Title of submission: Theories Meet Realities: Designing a learning game for girls

Category of submission: Design Case Study

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Theories Meet Realities: Designing a learning game for girls

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Abstract

Nongamers expert in interaction design, learning, girls and games, and art teamed up with avid gamers versed in game design to create a fun science learning game that teaches evolution, adaptation and the history of life on earth to 8th and 9th graders.

Funded by the National Science Foundation, we strove to design a game with high fun value, great science, and great pedagogy that also was good for girls. Ideally the game would integrate learning and fun in new ways.

Game design progressed through 50 versions across four quite different game concepts (Earth Zoo Ship, The Critter Card Game, The Tree of Life Game, and Life Preservers), informed by frequent playtesting as well as design team member input. Pedagogy, science, and fun often conflicted. Girls were harder to engage and motivate than boys. Version 50 playtested well and will be used in experimental research on playstyle, gender and learning.

Keywords

Children, Cognitive Psychology, Content, Games, Gender, Learning, Pedagogy, Playtesting, Prototyping, User Experience, User Research, User Studies

Project / problem statement

We sought to design a girl-friendly science learning game consistent with findings from our own and other research on what girls want from games. It was developed with funding from the National Science Foundation both to teach science and to use in research on gender differences in play styles and learning outcomes. We hypothesized girls would learn more from a learning game because they take their time and explore, while boys rush to beat the game.

We were free to choose any science topic for the game. As the project began a Gallup Poll documented widespread disbelief in or ignorance about scientific evidence supporting theories of evolution among nearly two thirds of the U.S adult population [1]. We were motivated to design a game to teach future generations about evolution, adaptation, and the history of life on Earth.

We are on Version 50 of the game. At the outset we called the game "Earth Zoo Ship." Two months into the project the name became "The Critter Card Game;" then "The Tree of Life;" then "Alien Invasion." The current title is "Life Preservers." Changes in the game itself from Version 1 to Version 50 have been more extreme than the progression of names.

Creating this game has been a fascinating challenge requiring frequent re-examination of our assumptions.

We are on Version 50 of the game. At the outset we called the game ***"Earth Zoo Ship."*** Two months into the project the name became ***"The Critter Card Game;"*** then ***"The Tree of Life;"*** then ***"Alien Invasion."*** The current title is ***"Life Preservers."***

Background

- Carrie Heeter is professor of Telecommunication, Information Studies, and Media. She is Principle Investigator for the NSF studies on girls and games and director of the Communication Technology Laboratory at Michigan State University. Heeter was project leader and learning architect for Life Preservers, with primary responsibility for pedagogy, science, girl-appeal, and playtesting. Brian Winn, Assistant Professor of TISM and founder of the Game Design and Development Specialization at MSU, was lead game designer and programmer. Darcy Drew Greene, professor of Journalism, served as Art Director. The design team also included interface and interaction designer Patrick Shaw, a new doctoral student and 10 year veteran of Electronic Arts, most recently working for Maxis on The Urbz. Amanda Flowers, an MA student and avid gamer, is our graphic artist. Heeter loves the idea of games but hasn't met a game she likes. She dreams of inventing future games that perhaps appeal even to her. Neither Heeter nor Greene play games. Winn, Shaw, and Flowers are from the game generation and are deeply engaged with modern games and their design. Dr. Randy Russell, content designer for the web site Windows to the Universe, served as Science Consultant.
- Development began in January 2005. The beta version was completed in June 2005. Public release is anticipated in January 2006, following additional science validation and experimental research on learning outcomes.
- The Life Preservers design and research project was proposed by the authors and funded by NSF towards the end of three years of NSF-funded research on girls and games [2, 3]. We had 1.) conducted literature reviews, 2.) observed girls and boys playing games at a 2 week intensive game design camp, 3.) analyzed the game concepts

proposed by our 8 same-age, same-gender child teams, produced digital video "promos" of the eight games as if they really existed, and 4.) showed the promos to 674 5th through 8th graders and surveyed their reactions.

- Version 50, Life Preservers, is fully functional Beta software. Throughout development the game has been informally playtested frequently and formally playtested three times. In fall 2005 and spring 2006 the game will be used in research to study playstyle, gender, and learning outcomes amongst 8th through 12th graders and undergraduates taking Intro to Biology.

Challenge

The gods of pedagogy, science, girl-appeal, and game design frequently war with each other. A tight budget, short time frame, and small staff added to the challenge. We strove to design a game which 1) fundamentally changes players' understanding of the nature of evolution of life on earth and 2) by example informs the emergence of new genres of fun learning games that are good for girls.

Solution

The game concept underwent radical redesigns four times, driven first by incompatibilities between the game concept and actual science and subsequently by problems revealed through playtesting. The final design meets our goals.

1.) Early Conceptualization (Earth Zoo Ship)

1.1 Process

In the week preceding funded work, the science consultant (SC), project leader (PL), and lead game designer (LGD) converged on a brief description of game play:

Game Concept: Players time travel to collect specimensfor their "Zoo of Ages" space ship/tourist attraction. Plan when and where to look for the specimens, then go try to capture critters. Learn about evolution, geography, climate, and ecosystems of Earth's past.

We intended to apply our own and others' research on girls and games to create a game appealing to girls. Some of the desired characteristics include:

• easy to play;
• clear instructions and in-game help;
• does not require fast reactions;
• not about fighting;
• does not make player start over if they make a mistake;
• somehow meaningful;
• more about playing than winning.

We began with nearly 10 pages of science learning objectives about the phylogenetic tree of life, adaptation of organisms to environments, fossils and stratigraphy, and plate tectonics. Each topic included roughly 5 subcategories and spanned a period of 2.5 billion years.

Figure 1. Goya was a buffalo-sized prehistoric guinea pig.

The design team intentionally brought together three experienced gamers with two female non-gamers (including the PL). Non-gamers, due to their lack of exposure to modern commercial games, naturally would "think outside of the box." Experienced gamers understood modern commercial digital games. Combining gamer expertise with nongamers ignorance might generate novel approaches to the challenge of designing a learning game.

1.2 Solutions

Moving from the brief game description to an actual game design turned out to be anything but straightforward. For a game to be accepted into K-12 schools today, it must teach national and state standards on which students are assessed and schools are rewarded. Only if a game does this can teachers justify spending class time on the activity.

Our initial list of learning objectives was far too long but also too abstract. The National Science Standards are deceptively simple, highly distilled, abstract concepts [4, 5]. For example, one of the eleven core standards we targeted in our game states: "Over long periods of time, natural selection leads to organisms well suited for survival in particular environments." We needed to find coherent, compelling examples to situate learning and teach the concept.

Our research showed girls like pets and cute animals. We intended to base the game on fascinating weird real life creatures from Earth's past. To build the game we needed a database of organisms throughout the history of life on earth including their environment, when they lived, and exactly how they had adapted to be well suited for survival in their environment. Isolated pieces of this kind of knowledge could be located on the web and in college biology textbooks, but we ended up conducting hundreds of hours of research to create the knowledgebase to enable game design.

The SC had limited availability; he was only paid on the project for two hours per week. The design team was fully funded and time was running out. The PL took on the role of finding examples and learning the science. She focused the SC on science research and validation tasks most in need of his expertise. The PL studied science while the design team independently worked on initial game ideation. Many proposed game ideas were rejected because they did not fit the science well. All of us read and understood the abstract concepts in the National Science standards, but we lacked a rich set of real world examples to draw on. As a result game design was speculative rather than grounded in actual instances. These frustrations compounded the inevitable tension between nongamers and gamer perspectives.

The PL insisted on design constraints counter to most modern games. Two extremist PL-imposed criteria strongly limited game design concepts:

The LGD and gamers on the design team naturally wanted to build in levels. Levels structure game play in most commercial games [6]. Levels motivate and reward game play. Players are permitted to experience higher levels only after they succeed at the preceding level. The nongamer PL was opposed to the idea of levels because she felt they would block players who perform poorly from learning advanced concepts.

The PL wanted every moment of game play to directly contribute to learning – Earth Zoo Ship should not be based on "gratuitous fun." Some learning games create a fun experience unrelated to learning and stick in occasional learning moments. For example, a battleship shooting game might be adapted to be a learning game in which players shoot at right or wrong answers. Or a narrative adventure game might mostly focus on a fictional story, interrupted periodically by an actual learning-related task. Neither approach was acceptable for Earth Zoo Ship.

LGD proposed a revised game concept, motivated in part by practical concerns of how to work towards an achievable game within the available resources and timeline. Working backwards, returning animals to their home time and place would simplify the environments we needed to design and focus game play.

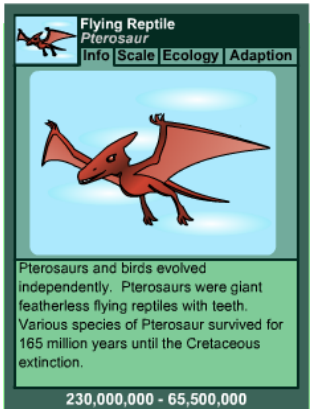

Figure 2. Front view of the Flying Reptile critter card with clickable scale, ecology, and adaptation tabs.

Game Concept: You find an alien Earth Zoo ship that accidentally wiped out life on Earth by capturing animals from important evolutionary steps. Return the critters to their original time and place to restore life on earth. Each critter you replace fills back in part of the Tree of Life.

1.3 Outcomes

Science didn't cooperate. The science of evolution did not fit the game concept. We intended to base the game on real creatures throughout earth's history. We assumed players would be able to guess when and where a critter lived and what it ate by looking at a drawing of the creature and perhaps asking questions about its behavior. In fact, after hundreds of hours of our own research, we discovered these relationships are subtle. Predicting ecosystem, diet, and behavior requires extensive background knowledge. Predicting era could use carbon dating, but is otherwise not very guessable.

Worse still, after the design team and PL had at last agreed upon the revised game concept, our SC completely rejected it. The proposed story line was not scientifically plausible. The fossil record is extremely incomplete. Although there are some exceptions, the majority of known ancient species were not the first of their family of critters. Most are not members of an elusive transitional species theories of evolution predict were the very first in a newly adapted branch. Therefore removing or returning a single captured organism to its proper time and place would have little or no impact on the phylogenetic tree of life on Earth.

2.) Prototype 1 (Critter Cards)

2.1 Process

We had used up 1.5 of our 4.5 funded months of development and we were back to the drawing board. At the LGD's pragmatic suggestion we abandoned dreams of a 3D immersive environment and began thinking about a 2D card based interface. We brainstormed electronic board games and card games.

We continued to base game play on real life critters from Earth's past and expanded the knowledgebase. We reduced the science learning goals from 10 pages to 1 page. The PL continued to expect players would find critters from Earth's past to be intrinsically fascinating.

Three game design goals guided this phase of development. The Critter Card Game should be a casual game, easy to learn and playable within 15 minutes. It

should be designed for repeat play. LGD argued games should have a random factor that leaves some things up to chance, and a skill factor challenging players to excel. Skill should be rewarded.

Three expectations about girl players also influenced development. We expected girls would like the critter art and the idea of critter cards. Girls would probably learn more because they focus on play and exploration rather than beating the game. Girls would read the instructions and be more likely to use help.

We were unable to locate a detailed tree of life timeline for the Cenozoic Era. Books and web sites more often diagram relationships between species like a human genealogical tree, showing who is descended from whom. These diagrams often do not map the branching onto a timeline. The SC researched and completed our own tree of life, mapping the entire game database of vertebrate critters and their major branches.

2.2 Solutions

After experimenting with different styles of drawing the prehistoric critters, we select a style that is fairly cute rather than photorealistic or menacing. Art was produced for the entire database of critters, providing the visual foundation for the Critter Card game.

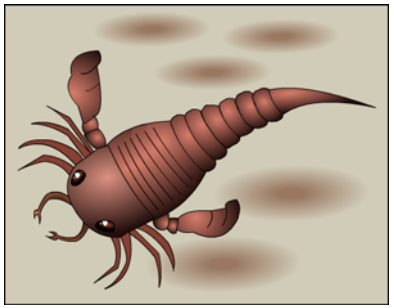

Figure 3. This stylized drawing of an ancient marine arthropod is based on fossil records yet looks appealing and game-like.

Game Concept: Drag "Critter Cards" onto matching "Who Am I" cards. Increase points by picking more complex "Who Am I" matches. You can retire a "Who Am I" card any time and draw a new one. Incorrect matches subtract points and that Critter Card is lost. Game play ends when all 47 Critter Cards in the deck are either placed or lost.

The art director (AD) battled with the PL over screen real estate. Science and learning conflicted with aesthetics. Like a ping pong game, space devoted to text filled the screen, then shrank to almost nothing each time the design changed hands. We compromised. Many times.

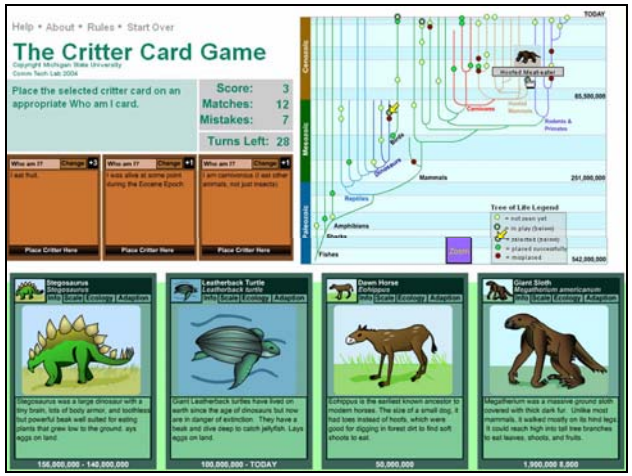

Figure 4. Version 12 of The Critter Card game shows critter cards along the bottom, Who Am I cards in the upper left, and a miniature Tree of Life in the upper right.

The Tree of Life in this version of the game covers Paleozoic through Cenozoic eras, 542,000,000 years ago through today. Players randomly draw 4 critter cards at a time (in green) from a deck of 47 critters and 3 Who Am I cards (in orange) from a deck of 80 Who Am I cards. Players match critter cards to appropriate Who Am I cards, earning points for correct matches and losing points for incorrect matches. Hard to match Who Am I cards award extra points.

When a critter card is selected, its position in the Tree of Life is highlighted. Players can zoom in on the tree of life for more detail. Each critter card has tabs to move among 4 views – info (critter drawing plus short description), scale (numerical and graphically compared to a 6 foot human), ecology (my environment, who ate me, who I ate), and adaptation notes. Players can turn in any Who Am I card, either because they can't match any of the four active critters or because they are hoping to draw a more valuable match. Players try to earn as many points as they can. The game ends when the player has played through all 47 critter cards.

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Figure 5. This row of Critter Cards shows the four tab views. The first card shows the critter drawing and short description. The second shows size, the third Ecology and the fourth Adaptation notes.

We wrote a 12 page instruction manual packed with science learning content. Actual rules of how to play could have been described in as little as half a page, but the PL wanted to use instructions as an opportunity to teach. She expected girls to read the manual.

2.3 Outcomes

Results of the first playtest left no room to dispute the complete failure of our initial game concept. We tested with 5 male and 5 female undergraduates. The game failed to appeal to girls, failed to teach, and was not fun.

The informational content of the game was either ignored or misinterpreted. Players did not realize the Tree of Life showed when each critter lived on a timeline. One player remarked "Wow, I had no idea so many strange animals were alive today." (Only four of

the 47 critters are still alive today – humans, leatherback turtles, gorillas, and condors.)

Only one of 10 test players (a female) clicked on tabs on the Critter Cards to reveal critter details. She explored the tabs for each critter in detail. The only two people who learned anything were the 2 out of 10 who read part of the instruction manual (one female and one male). Both of them got bored and stopped reading before the end of the instructions, but they did understand more about evolution than players who did not read any instructions. At least two players mentioned facts they learned from game play (without realizing these were misconceptions). One said "I didn't realize birds have teeth." (Only the first bird had teeth.)

Girls were not more likely to read the instructions. Girls were much slower to figure out how to play. They placed cards more slowly, placing about 10 cards during the allotted 15 minutes of play. Girls made more mistakes. Boys scored MUCH higher than girls. They got through all 47 Critter Cards to finish one round of the game. Average boy score was 53 with a high of 126. Average girl score was -3 with a high of 20.

Players were NOT intrinsically fascinated by the critters. Boys were sufficiently motivated to play through the game. They were willing to figure out the rules and do what was necessary to earn points. Girls were unmotivated to win points and uninterested in the content. Girls mostly guessed, and mostly guessed wrong.

Both genders liked the critter art. Everyone thought the game was "better than a boring lecture or textbook."

3.) Prototype 2 (The Tree of Life Game)

3.1 Process

A learning game that fails to teach is useless. We needed to completely rethink the pedagogy. Radical changes were called for to motivate girls to want to play.

Continuing to focus the game on real critters from Earth's past would make use of the months we had invested to build a critter database, draw critter art, and articulate details of the Tree of Life timeline.

3.2 Solutions

Game Concept: Traverse through the Paleozoic Era, Mesozoic Era, and Cenozoic Era, matching critters from the Tree of Life with Adaptation Challenges.

Figure 7. These are the adaptation challenges for Round 2 of the Age of Dinosaurs.

Figure 6. Version 19 of The Tree of Life game introduced many of the final interface elements including the guide and dialog box (left), Adaptation Challenges (right), Critter PDA/brochures (bottom) and era-specific tree of life (center).

Color schemes in the prototypes ranged from hot pink t dark blue and green boy colors depending on who was working on the interface. The AD eventually enforced a color scheme (many versions later).

We introduced levels to clarify science content, enhance pedagogy, improve player motivation, and help the player figure out how to play. We divided the content into three levels, based on time period. The Paleozoic Era had only 4 critters. The Mesozoic Era (age of dinosaurs) included 12 critters. And the Cenozoic Era (age of mammals) included 30 critters. Levels were based on science content. Higher level trees were progressively more complex in terms of branches and number of critters.

Each level was divided into rounds. Instead of randomly selecting "Who Am I" cards, we carefully wrote and sequenced up to three "Adaptation Challenges" per round. Sequencing was intended to guide player thinking about key concepts in adaptation and evolution.

Each round is reinforced by a narrated, animated cut scene. Cut scenes are linear animated or video sequences outside of game play. They are commonly used to transition between levels and tell the story in commercial games [7]. In our learning game cut scenes generalized the specific adaptation challenges players had just answered, describing the broader science concepts those examples represented.

Play was situated inside of the tree of life. Levels, adaptation challenges and cut scenes helped clarify the meaning of the tree and its branches.

The important learning in the game is actually the questions, NOT the answers. Today's close adherence to teaching what will be on standardized tests means only concepts appearing in national and state standards matter. Thus, that the first bird adapted from therapod dinosaurs around 150 million years ago is not relevant. However, "the basic idea of biological evolution is that present day species developed from earlier distantly different species" might appear on the test.

Vygotsky believed social interactions "create our cognitive structures and social interactions" [8]. Higher mental processes are co-constructed during shared activities. Piaget sees social interaction as creating disequilibrium, offering input that challenges existing beliefs and forces learners to either assimilate

consistent ideas or accommodate inconsistent ideas by adapting their cognitive schemas. The Tree of Life game acts as a good teacher, guiding learners to think about questions of evolution and adaptation in a carefully constructed order. Far more is available to be learned than just the answer to the specific questions.

Levels, points, and rank were designed to motivate play. Completing each level should yield a sense of accomplishment. Players can look forward to reaching the "age of dinosaurs" and the "age of mammals." Critters are increasingly familiar as the game progresses. Each correct answer adds a point to the score. As scores rise, the player's "rank" increases from Novice to Intermediate to Expert. We added a guide/friend to make the interface more personal and appealing.

Figure 8. One of many possible customizations of the chief scientist guide.

To entice players to read more, we wrote less. The amount of text was reduced by more than 50%. All critter info was presented on screen at once, in a PDA/brochure like display. Players were at least incidentally exposed to the content without having to click on tabs to get more info.

3.3 Outcomes

The Tree of Life game was playtested before we had a version we felt was ready. However, students in Heeter's graduate design research class had volunteered to conduct another round of playtests and they needed to finish their projects before the end of the semester. Player feedback is critical to the design process, so we welcomed the feedback. A very rough Version 19 was playtested. Many of the problems they found would have been better if the game version being tested incorporated more of the features we were already planning.

One set of researchers playtested five male college students. The other set of researchers playtested five female college students. The playtest conditions were not directly comparable. The research group playtesting males used Version 18 of the game and allowed players to play for 20 minutes. The research group playtesting females included both grad students on our design team. They created and thus were able to use Version 19 of the game, which had not existed that morning when the first playtests were conducted. The female playtest group stopped players after 10 minutes of play.

Despite the different playtest circumstances, some informative trends were observed. Male college students played much faster than female college students. In 10 minutes of play, girls barely got through Level 1 (3 simplified rounds using only four critters for a 6 adaptation challenges). In 20 minutes of play, boys completed all three levels (10 rounds for 30 adaptation challenges).

Female playtesters wished they could have spent more time in the age of dinosaurs. They spent almost the entire time getting through the Paleozoic era and experienced about one round of dinosaurs. They did not come close to reaching the Age of Mammals.

Versions 18 and 19 had a "continue" button appear as soon as the cut scene narration started after each round. Unfortunately playtesters skipped all of the cut scenes. Even without the learning benefit cut scenes could have provided, learning was better than we

observed with the previous version. Players seemed to understand the Tree of Life. They read more critter information than players of the Critter Card game did. They used what they read to pick correct answers.

Both genders liked the female guide. (We had planned to eventually offer a choice of male or female guide. But males liked the guide, commenting “she’s hot.”) All playtesters liked the critter art. The Tree of Life game was deemed by playtesters to be more fun than a boring lecture or textbook. Game play was still not very engaging.

4.) Final Prototype (Life Preservers)

4.1 Process

We wanted to find a way to engage players and particular girls more deeply in the game. Players were more interested in familiar critters than ancient fish and amphibians, so we looked for ways to get to the interesting critters right away. Displaying “Number Correct” provided limited motivation. To move forward in the game, all players needed to get all answers right. Playtesters remarked they would try harder if the game showed how many answers they got wrong.

Our initial concept was based on the Earth Zoo Ship story. When we shifted to a card based game we dropped the story. Once again we thought about some kind of story to embed in the cut scenes. Story can motivate game play and to interest players in finding out what happens next as they advance through the game. Ideally story contributes to science learning.

The science in the game was reasonably good. The pedagogy was unsatisfying. The game was mostly a multiple choice test, albeit one which guides minds to think about key concepts related to adaptation and evolution. The interface and game design afforded no room for critical thinking.

8th and 9th grade playtesters are harder to find on campus than college students, so we tested on college students until the game was in reasonably good shape. College students were not motivated to learn about adaptation and evolution. Most were done with biology classes for life. The game content fits well with what 8th graders and high school students learn in science class. 8th and 9th grade girls have different needs and interests. Now it was essential to playtest on the target audience.

4.2 Solutions

Game Concept: Learn as much as you can about life on earth. Decide which of two alien species heading towards Earth to block, protecting the evolution of life on Earth as much as possible.

We eliminated the Paleozoic Era and started the game in the Age of Dinosaurs to get players involved right away with familiar critters they might care about.

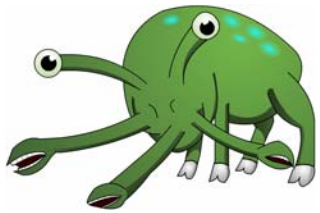
We added the number wrong in addition to the number correct to give players more motivation to make careful choices and avoid mistakes.

Figure 10. Aliens

Denebian Dragon

Centaurian Hoofed Fox

Andromedan Tree Crab



Arcturan Swarming Minigoat

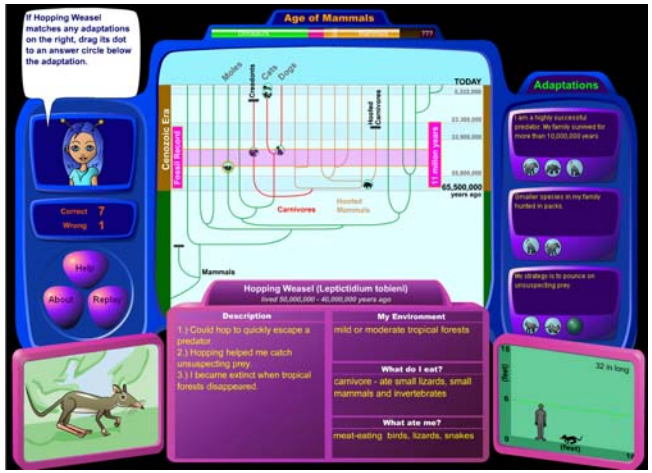


Figure 9. Version 50 of Life Preservers refined the interface, color scheme, guide, and content.

Non-native species “invading” an ecosystem is the second leading cause of extinction (a distant second to the leading cause, climate change). We magnified the drama and the impact of the invasive species by inventing Hunter Aliens who want to seed Earth with their favorite species to hunt. The hunters will show up much later, but they send two auto piloted ships filled with their favorite quarry. You are a member of the ancient alien organization, Life Preservers. You are leader of the team assigned to protect Earth. You only have enough nuclear thrusters to block one of the two incoming species. You need to learn enough about life in the Age of Dinosaurs to make a wise decision about which alien ship to block.

This story makes the game more engaging. We end each round foreshadowing the invasion and fostering speculation about what the aliens will be like. Then it’s time to make the choice. Two open ended questions guide players’ thinking – which four Earth species are the hoofed carnivores most likely to eat? Which are the flying dragons most likely to eat? Then the player chooses which ship to block and finds out the impact on life in the age of dinosaurs. A different alien race has launched two seed ships in the Age of Mammals. The story progression repeats.

Motivation, science, and pedagogy were all advanced by adding this story. Players are intrigued to find out what the aliens will be like and how the invasion might change life on earth. We hope they are motivated to pay more attention leading up to the invasion. Alien invasions present an ideal opportunity to apply and reinforce concepts of adaptation.

The alien invasion rounds provide a different pedagogy than normal rounds of the game. Answers are more speculative and flexible. Players choose up to four critters most likely to be impacted by each alien, then choose which alien to block. Players think through possible consequences for each earth critter, and make their own choices. The alien invasion rounds require critical thinking. The learner/players construct knowledge, drawing their own conclusions.

Lots of refinement and polish enhanced the interface including music, animated cut scenes, and revised adaptation challenges and critter info.

4.3 Outcomes

Five members of a local girl scout troop (matching the target age group) were observed and questioned one on one by five female playtest researchers as they played the game. This playtest concentrated on

assessing how well Life Preservers engaged and motivated the target audience.

The game begins by asking the player to customize the chief scientist/guide. Girls spent between 30 seconds and 2 minutes on this task. Three of the five girls chose to add antennae. None selected green or purple skin. One chose purple hair. All thought customizing the guide was “cool.”

All five girls were engrossed in the game during cut scenes and game play. For two, their concentration reduced somewhat in two mammals rounds, but attention focused strongly once again when the second alien invasion began.

The two girls who played the fastest completed Life Preservers in 30 minutes. They had recently studied evolution in science class and were quite familiar with dinosaurs, mammals, and adaptation. They made fewer mistakes. The 8th and 9th grade girls showed distinctly more interest in the critters and the concepts than college students playtesters had.

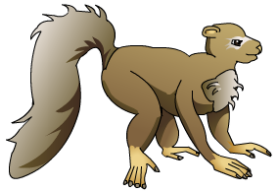


Figure 11. Most girls mentioned the squirrel-like early primate as a favorite critter.

The girls less familiar with the content took 40 minutes to play and made more mistakes. The majority of girls spent longer on round 1 (7 to 8 minutes) than on subsequent rounds. In general they got progressively faster. Number of errors increased or stayed the same as play continued, perhaps because girls made quicker decisions as the game went on. Total number wrong ranged from 8 to 15. The girls felt the difficulty level was about right. Not too easy, not too hard.

All of the girls liked the cut scenes. They said the cut scenes helped clarify and reinforce the learning. The girls felt the game was fun. All except one would like to play the game in school. (The one who was reluctant to play in school worried her friends would make fun of her.) Some would also play at home, especially if the game was assigned as homework.

They enjoyed the alien invasions and mostly took their time carefully evaluating potential consequences of each alien. They were able to articulate their thought process and some of what they were learning during the game. One wondered why aliens always attack Earth. Many liked the threat posed by the aliens and the lack of a happy ending. The design team had worried players would complain about there not being a clear “win state.” No matter what choice you make or how well you do, many Earth critters are impacted by the aliens. The girls specifically mentioned liking this aspect of the game.

They wanted to be able to turn off the music. They liked the buffalo-sized guinea pig and the squirrel-like early primate best. Several complained the game was too short, although the duration is necessary to fit into a class period. Two wanted to see what would have happened if they blocked the other aliens instead.

Overall the playtest showed we had achieved a high level of engagement and learning in our target audience.

5.) Future Work

5.1 Experimental research on gender, play patterns, and learning

The Life Preservers game presents a unique opportunity to conduct research on gender, games, and learning.

We will build data collection into the game to collect play style behavior. Also for research purposes, we will embed delivery of the game into LSE, an online Longitudinal Survey Engine designed by the Comm Tech Lab and Department of Epidemiology at Michigan State University.

In early fall we will conduct formal experimental research on 100 high school students and 100 college students. The game will be programmed to collect data on play patterns. A pretest and posttest delivered through LSE will measure gender, learning, and personality variables.

5.2 Additional Science Validation

Life Preservers is a playable and effective learning experience about important science topics. We have worked with our SC throughout the development process. However, evolution is the most controversial science topic in K-12 education. The game and support site need to be carefully credible. Teachers need to feel confident using Life Preservers in their classes. A national expert in teaching evolution to high school students will consult with us on final wording both within game and in the online teacher support materials.

5.3 Public Release

The validated and polished game will be promoted via UCAR's Window to the Universe site, the SETI Institute's Education and Outreach page, Sally Ride Science Clubs, and WGBH online. We will offer anonymous visitors to the web site the option of either playing with no data collection or granting us permission to track their data. Those who grant permission will be asked their age and gender, and their playstyle data will be recorded. Those who do choose not to grant permission will not be tracked at all.

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Acknowledgements

- Life Preservers was partially supported by a grant from the National Science Foundation. Thanks to Graduate students Patrick Shaw and Amanda Flowers for their design work on the project and to Timothy O'Brien, Gregory Mercer, and Hai Kyung Min for their work on sound.