From Beyond Barbie and Mortal Kombat: New Perspectives on Gender, Games, and Computing
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MIT Press, 2007

Section IV **Changing Girls, Changing Games**

Carrie Heeter

The authors of our fourth section, *Changing Girls, Changing Games* have strong ideas about how games and girls should be different and are working towards realizing those visions. We apply a plethora of design research techniques to understand player motivations and to design games which achieve the designers' goals. We want to change girls, empowering them to become technological superheroes. We want to change games, diversifying and enhancing the play and learning experience. Our motivations vary, from practical perspectives on how to make games more fun and sell to larger markets, to gender equity concerns about increasing girls' and women's information technology powers, to designing games for learning which accommodate diverse player types and learning strategies. We hope that the next generation of game designers will read our chapters and as a result, will approach their own future game designs with more gender-conscious perspectives. We hope they will be inspired to focus on game and player goals throughout the design process, informed by their own and others' design research.

Industry consultant Nicole Lazzaro, President of XEODesign, starts this section with a delightful reframing of the often-asked question: are games designed just for girls necessary? Necessary for what depends on who is asking the question. For example, game companies that hope to expand their market wonder whether girl games are the best way to sell games to female consumers. And activists that hope games will be a means to technological empowerment wonder whether girl games are the only way to entice girls to learn and love technology. On the other hand, in her chapter, *Are Boy Games Even Necessary?***,** Lazzaro questions whether the game industry should continue creating games for boys. She argues that the game industry remains stuck designing for a niche market –: the once adolescent but now aging males who were the original consumers of console first person shooter, war, and sports games. Segmenting the game market by sex, and developing for a narrow, extreme subset of either males or females limits market size. Designing games

which are strongly “male” typed (or strongly “female” typed) limits the appeal of a game. Extreme male games and extreme female games are probably not extremely fun games. Lazarro argues and her company’s research shows that what is fun for both sexes has more in common than different. She points the way to a game design approach based on what players want rather than what women or men want. Best selling games accommodate more different forms of fun and allow for a wider range of playstyles.

Elisabeth Hayes, professor with the University of Wisconsin Games, Learning, and Society Research Group, wants girls to play the games that boys play. She doesn’t want them to play just any game, it has to be games which help girls develop tech-savvy abilities, attitudes, and identities. In her chapter, *Girls, Gaming, and Trajectories of IT Expertise,* Hayes acknowledges girls are not technophobic; they do play games and in fact in surpass boys in some uses of computer technology such as blogging. But for Hayes, just playing games is not enough. It matters what games girls choose, and she wants girls to move beyond being players and engage in game-related practices such as creating in-game and game-related content. These kinds of activities develop domains of IT expertise and problem solving which translate easily into careers in programming and computer science and other fields that rely on technologies. Hayes considers strategies to intentionally foster girls’ deeper participation in game-related constructive activities, reminding us that “fun” is one of the primary underlying reasons that people want to play games.

Authors of the next three chapters are each leading large scale projects aimed at getting girls interested in and teaching them about computer programming or technology. Because women are an underrepresented group in science, math, engineering, and technology, the National Science Foundation (NSF) provides funding to find ways to broaden their participation in these fields. All three projects (Click! Urban Adventure, Storytelling Alice, and RAPUNSEL) were funded by the NSF and designed for middle school girls. Research has shown middle school to be a critical period when girls’ educational and career choices related to computers as well as science are formed.

In *Design to Promote Girls’ Agency through Educational Games: The Click! Urban Adventure*, Kristin Hughes outlines the design process of creating Click! a role-playing science adventure game for middle-school girls. Hughes is on the faculty at the top-ranked Carnegie Mellon University School of Design which is well known for innovation and excellence in design research. Her chapter is a fascinating case study detailing a four-semester exploratory and discovery phase of researching how to use games to change middle-school girls’ antipathy toward STEM (Science, Technology, Engineering, and Math) careers. The process itself, the insights gained about middle school girls, and the resulting product will inspire others working in this domain. Early in the design research process, the designers noticed that boy and girl players took very different approaches, and furthermore that when girls and boys played together, girls ended up in support roles. Because the project’s explicit goal was to increase girls’ agency with science and technology, they decided to create a girls only

experience. The discovery process applied a sequence of qualitative and quantitative research activities contributing to the design team's understanding of the types of play experience would excite and sustain girls' interests. Click! Is a mixed reality story-based multiplayer team mystery game involving five weeks of training to prepare for game day. The first test of the final game, conducted with 100 girls, succeeded in its goal of promoting girls' sense of agency in relation to STEM. Refinements and larger community deployment are underway.

Knowing how to program computers unlocks the power to create simulations, games, communication systems, and other information and communication systems. Women are strongly under-represented in computer science and their absence holds back not only individual careers but also integration of other-than-male perspectives in the creation of computer-based experiences. Caitlin Kelleher grew up interested and skilled in computer science. She earned a doctorate in Computer Science at Carnegie Mellon University without the benefit of the software that she has since designed to help interest girls in computer programming. Her chapter, *Using Storytellling to Introduce Girls to Computer Programming*, describes a multiyear iterative process of design, user testing, and refinement. Kelleher had worked with "Alice," a programming environment designed by Randy Pausch and colleagues at Carnegie Mellon University which enables novice programmers to create high quality animations. Because she believed that storytelling and sharing stories would provide stronger inherent motivation than animation alone for girls to want to learn programming, she adapted Alice to create Storytelling Alice. Kelleher began with the hunch that programming as a means to tell stories would attract girls. Over a three year period she prototyped, tested, and revised her design. She then conducted a trial of Stortyelling Alice involving 43 girls. The trial showed that Storytelling Alice was more successful than Alice at engaging middle school girls. The success of her program will grow larger with the announced donation by Electronic Arts of *The Sims 2* character library to be integrated into Alice and Storytelling Alice.

In *Design Heuristics for Activist Games*, academic, activist, and former commercial game designer Mary Flanagan and philosopher colleague Helen Nissenbaum propose a design heuristic for embedding activist values in a game. They draw examples from RAPUNSEL, a game designed to engage inner city girls and teach them programming. Their Values in Play method (V.A.P.) involves three often-overlapping phases: Discovery, Translation, and Verification. The goal of discovery is to identify relevant values. Translation operationalizes the values, transforming them into game features. Verification checks to see that the intended value goals are actually achieved. This process is applied each time the game design iterates. They advocate conscious consideration of values throughout the design process, from the definition of a project, to specification of game mechanics, to safeguarding critical values-rich design features during implementation and revision. V.A.P. provides an added layer of design methodology, to be applied in conjunction with whatever process game designers currently use. Flanagan and Nissenbaum describe the overriding social value of

RAPUNSEL, a game design to teach girls to program, as "gender equity." The game itself is based on girls' preferences and interests. RAPUNSEL addresses the goal of gender equity not within the confines of the game (which intentionally privileges girls' preferences) but within the larger societal perspective because of the extreme under representation of women in game design and computer science. RAPUNSEL also embodied values such as cooperation, sharing, and fair representation. Whether makers of media experiences intend to do so or not, they transmit values through their designs. Flanagan and Nissenbaum provide game designers with tools to appreciate and consciously apply the subtle power of this medium to embody and reinforce activist (or socially responsible) values.

Despite being games for learning, the exclusive focus of RAPUNSEL, Storytelling Alice, and Click! on girls' interests and preferences positions them as poor choices for classroom learning. Strategic adaptations could be made to incorporate play styles appealing to boys. Carrie Heeter and Brian Winn teach serious game design at the Michigan State University Games for Entertainment and Learn (GEL) Lab. In their chapter, *Implications of Gender, Player Type and Learning Strategies for the Design of Games for Learning*, they warn that educational game designs which blindly borrow from commercial game motifs and genres risk privileging male learners by replicating commercial games' historical exclusive emphasis on masculine interests and play styles. The authors propose four characteristics that should be incorporated into games intended for classroom learning: 1) classroom games strongly engage both girls and boys; 2) they accommodate diverse play style preferences, 3) they provide support where needed for learners with limited gaming experience; and 4) they result in deep learning through play. Heeter and Winn designed and studied a classroom learning game intended to accommodate both masculine and feminine play styles. Heeter and Winn propose and validate a taxonomy of player types for learning games, classifying players as Competitive (speedy, few errors), Engaged (slow exploration, few errors), Careless (speedy, many errors) and Lost (slow play, many errors). Competitive and Engaged play are successful learning strategies. Careless and Lost play are unsuccessful learning strategies. They tested three variations of in-game reward structures. Rewarding speedy play harmed girls and had no impact on boys' play. Rewarding exploration helped boys and had no impact on girls' play. The authors conclude with advice to designers about accommodating diverse play styles and using reward structures to attract learners to more successful play and learning strategies.

This section begins with persuasive arguments for why to design for players rather than for extreme male or female play preferences. Doing so will result in more satisfying, more fun, more widely appealing games. Games are assumed to be powerful, designed experiences able to engage and change players, experiences can be improved upon, made more powerful or more fun, through a combination of carefully held design objectives and design research

techniques. The authors' belief in the potential power of games underlies their own attempts to use games to engage and empower girls to themselves someday wield this power. Three chapters describe the design of games specifically for girl audience. This approach is less contradictory of Lazarro's chapter than it may seem because the authors' works are based on design research. Although they only consider girls' interests and preferences, the question they ask is not "what do girls want?" but "how do we understand and engage our (girl) audience?" Their goal is not to create games which are extreme girl games. They are trying to create games which are extremely appealing to girl players. We would expect that their games already accommodate a diversity of play styles, though slanted towards more feminine play styles. Should Hughes, Kelleher, Flanagan and Nissenbaum move to target a mix of female and male players, they will again use design research to find ways to incorporate more masculine play styles, expanding the appeal of their games. Games for classroom learning carry a mandate to be good for learning for both sexes. Great commercial games allow for many different play styles; great classroom learning games allow for many different learning styles. Gender differences can help inform that diversity, but in fun and learning players of both sexes have more in common than different.

Chapter **18**

Implications of Gender, Player Type, and Learning Strategies for the Design of Games for Learning

Carrie Heeter and Brian Winn

Educational computer games have earned a reputation as games that lack the production values and fun found in successful commercial games (Heeter, Chu, Maniar, Mishra, Egidio & Winn, 2003). The increasing technical and aesthetic sophistication and growing popularity of commercial digital games have attracted a rebirth of interest on the part of scholars and teachers to create new and improved games for learning. Successful commercial games are lauded as models of what great learning games should be (Gee, 2005). This assumption has a glaring flaw: Commercial digital games today are still a boy's medium.

Our research on gender and games in middle school, high school, and college shows that boys play digital games for more hours per week than girls do at every age studied (Caywood & Heeter, 2006). The magnitude of the weekly gender gap in time spent playing games increases with age; boys play 2.8 times longer than girls in middle school, 4.4 times longer in high school and 5.1 times longer in college. Extrapolating from our data, by the time an average male graduates from college, he will have logged thousands more hours of digital game play than his average female classmate. Reasons for this disparity are explored in many chapters in this volume (see also chapters by Hayes and Taylor, this volume).

If educational game designs blindly borrow from commercial game motifs and genres, they risk privileging male learners by focusing on masculine interests and play styles. This would be the natural outcome of copying commercial games without recognizing that the theme, genre and play style patterns on which they are based have been repeatedly proven by consumer behavior to appeal more to boys. Educational games should be designed to incorporate the

needs, interests, and play styles of both girls and boys. Commercial games can cater to niche markets and still achieve economic success. But games must be designed for all students if they are going to be used in the classroom.

The benefits of computer games in the classroom include increased student motivation and the potential for a well designed game to offer unique learning experiences (Cordova & Lepper,1996). When games are engaging, the game itself can pique student motivation, activating learning of subjects that players may not otherwise care about. The burden of motivation with a learning game shifts from the typical teacher's challenge of motivating students to learn a subject to the game designer's challenge of motivating players to become engaged with the game. Students can be assigned to play an educational game, but what students learn and do within the game depends upon the student. Players construct their own game experience by the actions they take. Each player's experience is unique in large, complex games (Steinkuehler, 2006). Even within smaller, simpler educational games, different players will have different experiences (Klawe, Inkpen, Philips, Upitis, & Rubin, 2002). In an educational game, it is the actions taken while playing which cause the learning experience to unfold. Players' freedom of action is also freedom of inaction. An unmotivated player, one who goes through some of the motions of playing during the assigned time but doesn't bother to figure out the rules of the game or engage with the game world and goals, will likely learn little or nothing.

Four characteristics should be incorporated in games intended for classroom learning: 1) they strongly engage both girls and boys; 2) they accommodate diverse play style preferences, 3) they provide support where needed for learners with limited gaming experience; and 4) they result in deep learning through play. Gender intersects with at least the first three goals and possibly the fourth. This chapter presents a design case study of Life Preservers, a game that was designed to incorporate all four characteristics while paying close attention to gender. We explore theoretical and practical implications of considering gender during the design of learning games. Findings from the study of Life Preservers in classrooms provide insights into how different reward structures in a learning game impact male and female players.

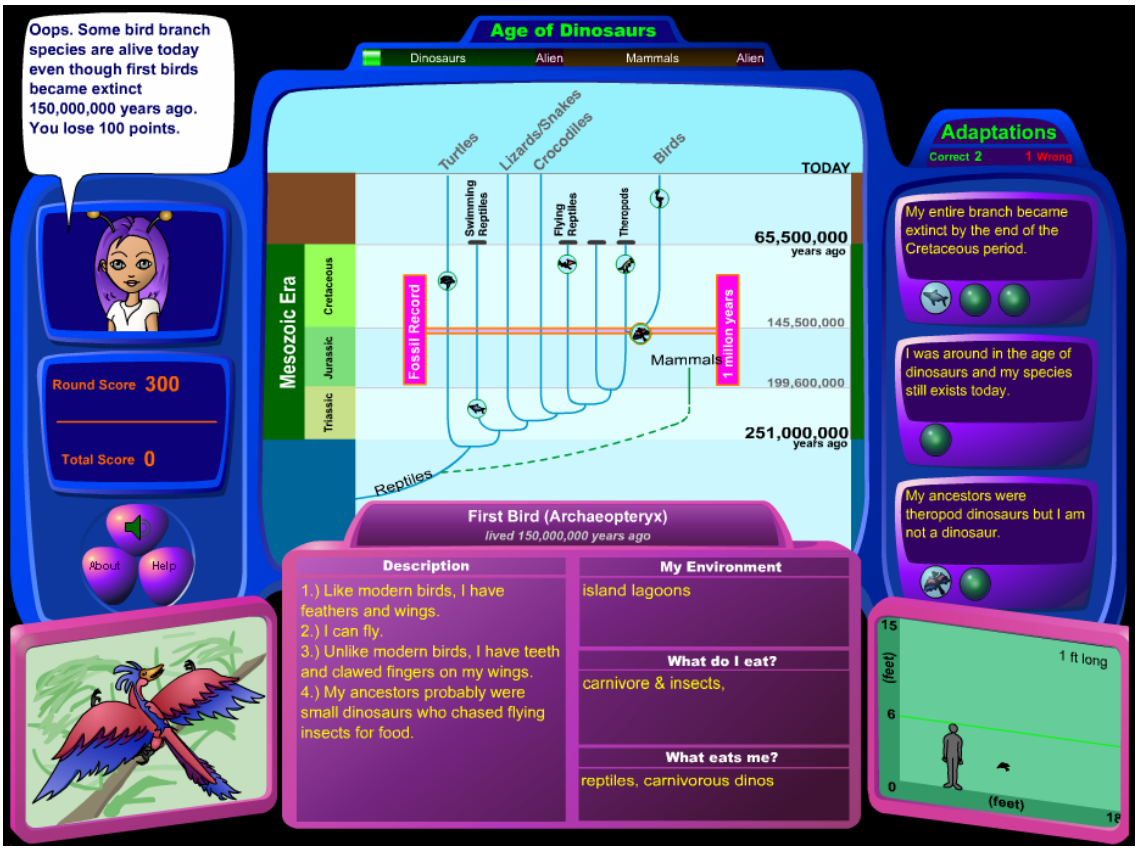
The Life Preservers Game

Life Preservers (LP) was created by the chapter authors for use in experimental research on the relationship between play style, gender, and learning. The game was designed to be playable in a single class period, to teach middle school and high school students national science standards about evolution (GEL Lab, 2006), to accommodate diverse play styles, and to appeal to both girls and boys. These goals were achieved through many iterations using a cycle of prototyping, playtesting, and revision.

In its final form, the game takes place within the Tree of Life, a diagram of the history of life on earth. In the main interface, for each round, three adaptation challenges related to a national science standard appear along the right side. The Level 1 Tree of Life, for Mesozoic Era, appears in the middle of the screen (Figure 1), with a timeline along the right side. Six "critter dots" represent the animals in play for this round. Clicking on a critter dot reveals details in the multi-panel display at the bottom, which includes a drawing of the animal, graphical size comparison to a 6 foot human, and an interesting, relevant description of the critter, its environment, what it eats, and what eats it. A customizable "Chief Scientist" character offers feedback and instructions. Players match critters with adaptation challenges to earn points and advance to the next round.

Figure 1

Life Preservers interface for Round 1 in the Age of Dinosaurs



Design to Engage Both Sexes

The authors have written elsewhere about the iterative process of prototyping, playtesting, and revision used to create LP, including a design case study about the process (Heeter, Winn, & Greene, 2005) and an analysis of how playtesting can be used not just to improve playability as is done for commercial games but also to resolve conflicts between pedagogy, game play and content experts (Winn & Heeter, in press).

Looking at our progression of prototypes, playtests, and revisions, engaging girls was far more difficult than engaging boys. Playtesting facilitated refinement of the game mechanics and pointed out the need to find additional ways to be clearer and more interesting in order to increase girls' engagement. Paying attention to sex differences during playtesting and revision proved to be fruitful and necessary.

LP successfully engages students' attention and motivates them to complete the game. Teachers who used the game with their middle and high school classes consistently reported their students were very engaged in the game. Post game surveys of 351 middle and high school players found no significant differences in boys' and girl's enjoyment of LP, nor were there sex differences in how much they would like to play LP at home or at school. The goal of making a game that is not skewed towards one sex or the other appears to have been achieved.

Play Style and Player Types

Psychologists have used play style as a construct to characterize child play behavior, combining toy selection, rough-and-tumble play (or lack thereof), and activity level (for example, Maccoby & Jacklin, 1987; Alexander & Hines, 1994). During play, a child's style can be characterized as masculine or feminine. A feminine play style could include choosing feminine toys, a lack of rough and tumble play, and limited physical activity. But play style can be fluid. A child may move from one play style to another in a single period of play and may engage in different play styles on different days or in different contexts. Girls exhibit feminine play styles more often than boys do and vice versa, but both sexes engage in masculine and feminine play styles.

At home or on the playground, children are free to select toys, playmates and activities. Play behavior is not always consistent with designer expectations. One can practice juggling using three Barbie dolls or play house using marbles to represent family members. Like toys, digital games can be designed to offer more or less gendered game experiences by using masculine, feminine, neutral, or mixed themes, game goals, and player interactions. Digital game design restricts or enables different play styles, but it is the player who decides how they

will play from moment to moment. Our interest in play style focuses on what happens within a particular game. For clarity in this chapter, play style will be used to describe the actions and choices a player makes while playing.

Published game research has looked at player types more so than play styles, and has done so in the context of massively multiplayer online games (MMOs). In 1990 Richard Bartle (1990/2006) was the first to develop a digital game player taxonomy, grouping players of an online "MUD" (a early form of multi-used online role play game, typically text-based) into four player types based on the kinds of pleasures they seek from playing. Two of the four player types (socializers and killers) are primarily driven by social interactions with other players. Socializers like to interact with other players, and killers like to frustrate and harm other players. Achievers and explorers are more interested in the game than in other players. Achievers seek to improve their power and status. Explorers delight in figuring out underlying game mechanics. They take pride in unearthing esoteric game features and bugs (Salen & Zimmerman, 2004, p. 466). Bartle made no mention of male or female players in relation to his player types.

Yee (this volume) extended the study of MUD player types to look at types of motivations for playing MMOs. Collecting survey data from more than 30,000 players, he identified five underlying player motivations for their MMO play: Achievement, Relationship, Immersion, Escapism and Manipulation (Yee, 2006). Most MMO players were adults and 85% were male. Male players scored significantly higher on Achievement (the desire to become powerful in the game) and Grief (objectifying and using other players for one's own gain) factors, and female players scored significantly higher on the Relationship play style (the desire to develop meaningful relationships with other players in the game).

Bartle and Yee's player types were developed to classify MMO gamers based on their motivations for playing. However, motivations and player types in an MMO may bear little relationship to player types in an educational game. MUDs and their modern descendents (MMOs) take place in vast, complex worlds with thousands of players logged in simultaneously (Torre, 2005). They are designed to attract players to spend hundreds of hours in the game. MMOs are a voluntary leisure time activity played mostly by adults for entertainment.

Educational games are more limited than MMOs in the kinds of play that can occur and in player motivations. Most are single player games, precluding any opportunity for interpersonal relationship building or antisocial bullying. Educational games for classroom use must fit within a 50 minute class period and are often shorter, taking as little as 5 or 10 minutes to play. Educational games are primarily designed for learning; entertainment is secondary though important. Different player goals may arise in a required classroom learning game than in a voluntary entertainment MMO. Fun is needed to motivate play, but individual players' personal goals while playing an educational game may also include (or exclude) wanting to learn the subject matter itself and a desire to perform well in class.

Klawe and colleagues (2002) observed 10,000 children playing various video and computer games at Science World computer games museum exhibit hall. They concluded that while boys are more interested in completing or winning the game and trying to finish in the shortest time possible, girls take a more exploratory approach. When playing educational games, boys are more likely to "rush to beat the game," and girls are more likely to take their time and explore (Laurel, 2001). Speedy play is therefore a masculine play style. Exploration is a feminine play style. Games which give players the freedom to engage in speedy play but also offer enticing possibilities of exploration allow for masculine and feminine play styles and should suit males and females better than a game that forces players into a play style inconsistent with their preferred way of playing.

LP was designed to accommodate speedy play and exploration. Exploration play is facilitated in LP by making more content available than is needed to play and win the game. For example, in Round 1 it is possible to correctly match critters for all three adaptation challenges without paying any attention to each critter's drawing, size diagram, or descriptive text. Players can be efficient and play quickly, or they can take their time and explore a wealth of interesting information. There is always more content available than is needed to advance in the game. It is also possible to complete the game simply by guessing, although doing so would result in a poor score. An efficient player focused on winning quickly could ignore content that is not necessary to advance. Thus, the game allows not only for speedy but also explorative play.

Gender, Play Style, and Learning

Which play style results in more learning from an educational game--speedy play or exploration? Educational psychologist Anita Woolfolk (2005) refers to time spent actively involved in specific learning tasks as "engaged time" or "time on task." Time spent on content is usually correlated with student learning (Berliner, 1998). On the other hand, Cordova and Lepper (1996) demonstrate the importance of intrinsic motivation to activate learning. Are speedy players more motivated than slower players?

LP served as the experimental stimulus for research on the relationship between play style, gender, and learning. Rewards and punishments are are typically built into a game to encourage or discourage certain behaviors, shaping future actions that players are likely to take (Salen & Zimmerman, 2004). Three variations on the reward structure of LP were developed with the goal of encouraging particular play styles. The default, or "plain" version offered no bonus points. Players earned 200 points for each correct match and they lost 100 points for each incorrect match. This default point system was intended to discourage guessing and to encourage carefully chosen, correct matches. In the plain version, players could play quickly. We might imagine those who do feel a

sense of accomplishment by finishing quickly, perhaps even earning bragging rights in the classroom. But these rewards for speed, in the plain version, are entirely external to the game.

A second variation did reward speedy play. In this version, a countdown clock appeared in each round. Completing the round before the clock ran out earned the player an extra 500 bonus points. The presence of a countdown clock reminded players of the urgency of playing quickly. Bonus speed points served as both a reward to speedy players and a punishment (lack of points) for slower players. Rewarding speed or setting time limits are techniques that game designers frequently use to increase the challenge or fun of a game. Based on Klawe's observations, rewarding speed will suit boys' play styles but conflict with girls' play styles.

The third variation rewarded exploration. Rewarding exploration is an unusual game mechanic that was accomplished by adding an onscreen "Critters Explored" counter. The counter kept track of and displayed the number of times the player looked at a different critter's details for at least 7 seconds in that round. At the end of the round, players earned 50 extra bonus points for each critter explored. Therefore, this version encourages exploration and discourages speedy play. Based on Klawe's observations, rewarding exploration will suit girls' play styles but conflict with boys' play styles.

Seventh graders from four cities in California played Life Preservers and completed an online pre-game and post-game survey in early June 2006. Since evolution is taught in 7th grade in this state, all players had been exposed to some of the concepts in the game prior to playing. Students logged in to the pre-test survey. At the end of the pre-test, they were randomly assigned to one of three variations of the game (default, reward speedy play, or reward exploration). As they played, the LP collected detailed play behavior data, including time, score, and critter selection. At the end of the game, players were taken to the online post-game survey. The 292 study participants were equally split between girl and boy players. Random assignment of the bonus point variations resulted in 91 plain, 91 reward speedy play, and 90 reward exploration players.

Findings

Several gender differences were found. Girl players took significantly longer to play, made more wrong matches, and repeated wrong matches more often than boy players. Female students took an average of 7 minutes and 57 seconds to complete the game (in addition to the introduction, cut scenes, and wrap up which took the same amount of time for all players). Male students played faster, finishing more than 30 seconds sooner, with an average of 7 minutes and 22 seconds playing time. On average, girls made 11 mistakes and boys made 9 mistakes.

We might expect boys who experienced the reward speed version to think the game was more fun than boys in the plain or reward exploration mode, and girls to more strongly enjoy the reward exploration version. This did not occur. There were no significant differences in how fun the game was for girls or boys in any of the reward modes.

The different reward modes resulted in different play speeds. Rewarding speedy play resulted in faster play. Rewarding exploration resulted in slower play. These time differences closely approached but did not achieve statistical significance. The different reward modes also resulted in differences in number of mistakes. The speedy play version resulted in the most mistakes (an average of 12.5 wrong matches, of which 3.6 were repeat errors). The reward exploration mode resulted in the least mistakes (an average of 8.7 mistakes, only 2 of which were repeated errors).

Looking closely at sex differences in the three play modes shows a very interesting pattern. For girls, the plain version and the reward exploration version resulted in almost identical play speed and identical wrong matches. However, when speedy play was rewarded, girls did play faster but they made many more mistakes and more repeated errors. Girls in the speedy play condition played more than one minute faster, and they made 3.6 more mistakes than girls in the other two modes.

For boys the picture was different. Boys in the plain version played at about the same speed as in the reward speed version. When speedy play was rewarded boys did not play faster, but they did make an average of 2 more wrong matches. Rewarding exploration improved boy's accuracy. Boys slowed down and explored more when exploration was rewarded. In that condition, they made the fewest wrong matches and the fewest repeat errors.

Within LP, mistakes mean a player either did not notice or did not understand the game content that would have permitted a correct match. Each correct and incorrect match brings up custom feedback to help the player understand what was wrong with the match. Thus, learning can happen in response to mistakes. However, repeated errors (making the exact same mistake more than once) suggest the player is not paying attention or understanding the feedback.

Rewarding speed is a common game mechanic. In the context of a learning game, rewarding speedy play caused both boys and girls to make more mistakes and it caused girls to play faster than they naturally would. Rewarding exploration is an uncommon and therefore somewhat unnatural game mechanic. However, rewarding exploration neither helped nor hindered girls' play, but had a positive impact on boys. It slowed boys down and resulted in more focused play with fewer errors. This finding has powerful implications for the design of games for learning. For example, designers should avoid rewarding speed and find ways to reinforce alternate play behaviours more closely tied to desired learning behaviors in the game.

A Taxonomy of Learning Game Player Types

Next we propose a taxonomy of player types for learning games. Learning game player types combine in-game measures of play style (speedy play and explore play) with score (see Table 1). We assume a high score (fewer wrong matches) reflects more learning than a low score (more wrong matches). Someone who plays quickly and gets a high score fits the profile of a ***competitive***, successful, achievement-oriented player. Someone who plays slowly, spends time exploring and earns a high score fits the profile of an ***engaged***, successful explorer. Those who play quickly and make many mistakes might be considered ***careless*** players. Those who play slowly AND make many mistakes might be thought of as ***lost***. Careless players make many mistakes because they are clicking quickly and not stopping to read. Lost players take time to read but still make many mistakes. Lost players have trouble understanding the game rules, the evolution content, or both.

Table 1
Learning Game Player Types

	COMPETITIVE	**ENGAGED**	**CARELESS**	**LOST**
SCORE	High	High	Low	Low
TIME	Fast	Slow	Fast	Slow

Players were classified into these player types. The fastest 50% of players were considered fast. The slowest 50% were categorized as slow. The 50% who made the fewest mistakes were high scorers. The bottom 50% were categorized as low scorers. Applying these classification methods, 26.4% of players were competitive; 24.5% were engaged; 23.1% were careless, and 26% were lost. We found that competitive players play quickly and efficiently. They make few mistakes. Engaged players took about twice as much time to play four rounds as competitive players did. Both Competitive and Engaged players scored well, but Competitive players made the fewest mistakes. They seem to be motivated by speed, score, and getting as many matches as possible right. Six percent of Competitive players' mistakes were repeat errors, compared to 11% of Engaged players' mistakes (see Table 2).

Table 2
Play Time and Mistakes by Player Type

	Competitive	Engaged	Careless	Lost	significance
Minutes	4:45	9:39	5:02	9:59	***
Mistakes	3.4	4.5	17.8	15.9	***
Repeated errors	0.2	0.5	5.5	5.1	***
% female	40%	49%	44%	66%	**
# of players	72	67	63	71	

Careless players made the most mistakes. Careless players made five times more mistakes, on average, than competitive players did. They also made the most repeated errors. Lost players took twice as long to play and made almost as many mistakes as Careless players did. The rate of repeated errors for Careless and Lost players was about 31%.

Competitive players focused on exactly what they needed to learn to advance in LP, and did not "waste time" exploring "irrelevant" details. Studies of visual attention in commercial video games show experienced gamers are better at ignoring irrelevant details than nongamers (Green & Bavelier, 2003; Dye & Bavelier, 2004). However, in education, more learning is better and extra learning is usually not irrelevant. Because they spent more time exploring different critters, the sheer amount of learning by engaged players likely extended beyond the minimum content required to play and win the game. Turning to the question of sex and player type, girls were significantly more likely to be Lost (66%) and significantly less likely to be Competitive (40%) or Careless (44%) than boys. The proportion of male and female Engaged players was essentially equal.

Play Style and Game Bonus Point Reward Structure

Rewarding speed decreased the percentage of Engaged players to 15% and increased the number of Careless and Lost players. Rewarding exploration increased the percent of Engaged players to 33%. In all three reward modes, the percent of Competitive players remained fairly constant (24% to 29% of players). Thus, rewarding exploration appears to be a promising way to encourage a play style likely to be optimal for learning (engaged play). On the other hand, rewarding speed decreases engaged play (the best play style for learning) and increases careless and lost play styles (see Table 3).

Table 3

Play Styles Evoked by Each Reward Structure

	Competitive	Engaged	Careless	Lost	n
Plain	29%	25%	21%	25%	91
Reward Speed	26%	**15%**	**28%**	**30%**	92
Reward Exploration	24%	**33%**	20%	22%	90

Discussion

There is a great deal of overlap in how girls and boys played LP, but significant sex differences were found for three of four player types. More boys than girls used a Competitive play style. Even so, 40% of Competitive players were girls. In addition, more girls than boys were categorized as Lost, but 34% of Lost players were boys. On average, girls played more slowly than boys did and girls made more mistakes.

Klawe and colleagues observed that boys rush to beat the game and girls explore. Our player types expand that idea to consider speed of play in relation to learning strategies. Competitive and engaged play strategies are both good for learning. Careless and lost player types will probably learn little from an educational game. Our experimental results show that when a learning game accommodates diverse play styles, players are free to engage in their natural, preferred play style. Furthermore, it appears that altering the reward structure in a game can encourage players who would not naturally engage in the rewarded behavior to modify their play style. While rewarding speed interferes with girls' success, it has little impact on boys' play because they naturally play quickly. On the other hand, rewarding exploration enhances boys' engagement but has no impact on girls' play because they naturally explore.

Player type sex differences in LP were detectable and important but certainly not descriptive of all girls and all boys. In contrast, sex differences observed during small scale playtesting of the two early LP prototypes were sharply divided. All female playtesters of the first prototype would have been classified as Lost as would most female playtesters of the second prototype. By continuing to make design improvements until the game strongly motivated female players, we decreased the percent of Lost female players. Once the game motivated them, the player type repertoire for girls expanded to include engaged, competitive, and sometimes careless play. An educational game prototype for which all or almost all female playtesters fit the Lost player type needs be improved before it is released for classroom use. Similarly, a prototype for which all or almost all male playtesters fit the Careless player type needs to be revised. Attention to the distribution of male and female playtesters' player

types can reveal important imbalances and help guide revisions.

Rewarding exploration is an uncommon game mechanic, but one that proved to be useful for learning without dampening enjoyment. Rewarding speed may not be good for learning. Educational game designers should carefully select reward structures, realizing their powerful potential to influence play and learning. Attention to gender, play style and player types during design and playtesting can help create educational games that engage and accommodate female and male players and masculine and feminine play styles. We refer to this as gender-enhanced learning game design.

Acknowledgements

The design and study of Life Preservers was supported by a grant from the National Science Foundation (NSF-0217197). We wish to thank Ruta Sevo from NSF and to acknowledge invaluable research, game design, and art support by graduate students Jillian Caywood, Patrick Shaw and Amanda Flowers and Art Direction by Darcy Drew Greene and to Yasmin Kafai and Jill Denner for great editorial feedback.

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