

Comparing 14 Plus 2 Forms of Fun In Commercial Versus Educational Space Exploration Digital Games

by Carrie Heeter, Kaitlan (chunhui) Chu, Apar Maniar, Brian Winn, Punya Mishra,
Rhonda Egidio, and Laura Portwood-Stacer, Michigan State University
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contact: Carrie Heeter
Professor of Telecommunication, Information Studies, and Media
Comm Tech Lab Director
Creative Director, Virtual University Design and Technology
Michigan State University in San Francisco
2467 Funston Avenue
San Francisco, CA 94116
415-681-6473
heeter@msu.edu

<http://commtechlab.msu.edu>
<http://spacepioneers.msu.edu>

Abstract

Educators lament that time spent playing commercial games does not contribute to knowledge about the real world. Educational games are derided as not fun enough. Two graduate students played 12 space exploration games (4 educational, 8 commercial) for 300 hours. They coded backstory, setting, player role, rules and goals, navigation and interaction, graphical elements, use of avatars, learning to play, duration of play, genre, and rankings along Garneau's fourteen forms of fun.

An in depth content analysis requiring hundreds of hours of game play and was conducted to look closely at a small group of 12 educational and commercial games. Differences between educational and commercial games are extreme and surprising, often counterintuitive and ironic. Playability in school settings mandates limits to the length and complexity of game play. Educational games are easier to install, easier to learn, less complex, shorter, and less challenging to play than commercial games. They involve less reading, less social interaction, and no typing or other use of the keyboard. Educational games seem to be gender neutral in both characters and themes. They include 30% fewer forms of fun than commercial games. Competition is moderate if present; there are no opponents. Learning about the real world, discovery and exploration, solving puzzles, and intellectual problem solving are their dominant forms of fun. Educational games are more grounded in reality, less imaginary and less imaginative.

INTRODUCTION

Games are an increasingly significant part of young people's lives. “The Games Generation has been raised with, and become accustomed to, the worldwide connectedness of email, broadcast messages, bulletin boards, user groups, chat, multiplayer games, and instant messaging” (Prensky, 2001, p. 57). American families with children aged 8–12 report that their children play video or computer games an average of 56 minutes per day, and those with children aged 13–17 report an average of 78 minutes of game play per day (Gentile & Walsh, 2002).

Most commercial games today are not designed to be educational, but they do require learning. Kids play games “not once or twice, but over and over and over again, for countless hours, weeks, and months, until they [are] really good at it” (Prensky, 2001, p. 38.) Piaget called play “the work of the child” (Piaget, 1951). Games are one form of play. Papert (1998) suggests kids dislike school not because it is hard but because “it is utterly boring.” In contrast, complex games are “hard fun.” Games require serious learning to master. “The basic skill today is the skill of learning, and the best use of games is to leverage the tendency to enhance it” (Papert, 1998, p. 88).

Gee (2003) elaborates on 36 “learning principles” which are or could be embedded in a good video game. Electronic games could also be a way for young people to learn skills and concepts they will need in a future world where digital imaging and processes are an integral part of learning and work in most areas. Of course, this is particularly important in the sciences.

However, the potential for games to be valuable learning tools has not often been met. Educators and gamers perceive a key distinction between commercial and educational games. Commercial games are seen as being fun with an under emphasis on learning. Any learning (if at all) that happens as a result of playing such games is a fortunate, though inadvertent, side effect. Educational games, on the other hand, are not much fun and are often derided as being boring. Educators lament that the time spent playing commercial computer games does not contribute to knowledge about the real world and they dismiss commercial games as being not educational enough. Gamers on the other hand declare that educational games are just not fun.

Though assertions about differences between educational and commercial games are heated and passionate, neither side has much solid, empirical data to support their positions. Does this “fun gap” really exist? Are commercial games more and differently fun than educational games? Are educational games harder to play than commercial games? Is nothing learned while playing commercial games? What is surprising is just how little is known about these issues.

The authors believe that games can be valuable and fun educational tools. However, the design of such games requires a careful understanding of just what “fun” means and what it is about games that engross gamers so much. Ideally new learning games will bridge the fun gap. To begin to pave the way a detailed analysis of what's fun about a good educational game and how that fun differs from what's fun about a good commercial game was conducted. Perhaps ways to improve both genres through careful understanding the current strengths and weaknesses of each can be identified.

Methods

Two graduate students (one male and one female) played 12 space exploration games for more than 300 total hours in preparation for coding the games. They took structured, in-depth notes on the experiences including back story, setting, player role, rules and goals, navigation and interaction, graphical elements, use of avatars, sound track, learning to play, duration of play, gender orientation, potential learning content, and subjective rankings along Garneau's (2001) fourteen forms of fun.

Table 1 lists the 12 space games. The far left column indicates whether each game was classified as commercial (C) or educational (E). Educational games were those games marketed primarily to schools and parents, with strong promotional web site emphasis on the science learning benefits of the game. Commercial games targeted a more general market. Approximate hours spent playing each game by the two graduate student researchers appears in the far right columns. Hours listed in bold indicate the primary coder for that game.

Table 1.
Twelve Space Games, Coding Hours, and Classification

	Game	f hours	m hours
E	Great Solar System Rescue	12	5
E	Liftoff	4	8
E	Magic Bus Lands on Mars	8	1
E	Space Academy GX	12	15
C	Dark Space	2	21
C	Earth and Beyond	7	61
C	Galactic Civilization	6	35
C	Masters of Orion	16	1
C	Moonbase Commander	8	5
C	Sim Earth	2	15
C	Star Wars	70	2
C	Starcraft	12	0

Coding Protocols, Definitions, and Reliability

A quantitative content analysis methodology was utilized so that statistical comparisons could be made. Areas quantified included Target Audience, Installation and System Requirements, Cost, Play Time, Learning to Play, Game Genres, Companions and Opponents, Avatars and NPCs, Interaction, Fantasy Elements, and Forms of Fun. The quantitative coding form underwent four iterations before reaching a coding protocol sufficiently that seemed reliable. At that point the two coders applied the form. For three of the games, both coders independently coded the games. Reliability (percent agreement) was computed for all variables.

Target Audience

Target audience was taken from product packaging or from the corporate web site. Three classifications were possible: Under 13 (often described by grade, must be pre high school), Over 13, or Both. Internet games and top-selling video games are rated by the Entertainment Software Rating Board based on game content and themes. Games with an ESRB rating of “everyone/mild violence” were coded as Both. “Teen/mild violence” was coded as Over 13. The educational games identified target grade levels or ages on their web site. Intercoder reliability was 100%.

Playing Time

The 12 games evidenced wide dispersion in how long it takes to complete them. Initially actual per game playing time was noted, in hours. To achieve better reliability the coding scheme and typical playing time was re-classified as less than 3 hours, 3 to 10 hours, more than 10 hours, and indefinite (some of the games have no ending, they continue forever). The revised coding yielded 100% reliability.

Learning Curve

Coders noted whether there was a print manual, electronic manual, both, or neither. Coders also estimated whether, when a player first starts playing the game, they are likely to have a problem understanding the game if they do not first go through the manual or tutorial. Some of the games required no learning time; players could turn on the game and just start playing. Others required many hours to learn. Coders classified game learning time as no time, 5 to 10 minutes, half an hour, an hour, or many hours.

Reliability was 67% for whether a manual is needed to play and for how long it takes to learn to play. To improve the validity of time to learn and whether a manual is needed, coders discussed each game and arrived at a consensus for all 12 games.

Game Genre Definitions

Seven genres were adapted from popular game review websites: Adventure, Combat (a combination of Action and Fighting), RPG (including MMORPG), Strategy, Sports, Simulation, World-Building (God-Building). Education and Puzzle were added for a total of nine genres. Review sites tend to classify games into only a single genre. However, allowing space games to be classified into more than one reveal more similarities and differences than would have been encountered if forced to place each game into a single genre category.

Detailed definitions for each genre were adapted from web sites devoted to the culture of gaming, such as grrlgamer.com and rpgfan.com:

Adventure. A significant portion of the game play requires or enables the players to explore the game world.

Combat. Any violent action against an opponent or opponents, be it hand-to-hand fighting, vehicle-to-vehicle conflict, or destruction of objects such as spacecraft, buildings or planets. This genre is a combination of what are traditionally called Action and Fighting (Hannon, 2003).

Role Play Game (RPG). Requires three elements. One is a character profile that describes “certain skills or aspects of that character.” (Archmage, 1998) Two, there must be “some method of increasing and strengthening those statistics (usually but not necessarily by way of the experience or level system).” Third, it must have a game play system utilizes the skills or aspects of the characters (adapted from Archmage).

Strategy. The player's main focus is to make use of elaborate and systematic plans of action to outsmart their opponents (adapted from Al-Herbish, 1999).

Sports. Organized competition amongst individual or team that is based on some kind of onscreen physical activity, where there are goals and rules.

Simulation. “A game that is trying to realistically simulate a real world situation is a simulation, or "sim" for short. The Sims is one example, Microsoft Flight Simulator is another.” (Hannon, 2003)

World-Building. A certain portion of the game involves building and managing societies or environments.

Education. A certain portion of the game is specifically intended to teach meaningful facts or concepts about the real world.

Puzzle/Mind game. A certain portion of the game includes well defined, focused problem solving (more involved than simple reflex actions) which is a mental challenge, though not necessarily meaningful other than within the context of the game.

The nine genres had an average intercoder reliability of 93%. The two coders and the project leader discussed each game, arriving at a genre consensus for all games.

Companions and Opponents

Games were coded as single player, multiplayer, or both (some games could be played in either mode). Coders determined whether there was an opponent, and if so whether it was a real person or computer generated opponent. They coded whether games involved individual play or team play. They noted whether it was possible to chat with other (live) players online. Each of these measures yielded 100% reliability.

Avatars and NPCs

An avatar is a representation of the player. Coders decided whether each game included an avatar and whether players can otherwise customize their avatar. The number of Non-Player characters was also counted.

Interaction

Interaction coding encompassed perspective and graphical player viewpoints, background music, use of keyboard and mouse, difficulty levels, and how the computer communicates with the player. Perspective coded whether the game interface used 3D models, 2D graphics, or a combination of 3D and 2D representations. Player viewpoint was coded as to whether there was a first person viewpoint and whether there was a third person viewpoint. Reliability was 67% for these three variables. Therefore, after initial ratings, consensus coding was used.

For the remaining Interaction variables, reliability was 100%. Coders noted whether there was continuous background music, and whether the player had control over that music. They noted whether it was necessary to use a keyboard, a mouse, or both simultaneously, and whether quick reflex actions were required. And they coded whether it was possible to customize keystroke commands.

Computer-Player interactions were coded as text only, voice only, both, or user can chose either voice or text.

Fantasy Elements

A likely area of differences between educational and commercial games is how closely the games are based on the real world (or real galaxy). Games were coded as having no back story, a short back story, or an extensive back story. Coding back story was straightforward, yielding 100% reliability.

The other fantasy elements were more subjective, often with reliability of 67%. Again consensus coding was used. Coders noted where the game takes place: this solar system, this galaxy, an imaginary solar system, or an imaginary galaxy. There was some disagreement –is it Earth’s moon and not some other moon? The decision was to assume it was this solar system or galaxy unless some aspect (planet or star names or features) made it obvious it was NOT based on this real galaxy.

Coders noted whether, in the game, humans live in space and/or on other planets. (If they travel in space it is assumed they live in space. If the game does not show, mention or imply humans living on other planets, the assumption is they do not.) Also coded was how many different species of aliens appeared in the game. Whether or not there are aliens was easy to agree upon (except for the talking Lizard on Magic Bus, who was of questionable planetary origin). How many species of aliens was difficult (estimates ranged from 0 to 999). Coding categories of 0, 1, 2, 3-10, 11-50, and more than 50 species of aliens in the game were applied.

14 Plus 2 Forms of Fun Definitions

The final coding and the title of this manuscript was how extensively fun each game was along the 14 forms of fun delineated in Pierre Alexandre Garneau’s (2001) Gamasutra article. Garneau’s goal in proposing 14 forms of fun was “to be as complete as possible in the enumeration of categories of activities that are fundamentally entertaining.” At least two particularly relevant forms of fun did not appear in Garneau’s original list. Learning about the world (the real world) can be enjoyable and is extremely germane to consideration of educational games. In addition, none of Garneau’s forms of fun address the pleasure of helping or taking care of others. Altruism might include helping another person, caring for a pet, or even saving humanity. Learning and altruism are forms of fun that might appeal to girls according to an AAUW (2000) report. Initially the 16 forms of fun were coded as 1 (non-existent), 2 (moderate), and 3 (extensive). The definitions, adapted from Garneau’s initial list, appear below.

Beauty is “that which pleases the senses” and may include graphics, music, sound effects or touch.

Immersion involves “going into an environment different from one’s usual environment by physical means or by use of one’s imagination.” This includes the pleasure of being in a different environment than usual, the pleasure of living a different life, the pleasure of escaping from one’s problems. Novels, story telling and movies are passive forms of

immersion. Artificial intelligence, sound and physics are also important aspects of immersion

Intellectual Problem Solving refers to "finding solutions to problematic situations that require thought." This can involve perceiving pattern of problems: rules (the constraints of the computer and of the programming language for programming, for example), a setting (the current situation in a board game, the program in which the module must be integrated for programming) and a goal (what it is that must be achieved).

Competition is "an activity where the goal is to show one's superiority" either over other players or against oneself, improving previous scores.

Social Interaction involves "doing things with other human beings" such as chatting, cooperating, or competing. (Social interaction is defined as NOT involving NPCs but only involving other real humans.)

Comedy is "things that make one want to laugh."

Thrill of Danger is fun where the stakes are high. Failure could lead to the player being killed or aliens destroying the earth or the space program being cancelled. According to Garneau, "some players found it to be more frustrating than fun"

Physical Activity refers to fun involving "activities requiring intense physical movements." (This was interpreted to mean more than mouse or keyboard movement. Therefore none of the 12 games included physical activity forms of fun.)

Love as a form of fun can include strong affection toward, love, lust, or caring for somebody (real or virtual, human or alien or pet). Love can include "Strong affection toward somebody.

Creation fun is "to make exist that which didn't." For this form of fun only games with creation as a main gameplay feature – games which focus more on creation than destruction – were counted.

Power as a form of fun involves the "capacity of having a strong effect, of acting with strength."

Discovery fun is about "finding something that wasn't known before." This can include new levels, new planets or aliens, new environments, new weapons, new enemies, etc., seeing new things, or doing new things.

Advancement and Completion fun means "going forward in, and eventually finishing, an activity."

Application of an Ability according to Garneau is "using one's physical abilities in a difficult setting." This study stuck with Garneau's focus on physical abilities such as hand-to-eye coordination and quick reflex actions in a challenging situation.

Altruism involves helping other players or helping NPCs (human, alien, or animal) or helping humanity.

Learning refers to increasing your understanding of or knowledge about the real world – this includes how high you can jump on Pluto, the impact of budgets on space exploration, why there are seasons, etc. The fun of learning facts and concepts which relate to the real world

Average intercoder reliability for the 16 forms of fun was 86%. Some were easy to code and agree upon. Some forms of fun are by nature more subjective than others. Hoping for better reliability, each form of fun was instead coded as being present not at all, a little, or a lot. This actually resulted in far worse reliability ratings. Beauty is in the eye of the beholder. Things which make one person want to laugh don't necessarily make another person want to laugh. The original three categories (non-existent, moderate, and extensive) were used, combined with the consensus method among the three first authors to arrive at ratings of forms of fun for each game.

Results

Target Audience

All four educational games were aimed at younger than high school kids. None of the commercial software targeted pre teens. A half targeted over 13, and the other half was sold for any age. The difference in target age between commercial and education games was statistically significant ($p=.02$)

The average cost of educational games (\$41.46) is not much different than the average cost of commercial games (\$39.58). Educational games need to be cross platform to reach the largest school market. Penetration of Apple computers is higher in schools than in the general U.S. population. All of the educational games were cross platform (Mac and PC) compared to 38% of commercial games ($p=.04$).

Along those same lines, 63% of the commercial space games required a 3D accelerator card, while none of the educational games did. ($p=.16$) 3D navigation can be more expensive to create, and requiring a card limits the market to newer computers than are found in many schools. Three fourths of both educational and commercial games need additional software installed to play, usually digital video system software such as QuickTime or Real Player. None of the educational games required a software patch, while 63% of commercial games required a patch. ($p=.16$)

All of the educational games took 5 minutes or less to install. 25% of commercial games took five minutes or less, 38% took 6 to 10 minutes, and 38% required 11 minutes or more. ($p=.05$) Consumers who purchase a game may be more willing to undergo complex installation procedures for the pleasure of playing a high end game. Teachers want to avoid complex, time consuming installation (usually on many computers).

Play Time

Educational games take less time to play than commercial games. One hundred percent of the educational games can be played in less than three hours, while no commercial game ends that quickly. One fourth of the commercial can be completed in 3 to 10 hours, half require more than 10 hours to complete a game, and 25% take an indefinite period – there is no ending. ($p=.01$)

If a teacher uses a game with her class, it is likely she will be limited to a single class period (45 to 50 minutes) to play. Few classrooms have one computer per child, so they would need to reserve and go to a computer lab somewhere in the school.

Realistically a typical class period under these circumstances probably only allows about a half hour of actual game play, given travel time and the time it would take to get 30 computers launched and running the game. Longer games might be continued across more than one class period, if there is a way to save the game and resume it. Playing a game that continues over several days of class (including connecting each child to where they left off previously) could be complicated in a shared or multipurpose computer lab where the computers are used for something else by someone else between game sessions.

Games played at home can take longer because external time constraints are not as rigid as in the classroom and the home computer is not “multipurposed” to the same extent as computer labs in schools. Games for younger kids may need to be shorter to accommodate shorter attention spans. It may be easier to concentrate on a game at home, where there are not 30 other kids in the room also playing games.

Commercial games advertise the number of unique play hours. Fifty to 60 hours is a normal expectation for a new game. Educational games stress quality of learning experience rather than lengthy duration of play. Most of the educational games offered a teachers’ manual or teachers’ guide containing lesson plans related to the game and suggestions on how to introduce and follow up on game play to enhance learning. Pre- and post-game learning activities are a different way of extending the game experience. Pre- and post-game learning activities are easier to structure in a classroom environment than is game play itself.

Learning to Play

Only one out of four educational games included a manual, compared to 100% of commercial games. ($p=.01$) It is necessary to use a manual to play 63% of commercial games and no educational games. ($p=.04$)

Educational games take significantly less time to learn how to play than commercial games. One educational game took no time to learn to play. The other three took about 30 minutes to learn to play. A short learning curve for an educational game to be played in schools is a structural necessity, just like a short playing time is required to accommodate school use.

A short learning curve might also be expected for commercial games, so players start having fun quickly. This is not what was found. One-fourth of commercial games required half an hour to learn to play, while the other three-fourths required many hours to learn. Commercial games require significantly longer to learn than do educational

games ($p=.04$) It seems paradoxical that players of commercial games spend much more time and have to work harder to learn how to play than do players of educational games. Obviously commercial game players are not averse to learning, though perhaps they are averse to learning about the real world? The shorter educational games fit better into short class periods. But the shorter length also reflects and requires lack of complexity of game play in educational games.

Learning to play a complex commercial game is hard and often requires many hours. The coders reported increases in their skill and knowledge of some commercial games even after 50 hours of play. Learning to play is often stressful and unpleasant, even more so for multiplayer online games where players can chat online. Remarkably, large numbers of players stick with the learning and become expert players.

Educational games tend to be accompanied by teachers' guides, including lesson plans for pre-game and post-game learning activities to prepare for and to reinforce and extend learning from the game. Thus, additional time may be spent in game-related learning, but not in game play.

Genre

Educational and commercial game genres are almost completely distinct from each other. Table 2 shows the percent of educational and commercial space games which fit the nine different genre categories. (Games could be classified into multiple genres.) Table 2.

Genres of Educational and Commercial Games

	Educational	Commercial	p
Combat	0%	88%	.00
God/World Building	0%	88%	.00
Adventure	50%	75%	.39
Strategy	0%	63%	.04
Role Play Game (RPG)	0%	25%	.27
Education	100%	13%	.00
Simulation	50%	13%	.16
Puzzle	100%	0%	.00
Sports	0%	0%	

The largest overlap between commercial and educational games was the Adventure genre, in which players explore the game world. Three fourths of commercial games and 50% of educational games were Adventure games.

None of the educational games involved Combat, God, Strategy, Role Play, or Sports genres. Every educational game involved Learning and solving mental Puzzles. Half of the educational games were also Adventure games, and half of the educational games involved Simulations of real world situations.

Most (88%) commercial games involved Combat and most (also 88%) were God games (building and managing societies or environments), compared to 0% of educational games. ($p=.00$) A majority (63%) of commercial games were Strategy games (elaborate and systematic planning to outsmart opponents), again compared to 0% of educational games. ($p=.04$)

Companions and Opponents

Overall, commercial games involved more interpersonal interaction. Commercial games were much more likely to allow more than one player to play together, whether against or with each other. Three-fourths of educational games were single player games,

compared to 25% of commercial games. Thirty-eight percent of commercial games could be played in either multiplayer or single player mode and 38% were exclusively multiplayer. (p=.09)

There were no opponents (either real people or computer-generated entities) in any of the educational games. However, 87% of commercial games did include real or virtual opponents. (p=.00) Half of the educational games had teams (either real or virtual) and half did not. Within commercial games, 75% had teams. (p=.386)

Three fourths of commercial games enabled players to chat online, while none of the educational games included online chat. (p=.01)

Avatars and NPCs

All of the educational games and all but one of the commercial games included an avatar (some form of representation of the player). (p=.46) In 43% of commercial games players can change the default and choose an avatar gender. In 100% of educational games players CANNOT chose avatar gender. (p=.15) In 75% of the educational games, players can modify aspects other than gender of their avatar, compared to 38% of commercial games. (p=.22)

All educational games include at least one NPC. One of the four educational games had a single NPC, one used two NPCs, and two used 5 NPCs. Sixty-three percent of commercial games had at least one NPC. Commercial games are less likely to include a NPC than educational games are, but when they do, commercial games usually include lots of NPCs. One fourth of commercial games used 50 or more NPCs; 13% used 11 NPCs; 13% used 2 NPCs, and 13% used one NPC. (p=.19) The differences in NPCs are not statistically significant.

None of the educational games or commercial games used exclusively male NPCs. One educational game used female NPCs, one used robots, and two used both male and female NPCs. Among commercial games which do include a NPC, 80% are a mix of males and females and 20% are robots. (p=.46) No NPCs were children.

Interaction

One fourth of educational games and 75% of commercial games use continuous background music. (p=.10).

Visual interfaces were not significantly different between educational and commercial games. All educational games use a 2D interface. Sixty-three percent of commercial games use a 2D interface; 25% use 3D, and 13% use a combination of 2D and 3D. (p=.37) One fourth of educational games and one fourth of commercial games offer a first person view. One fourth of commercial games offered a third person view, while no educational game did so. (p=.27)

Physical interactions in commercial games are more demanding than educational games. Educational game interactivity was entirely based on mouse clicks. All commercial games also use a mouse, but 88% also require use of a keyboard. (p=.00) Thirty-eight percent of commercial games allow players to customize keyboard actions. One fourth of commercial games require simultaneous use of keyboard and mouse, compared to none of the educational games. (p=.27) No educational games rely on quick reflex actions, but 63% of commercial games do. (p=.04)

In half of the commercial games, players must read to play the game. 50% of commercial games communicate with the player via text only; 25% use voice and text,

and 25% allow players to choose either voice or text. On the other hand, no educational games use text only. 75% use voice only and 25% allow selection of either voice or text.

Twenty-five percent of educational games let players set a difficulty level, compared to 63% of commercial games. ($p=.22$) Most educational games have only one level of difficulty.

Fantasy Elements

Educational games were more tied to reality and they offered less of a story narrative. Humans are usually shown living in space in both kinds of games, but more often shown living on other planets in commercial games. Commercial games are set farther in the future, in imaginary places, and often involved interactions with many different species of alien life form.

All of the educational games take place in Earth's solar system. Only one fourth of commercial games take place in Earth's solar system. Thirteen percent take place in an imaginary solar system and 63% in an imaginary galaxy. ($p=.05$) In 75% of educational games and 88% of commercial games, humans live in space. ($p=.54$) In 25% of educational games and 88% of commercial games, humans live on other planets. ($p=.03$)

Seventy-five percent of educational games had no back story, while 25% had an extensive back story. Within commercial games, 13% had no back story, 50% had a short back story and 38% had an extensive back story. ($p=.07$)

One of the four educational games may have included an alien (there was a dancing lizard in a space helmet on the bus), compared to 63% of commercial games that definitely included aliens. ($p=.22$)

Educational games either had no alien species or a single alien species, while commercial games, if they included aliens, usually included lots of alien species. Seventy-five percent of educational games had no alien species; 25% had a single alien species. Thirty-eight percent of commercial games had no alien species; 13% had two alien species; and 13% had three to 10 alien species. One fourth of commercial games had 11 to 50 alien species, and one fourth had more than 50 alien species. ($p=.26$)

Fourteen Plus 2 Forms of Fun

The average number of different categories educational games rated as at least moderately fun was 8.75 out of 16, compared to an average of 12.5 of the 16 fun categories per commercial game. ($p=.04$)

If moderately fun equals one and extremely fun equals two, the total possible extreme of funness combining the 16 forms of fun is 32. On average, educational games totaled 13.5 out of 32 possible degrees of fun, compared to 20.6 degrees of fun for the average commercial game. ($p=.03$)

One cannot conclude from these differences that commercial games are more fun, but one can conclude commercial games are fun in more different ways.

Tables 3 and 4 reveal which forms of fun appear in each of the 12 games. The forms of fun are ordered from most to least predominant. Table 3 shows how intensely fun each game was along the first 8 forms of fun. Dark grey means the game was extensively fun along that dimension. Light grey means moderately fun. And white

means this form of fun was non-existent in the game. The bottom of the table shows the percent of games overall which were extensively fun along each dimension, followed by the percent of educational and percent of commercial games.

Every game looked at was extensively fun in terms of IMMERSION: the pleasure of being immersed in a different environment than usual. All except one commercial game (Moonbase Commander) offered extensive fun of DISCOVERY: finding something that wasn't known before.

The fun of going forward in, and eventually finishing, an activity (ADVANCEMENT AND COMPLETION) was extensively present in all except one commercial game, but only one educational game. If ADVANCEMENT AND COMPLETION was not extensively present, then it was at least moderately present in all games of both types.

The fun of high stakes, also called the THRILL OF DANGER, was either extensively present or completely absent. The THRILL OF DANGER was extensively present in all of the same games where ADVANCEMENT AND COMPLETION was extensively present (88% of commercial games and 25% of educational games).

Table 3.

Intensity and Inclusion of Forms of Fun

	overall inclusion	educational	commercial
Immersion	100%	100%	100%
Discovery	92%	100%	88%
Advancement	67%	25%	88%
Thrill of danger	67%	25%	88%
Intellectual problem solving	58%	75%	50%
Competition	58%	0%	88%
Power	58%	0%	88%
Social Interaction	50%	25%	75%
Learning	42%	100%	13%
Altruism	42%	25%	50%
Beauty	25%	0%	38%
Ability	17%	0%	25%
Creation	8%	0%	13%
Love	8%	0%	13%
Comedy	0%	0%	0%
Physical activity	0%	0%	0%
extensively fun dimensions	7.08	4.25	8.25
moderately fun dimensions	4.25	4.75	4.75
absent fun dimensions	13.17	7.00	3.00
n	12	4	8

All of the games involved some amount of **INTELLECTUAL PROBLEM SOLVING**: finding solutions to problematic situations that require thought. Three fourths of the educational games were extensively fun in this regard, compared to half of the commercial games.

Nearly all commercial games (88%) are fun because they involve extensive fun of **COMPETITION**. Half of the educational games include a moderate amount of fun **COMPETITION**.

The same commercial games that are fun because of **COMPETITION** also offer extensive fun of feeling **POWERFUL**: the capacity of having a strong effect, of acting with strength. No educational games do so. None of the educational games are extensively or moderately fun in terms of feeling **POWERFUL**.

Commercial games involve more **SOCIAL INTERACTION**. Three fourths of commercial games and one fourth of educational games provide extensive fun in the form of **SOCIAL INTERACTION**.

All educational games and only one commercial game offer extensive fun of **LEARNING**: increasing your understanding of or knowledge about the real world.

Applying the idea of learning about real world concepts liberally, 63% of the commercial games provide a moderate amount of fun learning about the real world (for example, Star Wars Galaxy involves mining elements on different worlds; Dark Space includes seven different kinds of planets which vary in several dimensions which make them more or less habitable by humans). Commercial games do not make clear what is real and what is not. Although some learning (for example, about mining and transforming metals or gasses) may occur while playing a commercial game, the player does not know which gasses and which processes really exist in the world and which are made up for the game. Likewise in simulations the underlying assumptions of the model in commercial games are not explicit or directly observable.

ALTRUISM (helping others or another) is present to some extent in all except one commercial game (Earth and Beyond). **ALTRUISM** is moderately present in all educational games. It is extensively present in half of the commercial games and one fourth of the educational games. Overall, **ALTRUISM** is a bit more prominent in commercial games. Ironically, helping others in a commercial game often means helping them to fight a war or defeat an enemy.

BEAUTY is not extensively present in any educational game, though it is moderately present in them all. Thirty-eight percent of commercial games are **BEAUTIFUL** (extensively pleasing to the senses). All games except Sim Earth are at least moderately beautiful. Educational and commercial games sold to large markets incorporate reasonably high quality graphics.

APPLICATION OF A PHYSICAL ABILITY in a difficult setting occurred extensively in two commercial games and moderately in three more. No educational game showed up in this category. This category likely has a high correlation with requiring quick reflex actions (described earlier under interactions).

CREATION (making exist that which didn't) is moderately present in all commercial games except Sim Earth where it is extensively present. None of the educational space games involve **CREATION**.

LOVE (strong affection towards another) is rarely present in games today. **LOVE** played a moderate role in two commercial games and an extensive role in the third commercial

games (love stories are built into the larger plot of some of the games). LOVE appeared in one of the four educational games.

None of the games were extensively COMEDY, but there was a slight tendency for educational games to humorous (75% were moderately so) compared to 38% of commercial games.

None of the commercial or academic games involved the fun of PHYSICAL ACTIVITY.

Table 4 shows forms of fun sorted from the most to least predominant forms of fun in educational games. The second and third column are rank order of that form of fun for educational and commercial games. The fourth and fifth columns are the average score on a one to three scale where 1 is nonexistent, 2 is moderate, and 3 is extensive. The significance level is based on chi square analysis of the classification data.

Table 4.
Forms of Fun in Order of Prominence

	E-rank	C-rank	E-mean	C-mean	p
Learning	1.5	12	3	1.9	.000
Immersion	1.5	1.5	3	3	1.0
Discovery	3	1.5	2.9	3	0.14
Problem Solving	4	8	2.8	2.5	0.41
Advancement	5	3	2.25	2.9	0.07
Altruism	6.5	9.5	2	2.3	0.46
Beauty	6.5	9.5	2	2.3	0.22
Comedy	8	15	1.75	1.38	0.22
Competition	10	5	1.5	2.75	0.01
Social Interaction	10	7	1.5	2.75	0.09
Thrill of Danger	10	5	1.5	2.75	0.03
Love	12	14	1.25	1.5	0.76
Physical Activity	14.5	16	1	1	1
Creation	14.5	11	1	2.1	.000
Power	14.5	5	1	2.75	.000
Application of Ability	14.5	13	1	1.88	0.12

Educational games extensively include learning, immersion, discovery, and problem solving. To a more moderate extent they involve advancement and completion, comedy, altruism, and beauty. Rare or nonexistent forms of fun in education games include competition, social interaction, thrill of danger/high stakes, physical activity, creation, a sense of power, and application of a physical ability.

Commercial games extensively involve discovery, immersion, advancement and completion, competition, the thrill of danger/high stakes, and a sense of personal power. They somewhat extensively include social interaction and problem solving. At a more moderate degree altruism, beauty, creation, learning, and application of a new physical ability appeared in many commercial games. The almost nonexistent forms of fun in commercial space games are love, comedy, and physical activity.

Conclusions and Recommendations

The 12 games analyzed were chosen because they deal with space themes; they are not a random sample of educational and commercial games and therefore may not be representative of the entire set of commercial and educational games. The analysis does provide a first systematic in depth comparison.

The commercial space games analyzed are not necessarily good games. Some were considered fun by the graduate student coders and some were not fun. The educational space games analyzed are not bad games. After reviewing all twelve games the research team chose three of the educational games to include in Space Pioneer Learning Adventures camp. The camp faced the same constraints classrooms do – a short amount of time amidst many other competing activities, a need for games with a short learning curve that could be played within 45 minutes, and an aversion to exposing kids to combat and war.

Educational games differ dramatically and systematically from commercial games. Most likely because of the structural and systemic constraints of classroom play, the educational games are not played for 50 or 60 hours at a time. That deep, lengthy engagement in hard fun is something educators yearn to see resulting in learning about the real world.

The differences found between educational and commercial games are extreme and surprising, often counterintuitive and ironic.

Educational games are easier to install, easier to learn, less complex, shorter, and less challenging to play than commercial games. They involve less reading, less social interaction, and no typing or other use of the keyboard. Educational games seem to be gender neutral in both characters and themes. They include 30% fewer forms of fun than commercial games. Competition is moderate if present at all; there are no opponents. Learning about the real world, discovery and exploration, solving puzzles, and intellectual problem solving are their dominant forms of fun. Educational games are more grounded in reality, less imaginary and less imaginative.

Commercial games can be hard to install and are even harder to learn. They take a long time to play (some go on indefinitely), and they require reading and keyboarding. Commercial games are male-oriented in theme and game play while being somewhat gender-balanced in terms of NPCs and player characters. Most commercial games involve combat and competition but half of the commercial games also extensively involve altruism. World-building is almost always part of the game. Social interaction is more common in commercial games than in educational games. Commercial games offer discovery and exploration, a thrill of danger/high stakes, a sense of personal power, teammates and opponents to compete and cooperate with. Unlike educational games, commercial games provide opportunities for advancement and completion. They usually take place far in the future in an imaginary galaxy, including aliens (often many species of aliens) as well as humans living on other planets. A back story sets the context for the game. Sometimes a little scientific content is woven into the game, but it is never clear what few aspects of the game are real science amidst the majority of make believe.

Our findings raise some interesting issues regarding games and learning. Did the commercial games not involve learning? They did. But the issue is learning of what? One way of thinking about this may be in terms of semiotics. The commercial games do not “point to” anything outside of themselves. They define the world of the game, its rules, what

can and cannot be done. Thus any learning here has to be about that pre-defined world. Educational games on the other hand always point to something else. Thus there are two levels of learning required. One is learning the game and the other is learning the other stuff that you are playing the game for in the first place.

Educational games are schizoid. They continually try to serve two masters (learning versus fun) and that leads to problems. Commercial games are science fiction in the distant future (with a much heavier emphasis on fiction). Educational games are science fact and they avoid leaps of imagination into the fiction side of science fiction. They may be set in the near future, but they are carefully set within the bounds of what is likely to be possible someday.

Learning to play the game is different from learning science content. For educational game designers trying to please teachers, time spent learning how to play the game (unless it is also time spent learning science) is wasted time. For commercial game designers, science learning is completely irrelevant. Time spent learning the game can be as involved as it needs to be in order to result in a compelling game play experience once the game has been learned.

The users and the people who want to buy these games differ so the way they are marketed differs. Commercial games are sought after by kids who pester their parents to buy it. Educational games are both sought and bought by parents or teachers for the children. The constraint of educational games needing to be playable in a classroom situation may be a bigger constraint to creating a fun educational game than the focus on science learning. Structurally, 30 kids playing in a multipurpose shared school computer laboratory for 30 to 45 minutes requires a game that can be played within that time frame. Those 45 minutes include time needed to learn the game and time to play.

Designers could envision one 45 minute training game to learn to play, and a second session to actually play a real game. Designers could plan for 10 half hour play sessions, incorporating two weeks of curriculum into the game. However, increasing the complexity and time involved for teachers to use an educational game will reduce the potential market. Only teachers and schools willing to consider devoting 10 or more days to the game would consider buying it. School curricula are increasingly regulated and structured. It can be very difficult to incorporate content outside of the required text and required curriculum.

Playability in a school setting carries limits to the length and complexity of game play. Multiple levels of difficulty are expected, a necessary element of a commercial game. Educational games have no time to offer multiple levels of difficulty. Thus they provide less sense of personal power and little feeling of advancement and completion. Designers could plan for three different play sessions, each with increasing levels of difficulty. This could increase children's sense of accomplishment and advancement, and take more advantage of the time spent learning to play the game.

Playability in school settings argues for creating cross platform games that run well on older, slower computers. School settings also argue against multiplayer online games. Commercial games involve more social interaction than do educational games because educational games are usually designed to be single player games. This is ironic because most current learning theories emphasize the value of interaction, greater level of collaborative learning. Middle school teachers are often hesitant to connect to their class to the internet – kids surf the net instead of or in addition to participating in what the class is supposed to be doing; online chat can't be monitored and controlled presenting a potential

safety threat to the kids and also making it difficult maintain discipline within the class; and getting a CD game AND internet connection to work for 30 kids all at once is harder than just getting a CD game to work for 30 kids at once.

Educational games designed for the home could more closely parallel the appealing aspects of commercial games, because home game play doesn't have the same classroom time constraints and because home computers are usually connected to the internet and can be used for multiplayer online games. Perhaps a more involved home version and a shorter, more focused classroom version of the same game could be created. Children's homework would be to go home and play the game.

Classrooms are not all bad; they are not completely antithetical to learning and fun. After all, they do have teachers. All of the educational games recognize the value a teacher can bring to enhancing game learning, and include teachers' guides and lesson plans.

Even though a designer includes selected forms of fun in a game, individuals playing the game may not experience those dimensions of fun. A designer can build in potentially available forms of fun. The actual experienced fun depends upon many known and unknown factors including age, gender, context, how well they know how to play the game, and myriad other factors. This examination of forms of fun provides one means to help designers think about how to make learning games more fun and fun games better for learning.

Commercial games could do a service to science-ignorant adult populations by being more scientifically accurate when science is part of a game, and by somewhere-- either on the web site, the manual, or within the game itself-- identifying what parts of the game relate to real science. One could invite one or more qualified science advisors to join the design team, not full time, but at the planning stages and for review at key points during production. Perhaps even include a knowledge quiz for experienced players to show them what they learned. Maybe there could even be more commercial games not based on combat?

Maybe educational games could include a little more story, a little more imagination, maybe some aliens, without losing their focus on real science. Competition, higher stakes, and a sense of personal power and mastery could make educational games more fun.

College level educational games do not face the same classroom constraints as educational games for K-12. More complex and involved college level learning games could match the intensity of commercial games. The college curriculum is more flexible. Classes meet for longer periods. Online courses have students at computers during most of class anyway. College computer labs and college student home computers are connected to the internet, often by high speed modems or Ethernet. Advanced level electronic learning games are an emerging genre with great potential.

References

- AAUW Educational Commission on Teaching, Gender, and Teacher Education (2000). Tech-savvy: educating girls in the new computer age. Washington, DC: AAUW.
- Al-Herbish, T. (1999, December 10). PC strategic games FAQ. Retrieved September 21, 2004, from <http://www.faqs.org/faqs/games/strategic/pc/>
- Archmage. (1998). The definition of a role-playing game. [RPGFan.com](http://www.rpgfan.com). Retrieved September 21, 2004, from "<http://www.rpgfan.com/editorials/old/1998/0007.html>, RPGFan editorial.
- Garneau, P. A. (2001, October 12). Fourteen forms of fun. *Gamasutra*. Retrieved Retrieved September 21, 2004, from http://www.gamasutra.com/features/20011012/garneau_01.htm
- Gee, J. P.(2003). *What video games have to teach us about learning and literacy*. New York: Palgrave-MacMillan.
- Gentile, D., & Walsh, D. (2002). A normative study of family media habits. *Applied Developmental Psychology, 23*, 157–178.
- Hannon, C. (2003, August 30). "Genre glossary: What the heck is an RPG? Grrlgamer.com. Retrieved September 21, 2004, from <http://www.grrlgamer.com/resources/gametaxonomy.html>
- Papert, S. (1991). Situating constructivism. In I. Harel & S. Papert (Eds.), *Constructionism: Research reports and essays, 1985-1990* (pp. 1-11). Norwood, NJ: Ablex.
- Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer*. New York: Basic Books.
- Piaget, J. (1951). *Play, dreams, and imitation in childhood*. New York: W. W. Norton.
- Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.