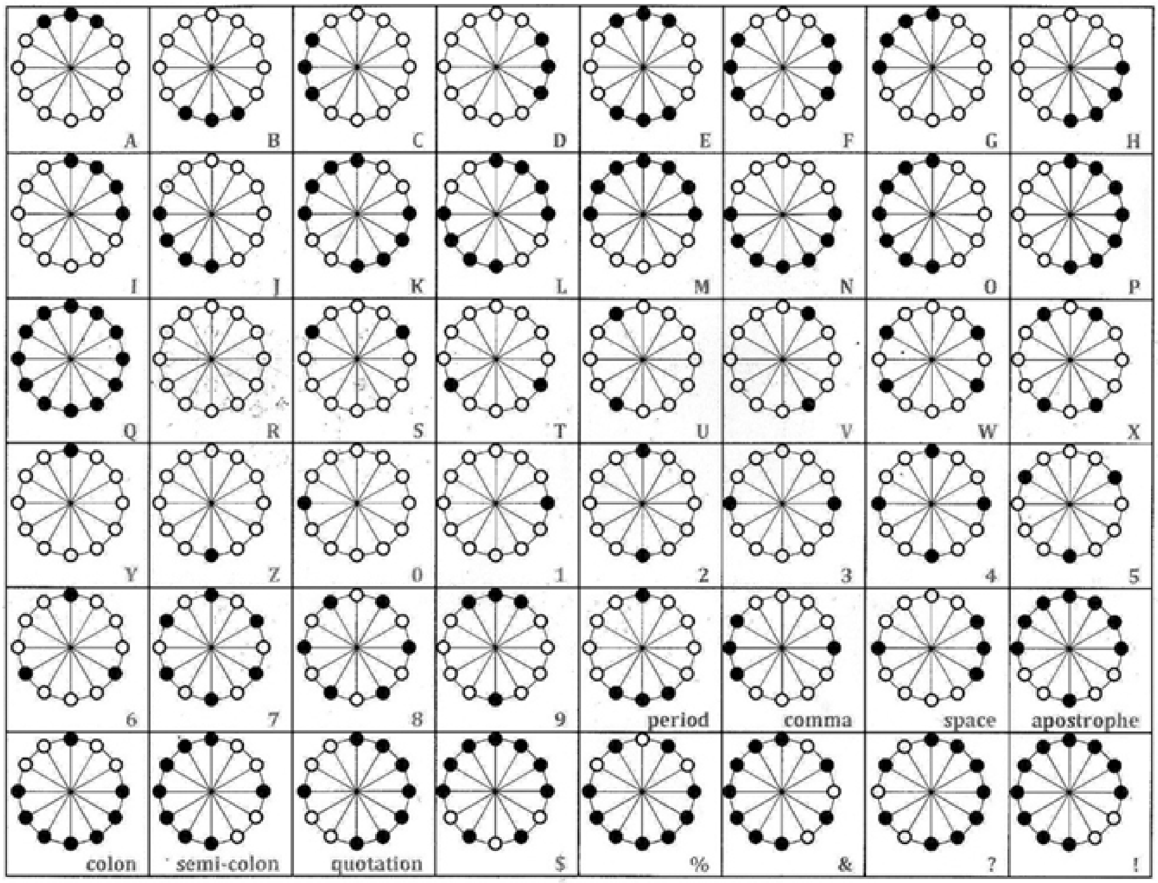


Table 4: **Example of a tactile alphabet based on the tactile patterns generated by 12 actuators**

Applications for the blind

Blind individuals are increasingly taking part in sports and leisure activities. To safely practice these activities, the blind individual often has to follow a guide who carries a small bell or speaks continuously so the blind subject can locate them. With both the guide and the blind individual carrying a mobile communication device, the blind individual's mobile can home in on the guide's mobile device and use a special program to tactilely communicate the bearing and range of the guides mobile to the blind subject wearing the device.

In an alternate application for the blind, the blind individual wearing the device and carrying a mobile equipped with a GPS and an electronic compass can navigate a city. A weak pulse in the North direction will provide the individual with a constant reference to the North, and a slightly stronger pulse using the "radar analogy" described earlier, will indicate the bearing and range of a landmark they wish to reach.

Application to the tactile perception of music and sounds

Using the device, music may be translated into tactile patterns impressed on the neck of a deaf person. Each note of a musical scale may be mapped to a specific actuator or group of actuators, which may be turned on and left on for a duration equal to the timing value of that specific note. In this fashion, the synchronous production of tactile patterns on the neck enables the deaf individual to experience music in a tactile fashion.

To translate music into an intuitive tactile experience, contiguous notes may be mapped to contiguous actuators, with higher-pitched notes mapped to the back and the lower-pitched notes mapped to the front of the neck. The tactile sensing of music may be made more pleasant by mapping each note simultaneously to pairs of symmetrical actuators located on the left and right side of the neck, thus providing the subject with a more symmetrical tactile experience.

Application of the Device as an Accompaniment to Music

A computer, video gaming system, personal music delivery device such as an iPod, or a public music delivery system may use the device to simultaneously deliver music and rhythmic organized tactile patterns to listeners.

An example of such an application is the use of the device as a tactile metronome delivering a complex beat pattern in the form of sequences of marquee patterns. In this fashion, a musician may use the device as a tactile metronome to “feel” complex beats while playing his/her instruments. In a dance club or a choir ensemble dancers or singers wearing the device may receive rhythmic organized tactile patterns along with the music assisting them in dancing or singing in unison.

Conclusion

A device is presented in which tactile stimuli is applied to the periphery of the subject’s neck using multiple evenly spaced tactile actuators arranged in a circle, in the form of a C-shaped structure worn snug around the neck by the subject. An electronic controller operated by a computer program drives the device based on signals received wirelessly from an external source. The device impresses sequences of tactile stimuli around the subject’s neck providing the subject with intelligible information, cues and warnings or certain game-related sensations.

References

Gilson, R. D., & Christopher, B. J. (2007). Patent No. US 2007/0139167 A1. United States.

Hayward, V., Pasquero, J., & Levesque, V. (2006). Patent No. US 2006/7,077,015 B2. United States.

King, Q. (2009). Patent No. US 2009/0289778 A1. United States.

MIT Touchlab. (2005). Laboratory for Human and Machine Haptics. RLE Progress Report 147. Boston, USA: MIT Touchlab Progress Report.

Nishiumi, S., Koshima, K., & Ohta, K. (2006). Patent No. US 2006/7,070,507 B2. United States.

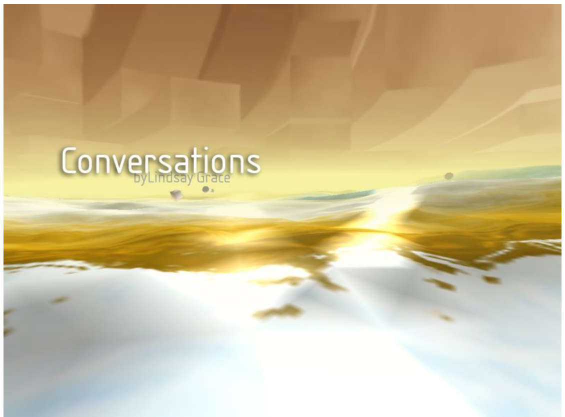
Rupert, A. H., & Kolev, O. I. (2008). The use of tactile cues to modify the perception of self motion. Proceeding of the 26th Army Science Conference. Chicago, USA.

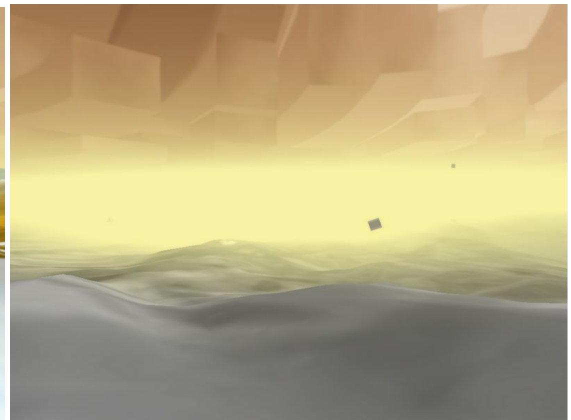
Zelek, J. S., & Holbein, M. (2008). Patent No. US 2008/0120029 A1. United States.

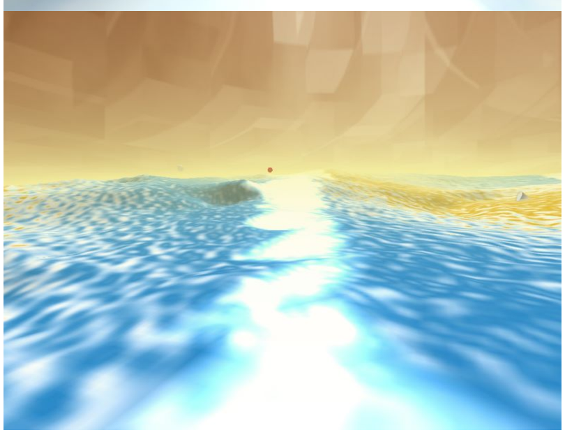
SHORT PAPERS

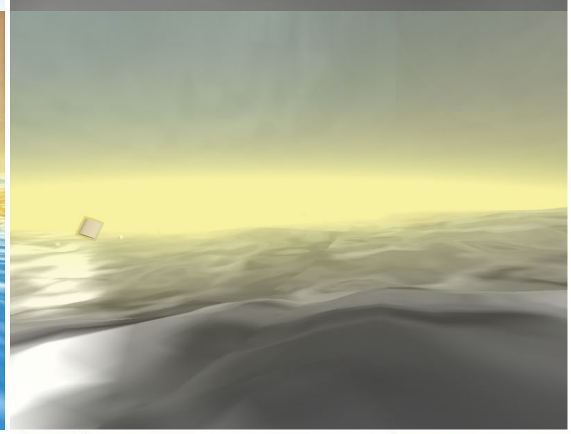
Conversations

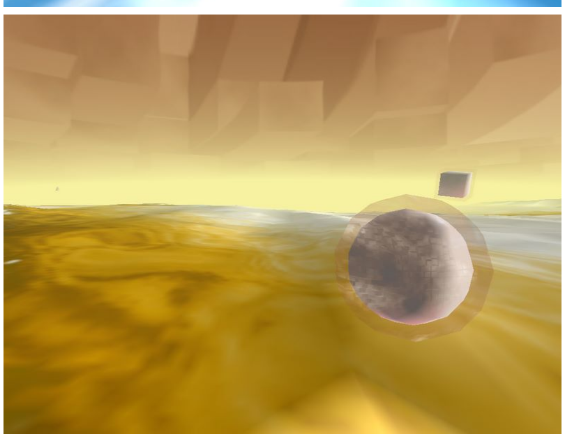
Lindsay Grace, Miami University, 800 High Street, Oxford, Ohio, Email: LGrace@MUohio.edu











Conversations

Conversations is a multi-format art piece centered on an abstraction of fiction and non-fiction. It uses stories collected from a variety of social-networking resources, including Facebook and YouTube. It places this collection in a constantly shifting game-like environment, obscuring both context and presence. The goal is to provide the participant an opportunity to explore a world that is an ambiguous cacophony of truth and lies, not unlike the web from which they were cultivated.

The narratives transpiring in this simplified landscape range from the emotional to the mundane. They discuss politics, personal intimacies, relationships, and others. The voices range from dynamic to inert, from convincing to suspicious.

Designed around an evolving virtual environment that is both expansive and painterly, the player moves in first person perspective. In the Installation version, players may pursue abstract polygons (spheres and cubes) that move at varied rates like non-player characters in an MMORPG. Each polygon tells a story, or at least a part of a story as the player pursues it. In the non-interactive version, *Conversations Lite*, viewers watch as the polygons glide toward and convey their stories to a passive audience.

In its current iteration, *Conversations* is about listening to stories and the distraction of simulation. The work is contained in a looping digital frame where bits of stories float past the viewing window. Some are fully perceptible; others require a concentrated listening effort. In this situation, do you construct a narrative from the pieces you have heard, composing a cohesive story where there may have been none? Do you question one stories relationship to the next, or understand them as individual entities? Does the visualization distract from the content you seek?

Critical Gameplay: Art Games in Instruction

Lindsay Grace, Miami University, 800 High Street, Oxford, Ohio, Email: LGrace@MUohio.edu

Overview

How do games affect the way we problem solve, socialize, or even view the world? When we shoot, do we learn to destroy obstacles instead of work around them? Does the binary world of enemies and adversaries teach us to ignore the gray in the everyday? Do games encourage us to ignore consequences and wait for second chances at the same problems? Are we forgetting how to play with each other because playing against each other is more fun?

Critical Gameplay is a collection of "strategically designed" video games. Each game asks what common game mechanics teach us. The games in the collection are designed to help reevaluate our perspective on gameplay experiences. *Critical Gameplay* seeks to offer alternate perspectives on the way we play.

Critical Gameplay does not attempt to answer these questions. Instead, it seeks to open the dialogue with demonstrative experiments in gameplay. It attempts to fill the space of "what if," with something tangible—a game. What if that avatar had a history before you destroyed it? What if you couldn't read the game world by stereotyping characters? *Critical Gameplay* is simply about raising questions that encourage critical reflection on gameplay experiences. The following games were exhibited:

Wait: A simple game where the player is encouraged to refrain from acting on the world. As the player moves, the world disappears, but when the player waits, the world becomes more interesting. The majesty is found in the slow, controlled effort. Players are awarded points when the little things in life reveal themselves.

Bang!: A game that allows the player to kill other players, but by killing them, the player must endure a long interruptive experience which reviews the fictive history of the victim.

Match: Seeks to challenge the game design pattern of matching and categorizing. Players are tasked with matching objects with people, then people with people, and finally people with a single representative object. Each time the player successfully matches, the pair is removed from the screen. However, some items simple don't have matches.

Healer: A top down "Saver." Instead of shooting players, characters must heal victims of historical massacres. The player can reverse death by removing bullets from the victims. The soldiers that committed these massacres are still lurking, so the player must work to keep the victims alive. The player can put themselves between the bullet and the target to protect the victims and distract the soldiers.

Levity: A game in which the collection mechanic hinders the player. Unlike many games which encourage players to collect items, anything the player collects weighs them down. Levity is a platformer in which the player's jump and walk speed are decreased as the player collects items. Players can convert what they have collected to charity, by giving their collected items, but the weight of having collected is never completely removed. The game is designed as an active revolt to collection values, emphasizing anti consumptive use.

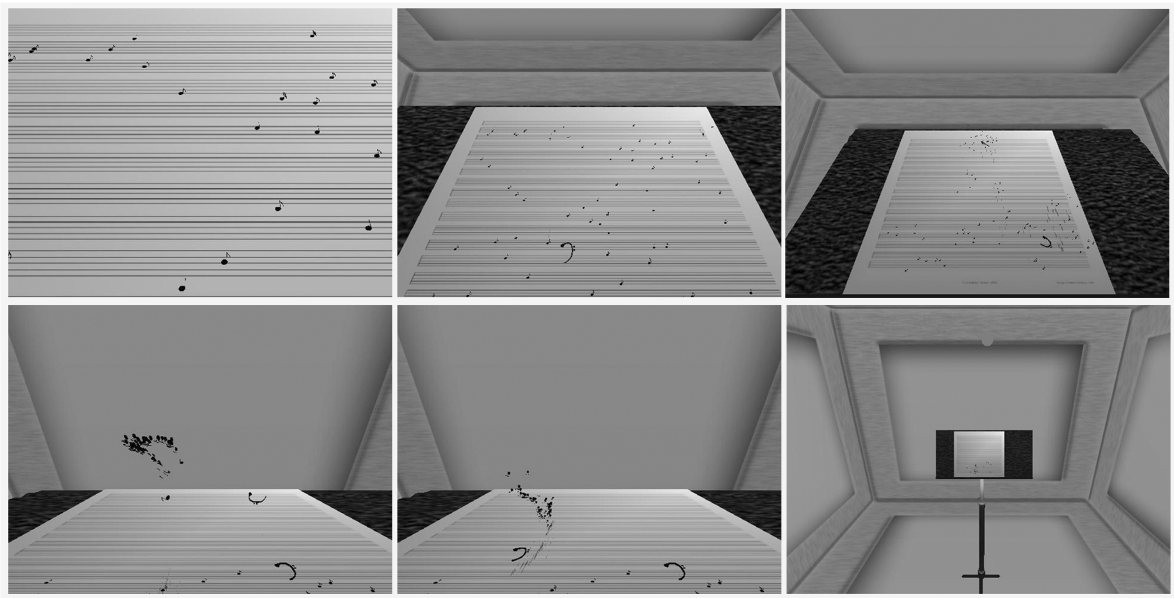
Black/White: A game in which stereotype is challenged. Instead of being able to identify a threat by appearance, the player must examine the threat by another means — behavior. To survive the game, the player must react to NPCs based on how they move. Two characters that look exactly the same may act very differently. The game is built within two levels, with two types of characters, animated in two frames with a series of other binary constructs (two actions, two colors, etc).

Simultaneity: An action-puzzler, where the player must navigate multiple robots to various exits on the game screen. Each robot is controlled by the same set of arrow keys, so a movement left moves all robots left. The player must practice mutual benefit to complete each level, as any physical contact with wall damages a robot. If too many robots are destroyed, the level cannot be completed.

Please visit http://www.criticalgameplay.com/ for more information.

Music Box: Emergent Behavior

Lindsay Grace, Miami University, 800 High Street, Oxford, Ohio, Email: LGrace@MUohio.edu



Overview

Music Box is an artistic implementation of emergent behavior to create music. *Music Box* employs a flocking algorithm (Reynolds, 1999) to display animated notes that rise from a written score and move to create a flock-lead musical arrangement. The result is emergent sound; a musical composition directed by the visual representation of flocking. The experience is a pseudo-synesthetic application of visual rules to the creation of music.

The philosophical goal of this creative exploration is to experiment with freeing the musical score from the prevalent model of composer, performer and listener. Instead the experience is more democratic. Here, the composer suggests, the performer follows a few loose rules, and the listener plays with the composition. As a performance, it attempts to conflate listener and composer, in much the same way author and player are combined in sandbox game narratives. This is accomplished through the development of artificial intelligence software that applies the visual rules of flocking behaviors to the algorithmic arrangement of musical tones.

Treatment

The piece begins when musical notations ascend from two dimensions to three. In pursuit of an analogical representation of contemporary compositional rules, the notes follow their clefs in a predator-prey relationship. The notes resound as they race around the clefs, seeking them out, but never actually catching them. The dance ends when the prey descends back to their two-dimensional world and the predators follow.

Each musical element from the score has its own tone. Changes in pitch and volume occur as it moves through the scene. There are but two timbres, the heavy tone of a bass clef and the plucky lightness of pursuing notes. The sound is scalar, emphasizing pursuit. The aesthetic is a black and white binary, visually demonstrating the dichotomous prey and predator.

Technology and Installation

Music Box was created using the Blitz3D game environment. The distinct algorithm for generating music combines 6 vector calculations for each element of the simulation. This vector sum dictates movement within the virtual space. The vector sum is then applied to a single initial frequency and coupled with a velocity relevant pitch (Grace, 2010).

This work is designed to be a small, intimate experience akin to a late night gaming session. As such, it has been exhibited as a small screen (15”-21”) interactive installation, an interactive black box room installation with projection, or as a looping video on a 10” inch video display. The interactive versions of the Music Box experience are controlled by a computer game controller.

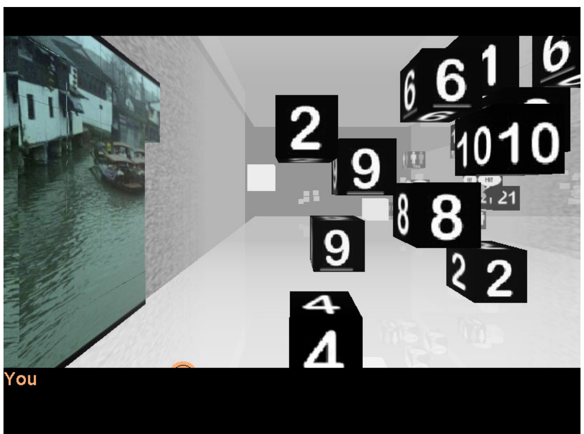
References

Grace, L.D. (2010). Music box: an algorithm for producing visual music. *Proceedings of the third international conferences on advances in computer-human interactions* (pp. 125-129). Washington, DC: 10.1109/ACHI.2010.18

Reynolds, C. W. (1999, March). Steering behaviors for autonomous characters. In *Proceedings of the Game Developer's Conference* (GDC) (pp. 763-782). San Jose, CA: Game Developer‘s Conference.

Polyglot Cubed

Lindsay Grace, Miami University, 800 High Street, Oxford, Ohio, Email: LGrace@MUohio.edu



Overview

Polyglot Cubed is an educational game to facilitate listening comprehension skills for a variety of languages. The modular language learning game works interchangeably with a variety of languages. The game relies on a matching mechanic intended to balance comprehension based language recognition with a casual game play mechanic. It is designed to entertain while enforcing language comprehension. The highly modular system was designed at the University of Illinois, Chicago and enhanced at Miami University. It works to aid in the retention of listening vocabulary with minimal training.

The game is designed around 6 rooms of floating, cubicle tiles. Each tile is assigned a foreign language word or sound and a pictographic representation of that word. For teaching language, the cubes are clustered by topic, usage, or form of speech to encourage contextual recognition and aid visual memory. The player must match the spoken word with the cube that corresponds to it.

The game has been demonstrated to a variety of international audiences and has been praised for its potential. It has been awarded at Michigan State University's Meaningful Play Conference (2008), recognized at the National Training Systems Association Serious Game Showcase (2009) and exhibited at the 5th ACM Advances in Computer Entertainment Conference (2009) and DevLearn (2009).

Polyglot Cubed has been implemented for Mandarin Chinese and Portuguese Criolu. Experimental versions have also been created to teach the language of anatomy, music and chemistry (Grace, 2011). The tool offers a basic modification tool designed to aid researchers in the development of their own educational experiments.

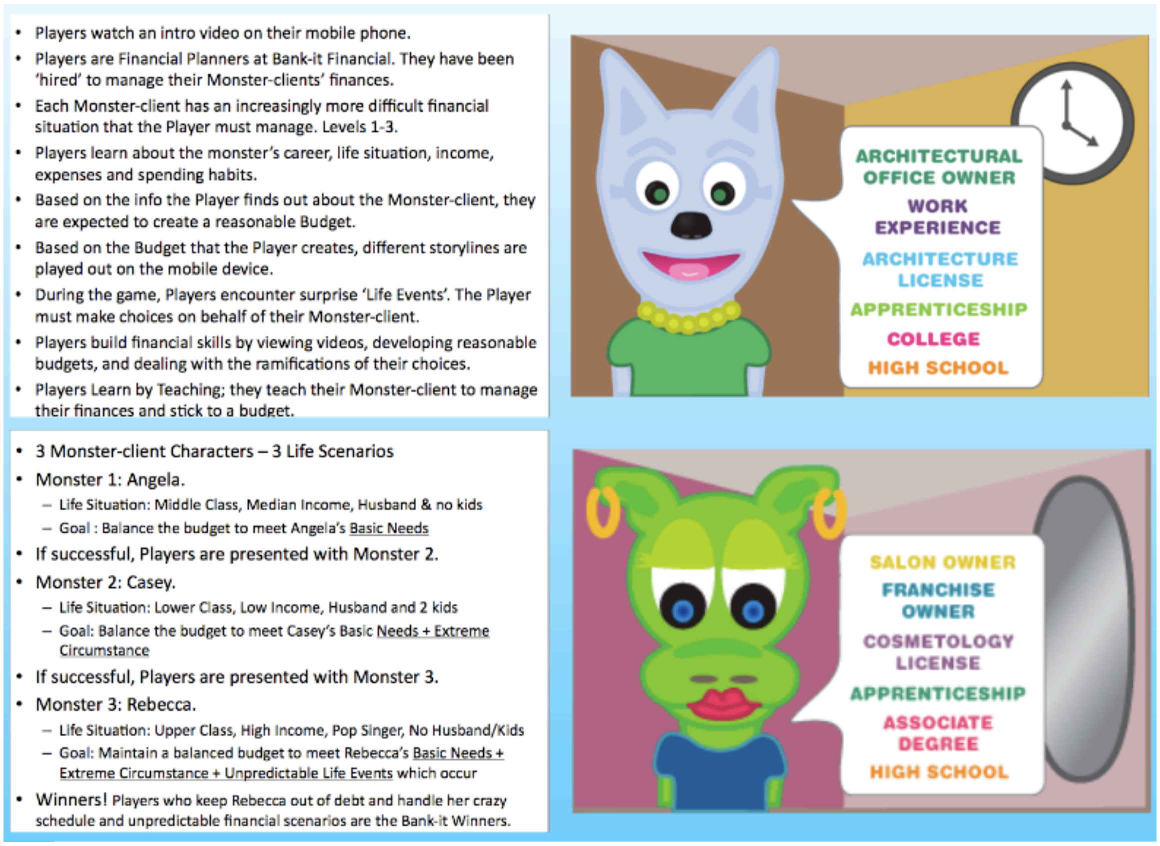
The game is available for download at http://www.PolyglotGame.com.

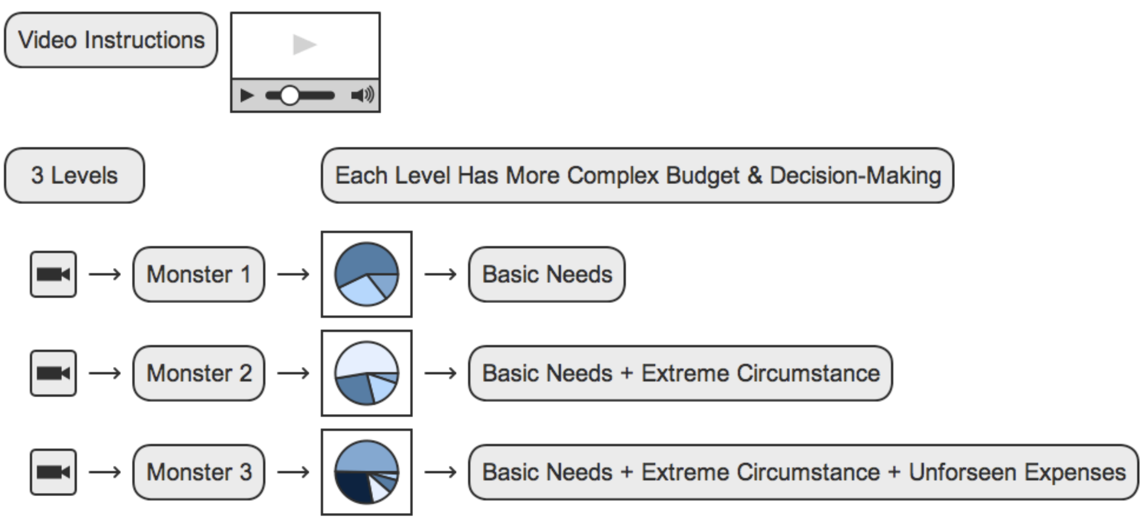
References

Grace, L. & Castaneda, M. (2011). Polyglot Cubed: a Multidisciplinary Listening Comprehension and Recognition Tool. In Proceedings of Society for Information Technology & Teacher Education International Conference 2011 (pp. 3219-3223). Chesapeake, VA: AACE.

Bank-It: A Mobile Financial Literacy Game

Marquina M. Iliev-Piselli, Department of Mathematics, Science & Technology
Cameron L. Fadjo, Institute for Learning Technologies; Department of Human Development
Joey J. Lee, Department of Mathematics, Science & Technology
Teachers College, Columbia University, New York, NY 10027 USA
Email: mmi2102@columbia.edu, clf2110@columbia.edu, jl3471@tc.columbia.edu





Mobile devices are quickly becoming the predominant platform for entertainment and communication between young adults in the U.S. While mobile gaming is a prominent activity among 12 to 17 year-olds (as 48% use a cell phone to play games, (Lenhart et al., 2008) and urban minority girls in this age group are likely to play games on these devices (Purcell et al., 2010), girls in this population are most likely to use mobile devices for maintaining social communications (Lenhart et al., 2008). The app *Bank-It* is designed to incorporate the social communications aspect of mobile computing that are successful among the target population with game mechanisms (challenges, goals, feedback, and safe play space) that will make instruction of Financial Literacy an engaging, motivating, and fun experience (Deterding, 2011).

Can an engaging mobile game be used to both teach the fundamental Financial Literacy concept of income & debt management, and change Financial Behavior (Hung et al., 2009) among the teenage demographic (young urban females) who are, according to the PACFL (2008), 'at risk' of economic hardship due to inadequate Financial Education? *Bank-It*, a mobile game for providing informal Financial Literacy instruction to young urban minority girls, is being developed to provide a mobile experience for engaging in and learning about fundamental banking skills. Specifically, the app is being designed to provide instruction on such critical basic financial topics as judgment and decision-making based on income and expenses and debt literacy (Lusardi & Tufano, 2008).

Using the Conceptual Model of Financial Literacy (see Hung et al., 2009), *Bank-It* is designed to develop Financial Knowledge through active money management and Financial Skills in a mobile game. Challenges are explicitly stated during interactive sessions and participation is reinforced through goal attainment. In the Financial Literacy literature it is often stated that the goal of financial literacy is to improve Financial Knowledge such that the individual will change her or his Financial Behavior (PACFL, 2008; Hung et al., 2009). We are currently collecting pilot data on how an 'off-the-shelf' finance-related mobile game can be used to inform our design considerations for *Bank-It*, and quantify Financial Behavioral trends among users.

References

Deterding, S. (2011). *Meaningful play: Getting «gamification« right.* Google Tech Talk. Retrieved from: http://www.slideshare.net/dings/meaningful-play-getting-gamification-right

Hung, A.A., Parker, A.M., Yoong, J.K. (2009). *Defining and measuring financial literacy: Working paper*. Retrieved from Rand Labor and Population, Rand Corporation: http://www.rand.org/pubs/working_papers/WR708.html

Lenhart, A., Kahn, J., Middaugh, E., Macgill, A., Evans, C., & Vitak, J. (2008) *Teens, video games, and civics*. Retrieved from Pew Internet & American Life: http://www.pewinternet.org/Reports/2008/Teens-Video-Games-and-Civics.aspx

Lusardi, A. & Tufano, P. (2008). *Debt literacy, financial experiences, and overindebtedness*. Dartmouth Working Paper.

President's Advisory Council on Financial Literacy (PACFL). (2008). 2008 annual report to the president. Retrieved from, http://www.treas.gov/offices/domestic-finance/financial-institution/fin-education/council/index.shtml

Purcell, K., Entner, R., & Henderson, N. (2010). *The rise of apps culture: 35% of U.S. adults have cell phones with apps, but only 24% of adults actually use them*. Pew Internet & American Life Project. http://pewinternet.org/Reports/2010/The-Rise-of-Apps-Culture.aspx

Reeves, B., & Read, J.L. (2009). *Total engagement: using games and virtual worlds to change the way people work and businesses compete.* Cambridge, Mass.:Harvard Business School Press.

Shuler, C. (2007). D is for digital: An analysis of the children's interactive media environment with a focus on mass marketed products that promote learning, p. 6-31 www.joanganzcooneycenter.org

Curatorial Statement for Games+Learning+Society Art Exhibition

Arnold Martin, University of Wisconsin-Madison, arnie.martin@gmail.com

The 2011 Games Learning and Art exhibition is a survey of artwork exploring the intersection between games, play and learning. The work spans a variety of artistic disciplines from painting and sculpture to digital media as well as games and game content from independent, academic and commercial game designers. This survey casts an intentionally wide net and explores psychological and intellectual development through play. Original playable games, creative works which blur the line between art objects and games, games aimed at community education, art objects exploring forms from games as well as their conceptual, intellectual, social, and psychological implications are all featured as part of this curated body of work. Playful thinking is apparent in each work and despite the wide range of work and media represented in the exhibit it lends an overall cohesive quality and represents the diversity and range of the international and cross-disciplinary reach of the GLS organization as a whole.

Artists: Mike Beall, Trevor Brown, Chen-Ya Chang, Shawn Everette, Lindsay Grace, Ted Lauterbach, Tyler Law, Collen Macklin, Arnold Martin, Brian Murer, Josh Nemec, Amanda Ochsner, Nick Pjevach, Rebecca Rettenmund, Jason Sandberg, Rebecca Vonesh, Fiona Zimmer, Eric Zimmerman

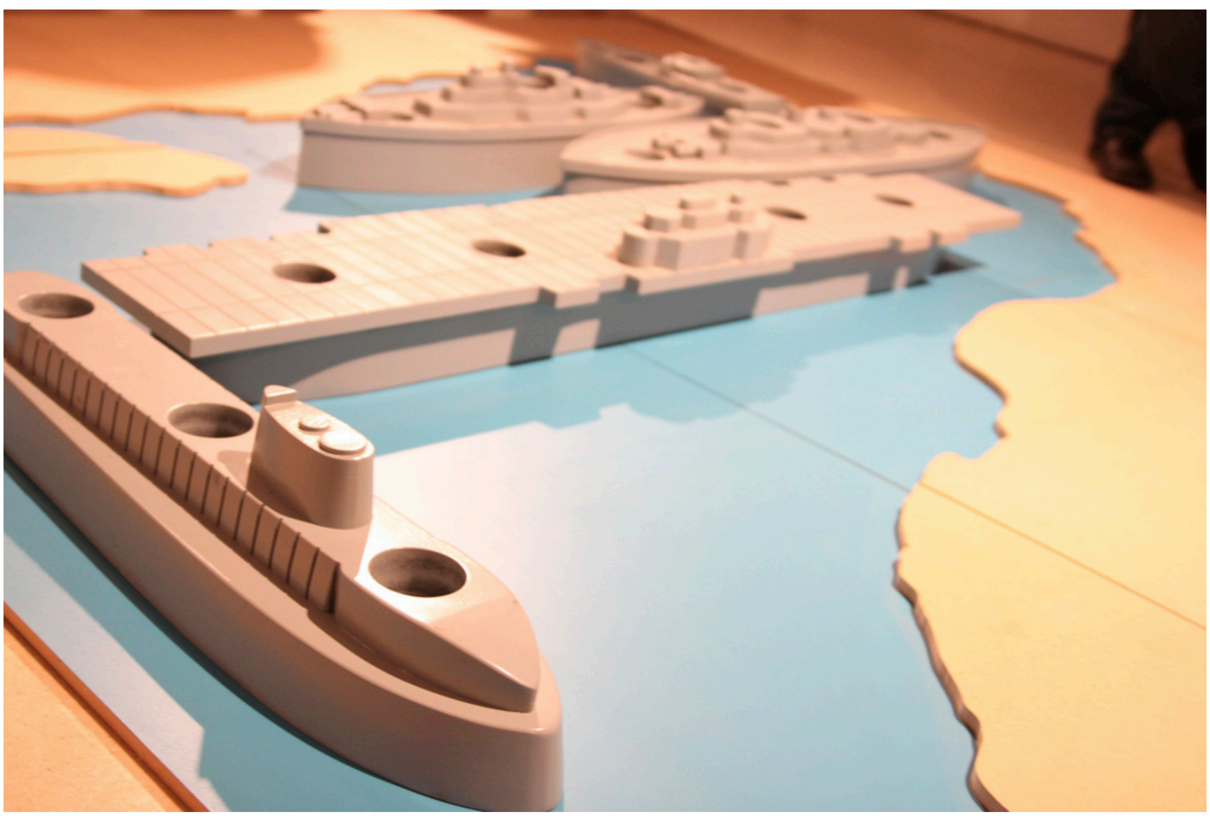


Figure 1: **Game Pieces by Jason Sandberg**

Figure 2: **Figment: The Switching Codes Game by Eric Zimmerman**

Figure 3: **Opening Reception**

Acknowledgements

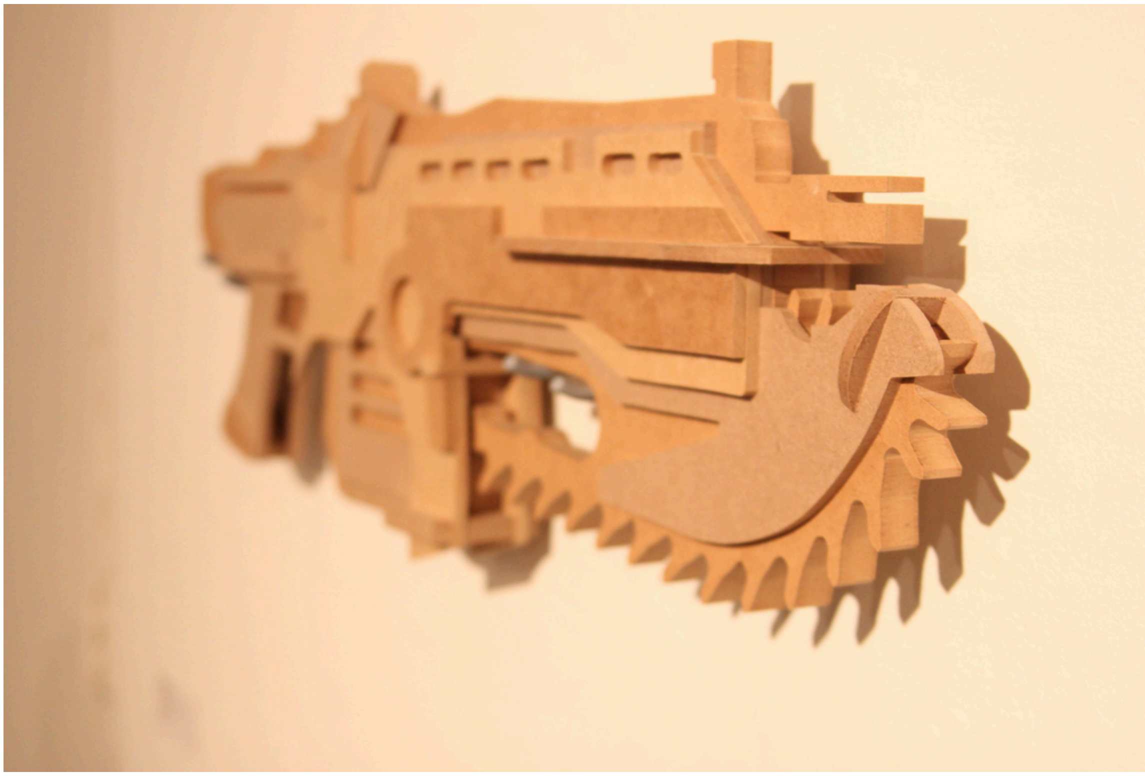
Photos by Mark Reichers (http://bymarkriechers.com/)

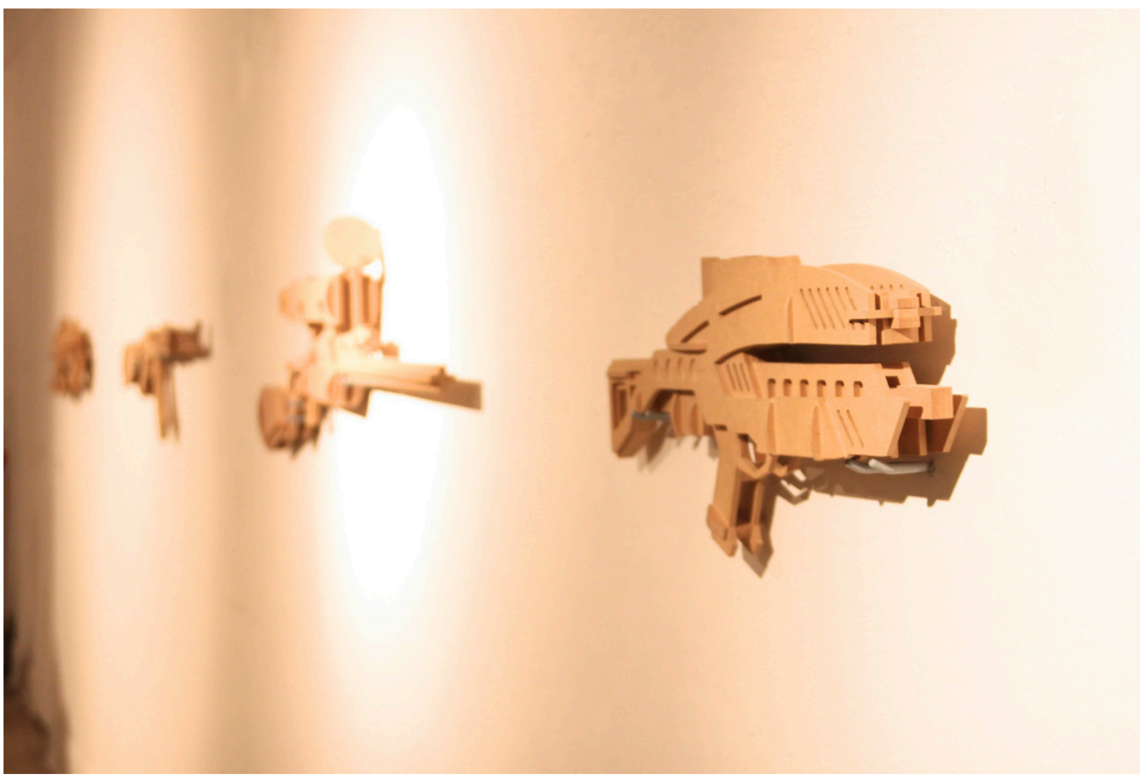
Fantasy Defense

Arnold Martin, University of Wisconsin-Madison, arnie.martin@gmail.com

Fantasy, Metaphor, and Understanding

Fantasy Defense is a series of sculptures modeled after video game and real world assault weapons. They are constructed in raw materials without color or embellishment to reflect an incomplete understanding of their function in fantasy as well as reality. The ridiculousness of function and comical proportions of the Lancer (Gears of War), Sniper Rifle (Team Fortress 2) and M7 Assault Rifle (Mass Effect) are contrasted with the cold functional reality of the M16 and AK47 (which appear in far too many videogames to list here and are among the most ubiquitous assault rifles in the world). While the effects of video game violence are widely considered, debated and discussed, video game violence is not the primary impetus for these pieces. Actual guns are in fact far more pervasive than video games and according to Justice Department estimates there are enough guns in private hands in the US to arm each and every citizen in the country, while only a quarter of adults are, in fact, gun owners. I believe this reflects a larger American Firearm Fantasy often overlooked yet still a cornerstone of American culture. This is a multifaceted fantasy with actual tangible political ramifications as the self defense angle leads to concealed carry and “castle doctrine” laws while the live-free-or-die aspect has led to widespread private militias aimed at defending individual liberty. One factor that ties the many facets of firearm fantasies together is a romantic worship of certain fictional and mythologized figures as heroes and the individualistic desire become a hero as well. From George Washington to John Wayne to the war heroes of the “greatest generation” our culture is saturated in mythical heroic figures doing the impossible to defend life and liberty; it is the national fascination with our own mythology that I believe drives a whole series of ridiculous paranoid fantasies from self-defense to armed uprising. As a gun owner myself I know that this applies to only a limited number of all firearms enthusiasts but the larger point is this: obscured by the fantasy and videogame violence debate are deep seeded national fantasies which are not only played out on televisions and video monitors by gamers and have real effects in the real world which should be considered in our culture: individualistic, steeped in myth, armed to the teeth, and desperately seeking an opportunity to become a hero.





Acknowledgements
Photos by Mark Reichers (http://bymarkriechers.com/)

Wiki for Designing Games at Summer Camp

Evgeny Patarakin, Nizhny Novgorod Pedagogical University, Russia, Email: patarakin@gmail.com
Boris Yarmakhov, Nizhny Novgorod State University, Russia, Email: yarmakhov@gmail.com

Abstract

In this paper, we present a wiki as a medium for storing and sharing materials for games and as an ecological system that can serve as a basis for creating games and simulations. We used both approaches in the framework of summer schools for students 10–12 years old between 2008–2010.

Summer Camp Activities

In August 2008 we organized our first one laptop per child summer camp in Russia. We taught 32 students from Nizhny Novgorod who used OLPC XOs in the natural environment. The XOs were used in 1:1 mode and each summer camp student became an owner of an XO for 10 days.

Summer camp activities included taking pictures of the plants and animals met in field trips, writing stories about their impressions and experiences, collecting and processing GIS data in the camp neighborhood, measuring sound volume and programming in the Scratch programming language. All the stories and pictures were stored in a MediaWiki run in a local wi-fi network. All 32 students registered in the MediaWiki and used the hypertext environment to collaborate with their peers.

In August 2009 we organized our second one laptop per child summer camp. We taught 35 students from Nizhny Novgorod who used OLPC XOs and Intel Classmate PCs in the same 1:1 mode and in the same wi-fi network based on MediaWiki usage.

Scratch projects

In 2008 we designed a Scratch programming activity as a collective project, in which students with diverse interests and attitudes could participate. The core of the activity was creating Scratch sprites and programming their behaviors as scripts, which were then used in a multi-agents model. Scratch programming consisted of four stages.

At stage 1 students designed a scenario of a Scratch based multi-agent game. They chose to create a Mario type game called “The Wanderer”. They decided that the Wanderer will walk across a forest, meet various creatures, such as frogs, bugs and dragonflies that will try to chase him. He will be able to reach the end of the road if he is not eaten by any of them.

At stage 2 the team collected and designed the sprites for the game. Each participant was responsible for their own sprites. The sprites were partially drawn by the “artists” and partially cut out from photos, made by “photographers”.

At stage 3 the game programming process was split into small tasks, each of which was fulfilled by an individual or by a pair of programmers. All the individual pieces of code, representing scripts, were shared as files on the collaborative MediaWiki environment.

At stage 4 all pieces of code were put together, tested, debugged and showcased as a game. This game is available on the Scratch website - http://scratch.mit.edu/projects/KatkovJuriy/652601

Figure 9. Strannik Project

In 2008 we designed Scratch programming activities as individual projects, in which students design projects with a single sprite. A single sprite contains all the necessary information, and reproduction of such a sprite, we get a ready-made model, in which the sprites behave as agents of the same breed.

For an example, the Flocking Sprite project - http://scratch.mit.edu/projects/patarakin/702827 Each separate sprite contains all the information about how a butterfly moves around the screen, and how it reacts to the behavior of other butterflies.

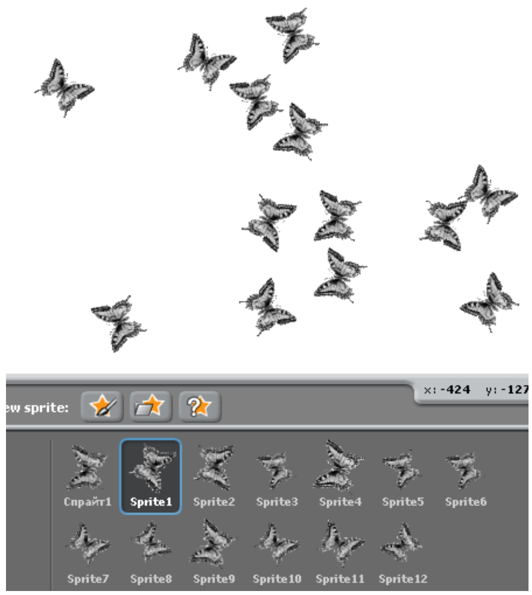


Figure 10. Flocking Sprite Project

Information about two species of butterflies was stored in the Battle Sprite Project. Each sprite in this model had the same script and it could be one or another species with the same behavior. If the agent met another creature it could change his breed or not.

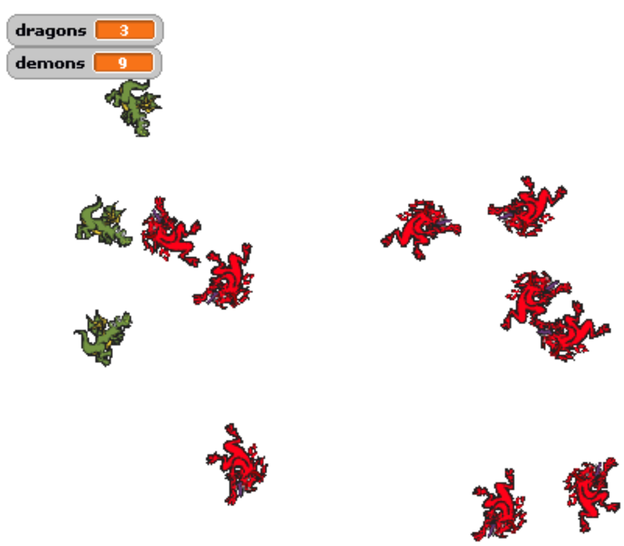


Figure 11. Battle Sprite Project

MediaWiki

Historically the development of the Scratch programming language in Russia is closely linked with the development of educational wiki communities. It is not a coincidence. Both wikis and Scratch are built on the metaphor of constructing bricks. Very often we draw attention to the fact that a wiki is a very simple and very quick way to create and deploy a new page in the network. In the same time attention is distracted from the point that it strengthens with the interaction of wiki pages and the collaborative efforts. What has been created by one person can be further used by other people. Articles inside a wiki assume power in their creation, we follow certain standards. We can collect articles from the finished blocks, the same way as the program collects from Lego blocks. Lego blocks or Wiki articles are useful and powerful not because they are simple but because they determine the exact template, and they are always compatible with each other.

All students were registered in the MediaWiki and used the hypertext environment to collaborate with others. All the stories and pictures were stored in a MediaWiki run in a local wi-fi network. Students used these materials, as well as materials from the digital collections to create games and stories in the Scratch environment.

In 2010 we made special MediaWiki extension which allowed us to insert Scratch applets in the MediaWiki website. In this first version of an extension you have to upload your scratch script on scratch.mit.edu The URL of extension is http://www.mediawiki.org/wiki/Extension:Scratch

Figure 12. Logo of Scratch extension

The approach to the storage of individual sprites and other materials in MediaWiki was successfully used in the course of two summer schools on the model of 1:1 in 2008 and 2009. The same approach with personal responsibilities for the project, we used from 2007–2009, as part of teaching students of Nizhny Novgorod State Pedagogical University.

Play to Order: What Huizinga Has to Say about Gamification

Cody Reimer, Purdue University, 500 Oval Dr., Lafayette IN 47909, Email: reimerc@purdue.edu

Abstract

In this paper, based off his Pecha Kucha micropresentation, the author discusses the lack of attention to Johan Huizinga's work in the debates on gamification, or the use of game mechanics and design to engage students. Huizinga's definition of play and concept of a magic circle surrounding play spaces can help shift our understanding of gamification from contested to productive. The presenter argues that because we can already view education and life as a game, our goal is not to apply a glossy veneer to class work, but to reveal the ways in which class work is already a game.

Gamification is the application of game mechanics and design to make a mundane task more engaging. In the past two years or so there have been numerous resources and arguments springing up about gamification. TED talks and wikis, numerous blogs, a panel at this past GDC, and several presentations at conferences are all discussing how and whether to use game mechanics such as point systems, badges, leaderboards, and the like to improve student, client, or customer engagement. However, the nascent scholarship on gamification has yet to bring Dutch play theorist Johan Huizinga—whose book *Homo Ludens* (1950) has been germinal to game studies—into the discussion. This paper will attempt to address the gap.

Due to obvious time constraints, I can't wax scholarly about the background of gamification and its connection to token economies and incentivization, but it's important to note that the current tenor of the conversation surrounding gamification is contested. At this past GDC, Ian Bogost and others have argued that gamification is not the way we want to integrate videogames (even principles or mechanics) into education or other industries. In a blog post, Bogost (2010) even went so far as to advocate relabeling the term "exploitationware" because he feels its sole principle undermines the difficulty and complexity of game design and works to exploit its users.

Detractors of gamification make some excellent points. They are concerned about gamified classes using Skinner box psychology, about deontological imperatives being devalued, about what Jesse Schell (2010) has called the "gamespocalypse" (a time when everything is gamified), but my main concern is about how we can bring games or game design into the classroom that won't result in another failure like edutainment. And I'm not sure serious or persuasive games or even virtual worlds have sufficient cultural capital to ride the growing wave of enthusiasm for games.

The early talk about gamification was concerned with aesthetics and surface level quick-fixes. The formula as it has been presented thus far in the majority of venues has been, Step 1: Slap points, achievements, badges, leaderboards, etc. on task. Step 2: ? ? ? Step 3: Profit. It's the question marks we need to be concerned with. Surface level fixes, such as calling assignments quests or grades levels won't do anything to motivate students.

More recently, critiques of "pointsification," (Robertson, 2010) and well-reasoned arguments about the complexity of game design in applying gamification have begun to steer gamification in a more appropriate direction, one that won't crush the current enthusiasm for games by turning gamification into another edutainment. We need to continue down the complex path and shun the cosmetic, glossy game veneer that others think of when they hear the term gamification.

Gamification is not triage for poor lesson plan design or apathetic students. Instead, it might offer us real ways to aid our students in navigating the education system which, as Alex Layne (2011) has argued cogently, can already be considered a game. But it can only provide such aid if we take gamification seriously and think about difficult questions that many have attempted to answer—some better than others—in numerous books, essays, and other publications.

The questions might be put forward as "what makes games fun?" or "what motivates play?" Few have discussed these questions with as much authority as Huizinga does in his influential book on the play element in culture, *Homo Ludens*. Huizinga has influenced the nascent area of game studies from its birth, but in all that I've read about gamification, nobody has consulted his works. I find this surprising, especially when what we're seeking with gamification is a means to get students to "play" the game of education.

Huizinga tells us that "play to order is no longer play" (p. 7). This means that we cannot require students to play a gamified classroom. Game mechanics do not a game make. Adding achievements to a syllabus does not make students want to play. Gold stars stopped serving as incentives in third grade. If we want students to play our game, we need to consider gamification not as a means to engage students, but as a means to reveal the ways in which education or school is already a game.

Thinking about Huizinga's magic circle can help us recast gamification from a means of external motivation to a means of making school a place that encourages play instead of orders it. The magic circle, we are told, is in form and function a play-ground, "a temporary world within the ordinary world, dedicated to the performance of an act apart" (p. 10). When we play a game, we enter or create this magic circle where special rules apply. In *Unit Operations*, Bogost (2006) correctly stipulates that there is a gap in the circle "through which players carry subjectivity in and out of the game space" (p. 135).

The gap is noted by nearly every game studies scholar who mentions the circle. Bonnie Nardi (2010) explains in her ethnography of *World of Warcraft* that "play does not, and cannot, exist in an imperturbable magic circle; it is always in dynamic relations of tension to other activities in which a player might engage" (p. 108). That is, the circle is porous.

When we begin to think about the procedural rhetorics and logics of a game, we are stepping—perhaps only tenuously—inside the circle. But how does this influence our reconception of gamification? My contention is that we need to think of gamification as a means not of motivating students, but as a means of revealing the potential for a magic circle in the classroom. We cannot order students to play, but we can create a space where play is encouraged through game mechanics.

Huizinga tells us that play exists in a continuum between levity and severity. Play can be serious. In a way, games *are* serious business. Students already have external motivators to play the education game—they're called grades and parents. Granted, grades and parents don't motivate every student, but my point is that mechanics won't necessarily do so either. What gamification can provide—and better than motivation—is a means for making clear the magic circle surrounding the game.

Instead of mechanics emphasizing competition such as leaderboards, which social cognitive theorists have agreed hinders motivation, we need to focus on game principles and mechanics that provide constant, clear feedback. The logic behind the mechanic is more important than the name of the mechanic. Talent trees which track progress can keep students in what Vygotsky (1978) called the Zone of Proximal Development while *showing* students their path.

Constructing a talent tree of tiered skills necessary to complete a project or assignment is perhaps as hard as designing a good game mechanic, but it's these types of complex mechanics we should be concerned with when we talk about gamification. Designing such a tree requires breaking down complex skills into their base components and figuring out how they scaffold to produce the desired result. There are other mechanics and design elements which can help reveal or create a magic circle within a classroom, making it more conducive for play. We need to figure out what they are, put them to the test, and figure out how to encourage play without ordering it.

References

Bogost, I. (2006). Unit operations: An approach to videogame criticism. Cambridge, MA: MIT Press.

Bogost, I. (2011, May 3). Persuasive games: Exploitationware. Retrieved from http://www.gamasutra.com/view/feature/6366/persuasive_games_exploitationware.php

Huizinga, J. (1950). Homo ludens. Boston: Beacon Press.

Layne, A. (2011, April 10). Gaming the system in a system of gaming: The inherent nature of games in pedagogy. Retrieved from http://www.samanthablackmon.net/notyourmamasgamer/?p=368

Nardi, B. (2010). My life as a night elf priest: An anthropological account of World of Warcraft. Ann Arbor, MI:University of Michigan Press.

Robertson, M. (2010, Oct. 6). Can't play, won't play. Retrieved from http://www.hideandseek.net/2010/10/06/cant-play-wont-play/

Schell, J. (2010). Design outside the box. Retrieved from http://gamification.org/wiki/Encyclopedia

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, Mass.: Harvard University Press.