

## **Comparing 14 Plus 2 Forms of Fun (and Learning and Gender Issues) In Commercial Versus Educational Space Exploration Digital Games**

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to be presented at the International Digital Games Research conference, 4-6 November 2003, University of Utrecht, The Netherlands

This project is part of a large National Science Foundation funded gender and science game design research project being conducted by faculty and students at Michigan State University in the Communication Technology Laboratory, Department of Telecommunication, and College of Education.

In this manuscript we report on one portion of the findings—our content analysis of commercial and educational space games conducted initially to help choose which games to include in Space Camp Pioneer Learning Adventures game design camp. As we progressed with the analysis, we realized interesting comparisons could be made between commercial and academic games that might yield useful recommendations for improving both kinds of games.

### **ABSTRACT**

Games are an increasingly significant part of young people's lives. Lots of learning and skill development is needed to play most commercial games. Educators lament that the time spend playing does not contribute to knowledge about the real world. Commercial games are dismissed as not educational. Educational games are derided as not fun enough. Ideally new games will bridge this gap. To begin to pave the way we are conducting a detailed analysis to understand what's fun about a good educational game and how that fun differs from what's fun about a good commercial game.

Two graduate students (one male and one female) were paid to play 12 space exploration games (4 educational, 8 commercial) for approximately 300 hours. 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 rankings along Garneau's fourteen forms of fun. These factors were quantified to allow statistical comparison between commercial and educational games.

The differences we found between educational and commercial games are extreme and surprising, often counterintuitive and ironic. Playability in a school setting 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 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 could do a service to our woefully science-ignorant adult population by doing a better job of accuracy of science when it is part of a game. Educational games could include a little more story, a little more imagination, and maybe some aliens, without losing their focus on real science. Competition, higher stakes, and a sense of personal power and mastery could expand educational games' forms of fun.

More complex and involved college level learning games could more closely match the intensity and fun of commercial games because online and in person college classes are free of many constraints posed by K-12 education.

## **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 and 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 this game 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? There are many more questions that we could ask. What is surprising is just how little is known about these issues.

We 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 engrosses gamers so much. Ideally new learning games will bridge the fun gap. To begin to pave the way we conducted 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. Perhaps we can identify ways to improve both genres through careful understanding the current strengths and weaknesses of each type of game.

## **METHODS**

We searched for space-related games which might possibly be incorporated into our Space Pioneer Learning Adventures game design camp. This camp was part of a larger project. Middle school children were exposed to diverse space learning experiences and participated in guided game design brainstorming envisioning their ideal space learning game. To identify optimal games to include in the space camp curriculum, copies of 12 space-related computer-based games were purchased and an in depth qualitative content analysis was conducted of each game. Before we could analyze the games, researchers had to play them long enough to experience the game.

Two graduate students (one male and one female) played 12 space exploration games for more than 300 total hours. 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 our 12 space games. The far left column indicates whether each game was classified as commercial (C) or educational (E). Approximate hours spent playing each game by two graduate student researchers appears in the far right

columns. Hours listed in bold indicate the primary coder for that game. An asterisk indicates the game was selected for inclusion in Space Pioneers Learning Adventures Camp and was played and rated by the 42 kids who participated in the camp.

Table 1: Twelve Space Games: A comparison of time spent playing and coding selected games

	Game Name and Corporate Web Site	Coder 1 Play Hours	Coder 2 Play Hours
E	Great Solar System Rescue* <a href="http://www.tomsnyder.com/products/ProductDetail.asp?PS=GREGSD">http://www.tomsnyder.com/products/ProductDetail.asp?PS=GREGSD</a>	12	<b>5</b>
E	Liftoff* <a href="http://www.eti-tech.com/phase3/liftoff/liftoff.html">http://www.eti-tech.com/phase3/liftoff/liftoff.html</a>	4	<b>8</b>
E	Magic Bus Lands on Mars <a href="http://www.microsoft.com/kids/msb/mars.htm">http://www.microsoft.com/kids/msb/mars.htm</a>	<b>8</b>	1
E	Space Academy GX* <a href="http://www.riverdeep.net/products/science/space_acad1.jhtml">http://www.riverdeep.net/products/science/space_acad1.jhtml</a>	12	<b>15</b>
C	Dark Space <a href="http://www.darkspace.net">www.darkspace.net</a>	2	<b>21</b>
C	Earth and Beyond <a href="http://www.earthandbeyond.com">www.earthandbeyond.com</a>	7	<b>61</b>
C	Galactic Civilization* <a href="http://www.galciv.com">www.galciv.com</a>	6	<b>35</b>
C	Masters of Orion <a href="http://moo3.quicksilver.com/">http://moo3.quicksilver.com/</a>	<b>16</b>	1
C	Moonbase Commander <a href="http://www.moonbasecommander.com/">http://www.moonbasecommander.com/</a>	<b>8</b>	5
C	Sim Earth creator Maxis no longer has a corporate web site	2	<b>15</b>
C	Star Wars <a href="http://starwarsgalaxies.station.sony.com/">http://starwarsgalaxies.station.sony.com/</a>	<b>70</b>	2
C	Starcraft <a href="http://www.blizzard.com/starcraft/">http://www.blizzard.com/starcraft/</a>	<b>12</b>	0

### Educational or Commercial Classification

We did not classify the games as educational or commercial until after the qualitative analysis was completed, to avoid imposing preconceived notions during coding. In sorting the 12 games, we decided to classify games based on how they were marketed and sold. 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 and did not emphasize science learning value of the game.

Producers of three of the four educational games were American companies selling learning software primarily to school markets (Riverdeep, Scholastic, and Tom Snyder productions). The fourth educational game is sold by ETI (Entertainment Technologies Incorporated) in Canada. On the page describing the new game, Liftoff,

the company web site claims “ETI is at the forefront in the development of exciting real-time game-based learning applications.”

Below are brief descriptions of the educational games (including genre classifications explicated in a later section in parentheses after the game name), followed by brief descriptions of the commercial games.

#### Educational Game Descriptions

##### ***The Great Solar System Rescue (adventure, education, puzzle)***

By role-playing four scientific experts, teams of four players analyze existing data, exchange opinions, and make decisions about where and how to find and rescue several probes lost in our solar system. Keeping within a reasonable budget may stop congress from cutting space exploration funding. Collaboration occurs through in person discussion, and then decisions are entered into the computer game.

##### ***Liftoff (simulation, education, puzzle)***

Players enter an astronaut training program where they participate in simulator space shuttle training and explore the history of past space exploration activities and technical specifications of a space shuttle.

##### ***Magic School Bus goes to Mars (adventure, education, puzzle)***

Players are magically transported in a school bus to Mars where they can explore the various facts about Mars through games, quizzes, interactive animations and narration.

##### ***Space Academy GX-1 (simulation, education, puzzle)***

Players start as a cadet in the academy and advance in rank by passing numerous tests based on interactions between the Sun, Moon and Earth, Gravitational Forces, Orbital Pull, Newton's Laws of Motion, Momentum and Acceleration. Orbital motions and launch trajectories can be manipulated in a simulation.

#### Commercial Game Descriptions

##### ***Dark Space (combat, strategy, god)***

Dark Space is a team-oriented, scenario-based strategy game in which the players choose a type of spacecraft, join a team (called a fleet), fight and compete with other fleets formed by other players for resources, galactic domination, and to earn prestige, rank, metals and badges.

##### ***Earth and Beyond (combat, adventure, RPG)***

Earth and Beyond is a MMORPG in which players pilot their own starships, adventure in a massive galaxy, take part in an online community, and advance their careers through any combination of combat, exploration, and trade.

***Galactic Civilizations (combat, adventure, strategy, god)***

Galactic Civilizations is a single-player, space-based strategy game in which the players, representing the human species, must research new technologies, build an economy, create a powerful military force, carefully balance their political, diplomatic, and trade skills, and all the while dealing with alien civilizations who are competing for control of the galaxy.

***Masters of Orion 3 (combat, adventure, strategy, god)***

Masters of Orion 3 is a strategy game which allows the player to choose to be one of 16 different alien species, build an economy, trade with different computer players in case of single player or human players in case of the online game. The aim of the game is to control the galaxy and be the most powerful or popular civilization

***Moonbase Commander (combat, adventure, strategy, god)***

Moonbase Commander is a strategy game based on the Lunar surface where multiple corporations are vying to harness and dominate the energy sources on the lunar surface. Along the way a goal is to eliminate your opponents.

***Sim Earth (simulation, god, education)***

Sim Earth is a single-player, “god game” in which the players control the development of earth’s geosphere, atmosphere, biosphere, and civilization, in a simulation of the interactions between the planet and its life-forms. Earth begins before there were dinosaurs and evolves to human inhabitants who eventually leave earth for other planets.

***Star Craft (combat, adventure, strategy, god)***

Star Craft is a single and multi player strategy game, involving three different species of life forms. Players build their own military force and conduct individual missions. Players can either team up with players to fight missions together against human or computer opponents

***Star Wars Galaxies (combat, adventure, RPG, strategy, god)***

In this massively multiplayer game online RPG players have the opportunity to build their character with different skills depending on the kind of profession they choose. Players can interact with each other, form groups and play as a team towards a common mission or goal helping each other in the process.

**CODING PROTOCOLS, DEFINITIONS, and RELIABILITY**

We attempted to develop a *quantitative* content analysis so that statistical comparisons could be made. Areas we quantified included Target Audience, Installation and System Requirements, Cost, Play Time, Learning to Play, Game Genres, Companions and Opponents, Avatars and Guides, Interaction, Fantasy Elements, and Forms of Fun. The quantitative coding form underwent four iterations before we arrived at coding protocols which seemed sufficiently well defined that independent coders would code any game the same way. 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.

Next we will define the quantitative coding protocols and final definitions and report on reliability, based on percent agreement between two independent coders across three games.

### 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. Games which did not list an ESRB rating (the educational games) identified target grade levels or age on their web site. Reliability was 100%.

We also noted whether the game shipped with teacher information or the corporate web site referenced National or State Science Standards.

### Installation Complexity and System Requirements

Installation and system requirements can have market implications. More complex system requirements limit potential audience, but can offer a richer game experience. We coded whether each game was available on PC or Mac or both platforms, whether a 3D accelerator card was required, whether any software patches or additional software was needed, and how long it took to install the game (categorized as 5 minutes or less, 6 to 11 minutes, or more than 11 minutes). All of the installation complexity variables had 100% reliability.

### Playing Time

The 12 games evidenced wide dispersion in how long it takes to complete a typical game. Initially we recorded how long a game took, in hours. To achieve better reliability we refined the coding scheme and classified typical playing time 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 approach yielded 100% reliability.

### Time to Learn

We coded whether there was a corporate web site, and whether there was at least one player-maintained web site about each game.

Games may or may not come with a manual. If there is a manual, it may be a print manual, and electronic manual, or both. Games may or may not include a tutorial. A

tutorial can be anything in electronic form that is integrated into the game. It is not a .pdf or .text file user manual. A tutorial is any content embedded in the game that helps the users understand the game. We coded 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. We classified game learning time as no time, 5 to 10 minutes, half an hour, an hour, or many hours.

Reliability on Time to Learn measures was 100% for tutorial, manual, and manual length. It was 67% for whether a manual is needed to play and how long it takes to learn to play. To improve the validity of time to learn and whether a manual is needed, the first three authors discussed each game and arrived at a consensus.

### Game Genre Definitions

To better distinguish the characteristics between educational and commercial games, 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). We added Education, and Puzzle for a total of 9 genres. Review sites tend to classify games into only a single genre. However, allowing space games to be classified into more than one may allow us to notice more similarities and differences than we would have encountered if we forced each game into a single genre category.

More detailed definitions for each genre were adapted from web sites devoted to the culture of gaming, such as [grrlgamer.com](http://grrlgamer.com) and [rpgfan.com](http://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).

**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)

**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 9 genres had an average intercoder reliability of 93%. Since we had a small sample of 12 games we further improved on the accuracy of the coding by using a consensus method. The two coders and project leader discussed each game, arriving at a consensus of what genres to code for each game. It was not difficult in any of the games to arrive at consensus after discussion.

### Companions and Opponents

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

### Avatars and Guides (“Sutradhars”)

An avatar is a representation of the player. We coded whether each game included an avatar. We coded the default gender of that avatar, whether players can choose the avatar gender, and whether players can otherwise customize their avatar. Avatar coding had a reliability of 100%, with the exception of default gender which had a reliability of 67%. Through discussion we realized the disagreement came in relation to whether a robot should be classified as male, female, or unknown. We added a new category (male, female, robot, mixed, or unknown) and we discussed each game and arrived at a consensus.

We initially tried to code for the existence of a narrator, how many narrators there were, and narrator gender and age. Reliability was terrible, around 33%. We realized the concept of narrator was unclear. One coder interpreted every NPC to be

a narrator, while the other used a much more limited definition. We decided the most correct comparison would be to treat every NPC who helped move the game along by offering instructions or advice would be counted as a guide. A better word for guide was proposed, derived from the Indian character in theater and dance called a “Sutradhar.” Since the word avatar was borrowed from a Hindu myth, it seemed appropriate to borrow a second very fitting concept from India. A Sutradhar is:

*a person or entity who knows and conducts itself as someone who can help people by giving instructions, narrating and relating a part of the story, who also has the power to pop in and pop out at any time without affecting the flow of events as they should happen A guide, a mediator between you and the system you interact with. (A. Maniar, personal communication, August 21, 2003)*

There is a high overlap between the number of NPCs and the number of Sutradhars. In the end we coded only Sutradhars. We used the consensus/discussion method to code Sutradhars.

### 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 coded whether there was a first person viewpoint and whether there was a third person viewpoint. Reliability was 67% for these three variables. We therefore discussed each game and arrived at consensus coding.

For the remaining Interaction variables, reliability was 100%. We noted whether there was continuous background music, and whether the player had control over that music. We noted whether it was necessary to use a keyboard, a mouse, or both simultaneously, and whether quick reflex actions were required. We coded whether it was possible to customize keystroke commands. In some games, players could select a difficulty level.

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). First we looked at back story. 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%. We again resorted to consensus to code them. We coded where the game takes place: either our solar system, our galaxy, an imaginary solar system, or an imaginary galaxy. There was some disagreement – how do you know that is our moon and not some other moon? We decided to assume it was our solar system or galaxy unless some aspect (planet or star names or features) made it obvious it was NOT based on our real galaxy.

We coded whether, in the game, humans live in space and/or on other planets. (If they travel in space we assume they live in space. If the game does not show or mention or imply humans living on other planets, we assume they do not.) We coded whether there were aliens in the game, and, if so, how many different species of alien appear 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). We adopted coding categories of 0, 1, 2, 3-10, 11-50, and more than 50 species of aliens in the game.

#### 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." Perhaps because we are interested in learning and gender issues, we noticed the list left out at least two particularly relevant forms of fun. 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 seemed to address the pleasure of helping or taking care of others. Altruism might including 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. Adding these will help us to mitigate possible gender bias in the Garneau scale. Initially we coded the 16 forms of fun as 1 (non-existent), 2 (moderate), and 3 (extensive) and we used Garneau's article as the basis of the definitions of forms of fun. The definitions 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. (We defined social interaction 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." (We interpreted this to mean more than mouse or keyboard movement. Therefore none of our 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 we coded games with creation as a main gameplay feature – games which focus more on creation than destruction.

**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." We stuck with Garneau's focus on physical abilities such as hand-to-eye coordination and quick reflex actions in a challenging situation.

We added two more forms of fun:

**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, we redefined the coding values. Each form of fun was instead coded as being present not at all, a little, or a lot. This resulted in far worse reliability! 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. We returned to the original three categories (non-existent, moderate, and extensive) and we used the consensus method among the three first authors to arrive at ratings of forms of fun for each game.

### Space Pioneer Survey Data

42 fifth and eighth grade girls and boys working in gender-isolated groups of 5 or 6 played three of the educational space games (Great Solar System Rescue, Space Academy GX, and Liftoff) and one commercial space game (Galactic Civilizations) as part of the 2 week Space Pioneer Learning Adventures camp. After each game play experience, kids completed a one page "reflections" survey assessing interesting things they learned, how fun the experience was, career expectations related to some aspect of the game, how important three motivations for exploring space related to the game were to them, and how well they felt they could learn from games like this. Their reactions to the games will be compared.

## RESULTS

### Target Audience

The intended market for a game imposes practical and technical design constraints. Hypothetically there could be an educational game targeted for adults, but the market for adult educational games does not appear lucrative enough for companies to pursue. In practice, the commercial game closest to adult education was Sim Earth, and it has been discontinued. Kids under 13 are not primary consumers. Almost always an intermediary (parent or school) makes the actual purchase of a digital game for kids. Two of the four educational games (Solar System Rescue and Space Academy) sell primarily to school markets. Liftoff and Magic Bus target both teachers and parents. All four were aimed at younger than high school kids.

None of the commercial software targeted pre teens. One 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 ( $p=.02$ )

All educational games included either online or printed teacher's guides and most provided links to State or National Science Learning Standards. For one commercial game (Sim Earth) we did locate a reference to an obsolete web site which mentioned a teachers guide and educational version. The version we coded (and the only one we could find for sale) appear to be a consumer version and contained no reference to an educational version.

The average cost of educational games (\$41.46) is not much different than the average cost of commercial games (\$39.58).

### INSTALLATION AND SYSTEM REQUIREMENTS

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. 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 20 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).

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.

### PLAY TIME

Educational games take less time to play than commercial games. 100% of 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 less than three hours; half of the commercial games take 3 to 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. 50 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

One out of four educational games include a tutorial, compared to 75% of commercial games. ( $p=.39$ ) Likewise only one out of four educational games include a manual, compared to 100% of commercial games. ( $p=.01$ ) Not surprisingly, it is not necessary to use a manual to play any of the educational games. It is necessary to use a manual to play 63% of commercial games. ( $p=.04$ )

When there is a manual it is likely to be a long one. The one educational game which uses a manual involved lots of pages, as did 88% of commercial game manuals. ( $p=.71$ ) Almost all manuals are both electronic and print.

All educational games and 88% of commercial games had a company web site about the game. ( $p=.46$ ) All educational games and all commercial games had inspired enthusiasts who constructed their own web site about the game. The player-constructed sites for commercial games include crucial tips on how to play better. Player-constructed sites for educational games talk about how to teach with the game.

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 we 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 adverse to learning, though perhaps they are adverse to learning about the real world? The shorter educational games fit better into short class periods. But the shorter length also reflect and require lack of complexity of game play in educational games.

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.

#### LEARNING TO PLAY ANECDOTE

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. The anecdote below was recorded by our female coder while she was learning to play Dark Space.

*I finally managed to enter the game (it took a while to locate the instructions for how to enter the game on the website). Switching back and forth between website instructions and the game, I figured out that I have to orbit a planet before I can manage it. (This explains my numerous previous frustrating failures.) Following instructions, I located diamond dots on the planets representing constructions. Experimentally, I clicked around my tool panel, and one button, "scrap," reacted to the diamond dots. Overwhelmed by my big discovery, I worked hard to scrap every unit I saw.*

*On the left-top is the chat channel which auto-scrolls as players add new messages. The chat window cannot be turned off. Obviously, some players were confused and mad about something happening to their planets.*

A: Stop it!

A: Who's messing up [planet name]?! Stop that!

B: What's up A?

A: Someone screwed up my planet! Find the fool and kill him!

*Some people respond with 'lol.' A while later...*

A: Don't scrap my [construction unit]! Stooooooooooooooooooooooooooooopp I say!

*At this point I realized the scrapping they were mad about was my doing because I had just clicked on the [construction unit] A mentioned and then I had clicked scrap. I stopped in a panic. I wanted to explain so I experimented with buttons that looked like communication functions. One yellow button looked promising. I clicked it and the game sent an automatic message to the chat window: "Distress: [my name] needs supplies!" OK, that was at least communicating, but not the apology I wanted to send. I tried the next button, which sent out: "Distress: [my name] is under attack!"*

X: (Noticing the distress message) Ha! That's him.  
 (I am not sure if this is the same guy as A in the previous exchange)

Y: Who?

X: The one who screwed up my planet. Don't help him.

Y: Yeh, let him die.

...

*A little while later I saw some flashing lights followed by the message: "Your ship has been destroyed."*

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 our 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
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 and 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. ( $p=.01$ ) As we saw in the Learning to Play Anecdote, the content of chat may be friendly or hostile, among teammates, cooperating factions, or opponents.

### AVATARS and SUTRADHARS

All of the educational games and all but one of the commercial games included an avatar (some form of representation of the player). ( $p=.46$ ) Since commercial games are said to be designed by males for males, one might expect to find predominantly male avatars and sutradhars (Non-Player Characters who advance the action by giving instructions, narrating, or relating a part of the story) in commercial games. One might expect that more politically correct educational games would use more female avatars and sutradhars. This is not what we found.

In one of four educational games, the default avatar is male, and in three fourths of educational games the default avatar or avatars are both male and female. In commercial games, 29% have a default male avatars, 58% are both male and female and 14% are of indiscernible gender. ( $p=.70$ ) Fewer than one third of commercial and educational games default to a male avatar. No significant difference was found in the gender of educational and commercial game avatars.

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 sutradhar. One of the four educational games had a single sutradhar, one used two sutradhars, and two used 5 sutradhars.

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

None of the educational games or commercial games used exclusively male sutradhars. One educational game used female sutradhars, one used robots, and two used both male and female sutradhars. Among commercial games which do include a sutradhar, 80% are a mix of males and females and 20% are robots. (p=.46) No sutradhars were children. Our coding system was not detailed enough to identify the proportion of male to female sutradhars.

## INTERACTION

Commercial space games tend to make more use of background music than educational games do, although the difference is not statistically significant. 25% of educational games and 75% of commercial games use continuous background music. (p=.10). In every game featuring background music, the user can control the music.

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, with no keyboard interaction. 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 players to select either voice or text.

25% 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 our solar system. Only one fourth of commercial games take place in our 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. ( $p=.03$ )

We cannot conclude from these difference commercial games are more fun, but we can conclude commercial games are fun in more different ways.

Tables 3 and 4 reveal which forms of fun appear in each of our 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 we 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 of 16 Forms of Fun, by Game and Type of Game Part I

	immersion	discovery	advance	thrill	intellect	competition	power	social interaction
Dark Space								
Galactic Civilization								
Earth and Beyond								
Sim Earth								
Starcraft								
Star Wars								
Moonbase Commander								
Masters of Orion								
Solar System Rescue								
Liftoff								
Space Academy								
Magic Bus								
overall	100%	92%	67%	67%	58%	58%	58%	50%
educational	100%	100%	25%	25%	75%	0%	0%	25%
commercial	100%	88%	88%	88%	50%	88%	88%	75%

All of our 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.

Table 4 continues the list with less common forms of fun. All educational games and only one commercial game offer extensive fun of LEARNING: increasing your understanding of or knowledge about the real world.

Table 4: Intensity of 16 Forms of Fun, by Game and Type of Game Part II

	learning	altruism	beauty	ability	creation	love	comedy	physical activity
Dark Space								
Galactic Civilization								
Earth and Beyond								
Sim Earth								
Starcraft								
Star Wars								
Moonbase Commander								
Masters of Orion								
Solar System Rescue								
Liftoff								
Space Academy								
Magic Bus								
overall	42%	42%	25%	17%	8%	8%	0%	0%
educational	100%	25%	0%	0%	0%	0%	0%	0%
commercial	13%	50%	38%	25%	13%	13%	0%	0%

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 our 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 a 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 our commercial or academic games involved the fun of PHYSICAL ACTIVITY.

Table 5 shows forms of fun sorted from the most to least predominant forms of fun in educational games (the average score of 3 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.

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.

Table 5: Forms of Fun Sorted by Their Predominance in Educational Space Games

	<b>Educational</b>	Commercial	p
<b>Learning</b>	3.0	1.9	.00
Immersion	3.0	3.0	1.0
Discovery	2.9	3.0	.14
Problem Solving	2.8	2.5	.41
Advancement	2.25	2.9	.07
Altruism	2.0	2.3	.46
Beauty	2.0	2.3	.22
Comedy	1.75	1.38	.22
<b>Competition</b>	1.5	2.75	.01
Social Interaction	1.5	2.6	.09
<b>Thrill of Danger</b>	1.5	2.75	.03
Love	1.25	1.5	.76
Physical Activity	1	1	1.0
<b>Creation</b>	1	2.1	.00
<b>Power</b>	1	2.75	.00
Application of ability	1	1.88	.12

Table 6 presents the same data, sorted by predominance of forms of fun in commercial space games. 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 we find altruism, beauty, creation, learning, and application of a new physical ability. Almost nonexistent forms of fun in commercial space games are love, comedy, and physical activity.

Table 6: Forms of Fun Sorted by Their Predominance in Commercial Space Games

	Educational	Commercial	p
Immersion	3.0	3.0	1.0
Discovery	2.9	3.0	.14
Advancement	2.25	2.9	.07
<b>Competition</b>	1.5	2.75	.01
<b>Thrill of Danger</b>	1.5	2.75	.03
<b>Power</b>	1	2.75	.00
Social Interaction	1.5	2.6	.09
Problem Solving	2.8	2.5	.41
Altruism	2.0	2.3	.46
Beauty	2.0	2.3	.22
<b>Creation</b>	1	2.1	.00
<b>Learning</b>	3.0	1.9	.00
Application of ability	1	1.88	.12
Love	1.25	1.5	.76
Comedy	1.75	1.38	.22
Physical Activity	1	1	1.0

GENDER ORIENTATION

As part of the qualitative content analysis of the games, our coders reflected on perceived gender orientation of each game. Reflections on the four games we ultimately categorized as educational indicated no apparent gender bias. Here are their comments:

**Great Solar System Rescue**

*There is no obvious gender orientation in the game. The computer assistant who gives instructions to the team at each stage and guides them through the game play has a male voice. There are several female, male, and can't-tell-gender voices representing the computer systems of the probes the team locates. But they don't seem to have a specific gender because they're computer operating systems.*

**Space Academy**

*Gender orientation of the game is not apparent. There are equal number crew members in gender: 2 male 2 female. There is a female voice throughout the game.*

**Liftoff**

*Assuming the same degree of interest in space science in both genders, there is no gender orientation of the game. In the Space Camp promo video, a female (wearing a standard NASA light blue flight suit) hosts the video. When first starting the game, the player is greeted by a female narrator. In the intro movie a male introduces the training program*

*and gives the player the goal of the game. In Launch Simulator there are 3 voice narrators, 2 male 1 female. The training supervisor who gives briefings and judges your actions for accuracy is male.*

### **Magic Bus**

*The game looked gender-neutral. There are four kids (two girls and two boys) and the class teacher is a woman. Throughout the game many different characters interact with the player by voice.*

The commercial games were less male-biased than we would have predicted, though more biased than we might hope. Consistent with the quantitative content analysis, there was always a mix of male and female characters, although the female characters were less frequent and sometimes appeared in stereotypical ways. If there was a strong male bias in the commercial space games, it was due to the nature of the game activities and game play (combat and violence). Coder reflections on gender bias in the commercial games are reported below.

### **Galactic Civilization**

*There's a male narrator in the intro animation. The head of scientists appears to be male. He appears when the player assigns the ships to move to a location that's out of range. The communications operator is an alien female. The player can choose governors for the colonies. The portrait of the governors are mostly male, although there are four types of governor to be chosen from (Mr. X, Ms. Y, Dr. Z and Gen. A)*

### **Dark Space**

*This game is not girl-friendly. 1.) One dies a lot and has to start over each time; 2.) There is lots of direct conflict among players, even among those in the same team; 3.) The environment feels hostile environment because a big portion of content is formed by other players. Compared to games with more NPC game-characters and fewer human player-characters, interaction with other humans requires a higher level of delicateness. For a newbie messing around to get to know the interface, it is easy to violate other players' interests and arouse hostility. 4.) Competition is aggressive; 5.) The almost non-existent storyline makes it boring to play.*

### **Earth and Beyond**

*Megan, the computer assistant, guide, and narrator, is female. There is an approximately equal gender ratio of NPCs. Among player characters to choose from, there are somewhat more male than female characters (approximately 3:2 males to females), however females are not uncommon.*

### **Masters of Orion**

*The game is definitely more oriented towards the male, because although there are elements like exploration the player does engage in a lot of strategizing about and engaging in battles. The narrator is only in the start of the game for the introduction animation, which is a male voice. Female have been given roles of leaders of empires like males and they could be either enemies or allies depending on the state of the game and there is no difference in terms of their capabilities as foes or friends.*

**Moonbase Commander**

*The game is biased a little towards male orientation, with the underlying principle of the game being that of war. However it also has an exploration aspect. There are both male and female narrators. The tone of voice in case of the male is authoritative and the female voice speaks more like making a request at times even hinting apology.*

**Sim Earth**

*There seems to be no gender orientation. Interest in earth science is probably a better predictor of enjoyment of this game than gender.*

**Star Craft**

*The gender orientation is definitely biased towards males. Most narrators are male. There are two characters with female voices; one is part cyborg and part human the other is a female commander. The only difference with female characters is that they are shown in a different colored clothing. The game has a lot of violence, is completely based on war with no element of managing resources to develop your colony.*

**Star Wars Galaxies**

*For a game of this genre, Star Wars Galaxies is quite female-friendly. Gender has no impact on a players' character's starting attributes, although it does affect their character's maximum and minimum height choices (for all 8 alien species females are a bit shorter) and changes some of the available customization options. Although combat is a pervasive activity, there are other roles such as entertainer and artisan. Genders of the characters are chosen by the players. I noticed a large number of female players (perhaps as high as half) during my hour of play. Player versus player combat is not enabled by default – players must actively choose to participate and make themselves vulnerable to attacks by other players.*

A male orientation in commercial space games derived from violence and war themes much more than from representation of male and female avatars and sutradhars in the games.

**FUN SURVEY DATA**

As part of our 2 week Space Pioneer Learning Adventures game design camp and research project, 42 fifth and eighth grade girls and boys in gender- and age-isolated groups of 5 or 6 played three of the educational space games (Great Solar System Rescue, Space Academy GX, and Liftoff) and one commercial space game (Galactic Civilizations) on different days for about 45 minutes per game. After each game play experience, kids completed a one page “reflections” survey assessing (among other things) how fun the experience was, whether they would like to play it again, and how strongly there were concentrating while they played. This small portion of our massive data set is reported here, to begin to consider the relationship between content analysis of forms of fun with perceived fun experienced by kids of different ages and genders. Overall results are reported first, followed by breakdowns of 8<sup>th</sup> and 5<sup>th</sup> grade boys and girls.

Table 7: Overall Average Ratings for Fun, Play Again, and Concentration (n=33 to 41)

	n	Fun	Play Again?	Concentration
Great Solar System Rescue	41	4.1	1.4	4.4
Liftoff	33	3.9	1.7	4.3
Space Academy GX	41	3.9	1.7	4.1
Galactic Civilizations	34	3.6	1.7	4.0
		5=very fun, 1=not fun at all	1=I would like to; 2= I might like to; 3=I would NOT like to	5=all the time; 1=not at all

Contrary to what one might predict based on the quantitative analysis of forms of fun which found commercial games to include significantly more forms of fun than educational games, the only commercial space game played at camp (Galactic Civilizations) had the lowest or was tied for the lowest rating on all three measures of fun, compared to the three educational games. According to the graduate student game coders, Galactic Civilization (and most other commercial games) does not become fun until you know what you are doing, often after 10 or more hours of learning to play. The data reported here are based on the first 45 minutes of play, which may be a reasonable parallel to the fun of educational games designed to be played during a single class session at school, but not a very accurate parallel to the fun of a commercial game played at home for many hours over days, weeks, or months.

On average the four games were quite similar. Galactic Civilization was rated least fun, but the range between least fun and most fun was small – 3.6 for the least fun and 4.1 for the most fun, on a scale where 5 is very fun and 1 is not fun at all. Great Solar System Rescue was the game kids would most like to play again. Concentration was quite high and not very different across the games, ranging from 4 to 4.4 on a 1 to 5 scale where 5 is totally concentrating on the game the entire time and 1 is not concentrating at all.

Examining age and gender subgroups, this homogeneity of average responses turns out to be masking large age and gender variations in the experience of fun across the four games. In fact, Galactic Civilizations was one subgroup’s favorite game. Many other differences emerge. Age, gender, context, and duration of play likely all impact the experience of fun.

Table 8: 8<sup>th</sup> Grade Boys Average Ratings for Fun, Play Again, and Concentration (n=7 to 11)

	n	Fun	Play Again?	Concentration
Great Solar System Rescue	11	3.2	1.7	3.6
Liftoff	8	3.6	2	4.8
Space Academy GX	11	3.3	1.8	3.5
Galactic Civilizations	7	3.6	1.4	4.9
		5=very fun, 1=not fun at all	1=I would like to; 2= I might like to; 3=I would NOT like to	5=all the time; 1=not at all

The 8<sup>th</sup> grade boys rating of fun had the smallest range (from 3.2 to 3.6) and their fun ratings were almost always lowest compared to the other three groups of kids. The games 8<sup>th</sup> grade boys reported to be most fun were Liftoff and Galactic Civilizations. However they are most interested in playing Galactic Civilizations again (the only commercial title) and least interested in playing Liftoff again. 8<sup>th</sup> grade boys concentrate much more when playing the games they find more fun (Galactic Civilizations and Liftoff); for the other two games their concentration was low.

Table 9: 5<sup>th</sup> Grade Boys Average Ratings for Fun, Play Again, and Concentration (n=3 to 10)

	n	Fun	Play Again?	Concentration
Great Solar System Rescue	9	3.9	1.2	4.9
Liftoff	3	3.8	2.3	4.3
Space Academy GX	10	3.8	1.8	3.8
Galactic Civilizations	10	3.1	2	3.6
		5=very fun, 1=not fun at all	1=I would like to; 2= I might like to; 3=I would NOT like to	5=all the time; 1=not at all

Fifth grade boys had higher fun rating than 8<sup>th</sup> grade boys on every game except Galactic Civilizations which was their least favorite game. They concentrated most on the Great Solar System Rescue and were most interested in playing it again. (One of the 5 person groups of 5<sup>th</sup> graders did not complete a reflections survey after playing Liftoff. Thus those data are very unreliable, based on only 3 cases.)

Table 10: 8<sup>th</sup> Grade Girls Average Ratings for Fun, Play Again, and Concentration (n=8 to 10)

	n	Fun	Play Again?	Concentration
Great Solar System Rescue	10	4.3	1.3	4.9
Liftoff	9	4.4	1.2	4.6
Space Academy GX	10	3.7	1.7	4.4
Galactic Civilizations	8	3.6	1.6	4.4
		5=very fun, 1=not fun at all	1=I would like to; 2= I might like to; 3=I would NOT like to	5=all the time; 1=not at all

8<sup>th</sup> grade girls’ favorite titles measured by fun and willingness to play again were Liftoff and The Great Solar System Rescue. They had the least fun with Galactic Civilizations and Space Academy and were less interested in playing them again. Overall their concentration was high and they reported higher fun ratings than either group of boys.

Table 11: 5<sup>th</sup> Grade Girls Average Ratings for Fun, Play Again, and Concentration (n=9 to 10)

	n	Fun	Play Again?	Concentration
Great Solar System Rescue	10	4.9	1.1	4.3
Liftoff	10	3.9	1.7	3.8
Space Academy GX	10	4.8	1.3	4.8
Galactic Civilizations	9	4	1.6	3.6
		5=very fun, 1=not fun at all	1=I would like to; 2= I might like to; 3=I would NOT like to	5=all the time; 1=not at all

5<sup>th</sup> grade girls’ had the highest fun ratings of any age and grade. Their favorite titles, in terms of fun and interest in playing again, were The Great Solar System Rescue and Space Academy GX. 5<sup>th</sup> grade girl favorite titles were also the games closest to age appropriate for 5<sup>th</sup> graders. Their least favorite titles were Liftoff and Galactic Civilizations.

### CONCLUSIONS AND RECOMMENDATIONS

The 12 games we 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 we analyzed are not necessarily good games. Some were considered fun by our graduate student coders and some were not fun. The educational space games we analyzed are not bad games. In fact, The Great Solar System Rescue is

well loved by teachers, was found to be very fun by three of our four groups of kids, and was considered fun by both coders. Liftoff is a new educational game created by a commercial entertainment game company, receiving positive reviews by teachers and also was enjoyed by our 8<sup>th</sup> grade kids and our coders. After reviewing all twelve games we ourselves chose three of the educational games to include in Space Pioneer Learning Adventures camp. We 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 we 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 kids 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. Kids 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.

Our data of kids' ratings of fun of four of the games in the study remind us of the complexity of creating a fun game. 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. Our 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 our woefully science-ignorant adult population by doing a better job of accuracy of science when it 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. 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.

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