GENDER-ORIENTED VS. GENDER-NEUTRAL COMPUTER GAMES IN EDUCATION

DISSERTATION

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By

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ABSTRACT

The purpose of this study was to examine student preferences for and performance on gender-oriented versus gender-neutral educational computer games. As a secondary purpose, this looked at the issue of whether educational computer games affect girls' and boys' perceptions of the study of mathematics and the relevance of mathematics to their lives.

Some theorists have stated that gender-neutral educational media do not have the same appeal to students as gender-oriented media. This study sought to answer the specific question of whether students preferred using gender-neutral or gender-oriented computer games related to the subject of math.

A descriptive-correlational research design combined with a qualitative research data-collection approach was used. Data included pre-game-playing and post-game-playing interviews, performance data based on computer game scores, and the researcher's observations. The study was conducted in the spring of 2003 with the two fourth-grade classes at a Midwestern public elementary school.

Study participants were asked to play three specific computer games: a female-oriented game, a male-oriented game, and a gender-neutral game. The gender orientation of the three games had been determined by the researcher based on an in-depth study of the body of relevant literature on gender-related characteristics of video and computer games.

The findings showed that participants, both the girls and the boys, identified Mind Twister Math, the gender-neutral game as their favorite game. When participants were asked to name their second favorite game, their responses were along gender lines, i.e., the girls chose Phoenix Quest, the female-oriented game as their second favorite, while the boys chose NFL Math, the male-oriented game, as their second favorite. Findings indicated that boys scored higher on all three computer games; however, with repeated sessions of play, the girls' scores increased significantly and the girls' final scores were drawing close to the boys' final scores.

The study also found that both girls and boys believed the subject of math was relevant to their daily lives both before and after the game-playing. Game-playing significantly affected the girls' and boys' perceptions of liking or disliking the subject of mathematics. The study concludes that math-related educational computer games that are gender-neutral in orientation can appeal to both girls and boys and can positively affect their perceptions of the subject of mathematics.

Dedicated to my family, especially my parents, brothers, and sisters

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CHAPTER 1

INTRODUCTION TO THE STUDY

By the 1980s, electronic games had assumed a prominent role in the culture of American children. Acknowledging the popularity of the electronic games, educators began considering classroom applications for these computer and video games. Educators discovered that electronic games can fit into the educational environment in a variety of ways, ranging from creating total-learning systems to serving as components in a more traditional learning environment. Educational games that offer total-learning environments can include games that introduce students to a specific foreign language; the games teach students basic vocabulary and grammar, allow students to move at their own pace, offer electronic conversation partners, and include tests, re-tests, and feedback. The games used as components in more traditional classroom settings-- which currently account for the predominant use of computer games in education--are tools used to add realism and depth to discussions, as well as to give support to the teacher. Examples of these include games that offer multiplication drills or games that reinforce classroom government studies by taking students on a virtual-reality tour of the nation's capital.

According to Tzeng (1999), computer games are an effective classroom strategy to amplify motivation and cognition. Tzeng writes that the educational benefits from the use of computer games include: the games typically elicit complete mental involvement from participants; the games have concrete goals and rules that help focus attention and direct action; the games typically require a high degree of player interaction and provide immediate feedback; well-designed games often incorporate variable levels of challenge to keep players involved as their skills increase; games that enhance recall and transfer of knowledge; the mental imagery evoked by game environments or “worlds” facilitate the retention of educational materials embedded in the game; and well-designed games are fun to play.

But the use of computer games in education also has been criticized, primarily on the basis of gender issues. Kafai (1996) writes that computer games typically have been designed by males for use by other males. Kafai adds that female characters are rarely cast in major roles in these male-oriented computer games. By the early 1990s, a number of educational researchers began investigating the elements of computer games in an effort to determine which game characteristics appeal to girls and which game characteristics appeal to boys. Educational software designers have begun using this information to develop computer games that might have appeal to both genders.

The purpose of this study was to investigate gender preferences in educational computer games related to the subject of mathematics as perceived by fourth-grade students. A second purpose of this study was to investigate gender performance on the computer games by comparing girls’ and boys’ scores on the female-oriented, male-oriented, and gender-neutral computer games.

Defining Electronic Games

Dempsey (1996) defines a game as a set of activities involving one or more players. The players are governed by the rules of the game. For Gredler (1994), a game is any contest or play in which the players operate under certain constraints or rules for the objective of wining or some sort of pay-off. It is important to remember, continues Gredler, that any game is a fantasy world, defined by its particular sets of rules that are not replications of real life, and efforts to win are within those rules.

Electronic games are games displayed on a television screen (video games) or on a monitor using a console or a personal computer (computer games). Computer games often are distributed on CD-ROMs, as well as over the Internet. The newer models of consoles come with stunning 3-D graphics, high-speed processing, and sophisticated audio capabilities which deliver an impressive and compelling gaming experience. With its powerful design, tools, and flexible architecture, the new Microsoft console known as the Xbox allows game designers and programmers to produce visually stunning and highly entertaining video games. The Xbox takes the concept of interactivity, control, and imagination to a new level that pushes the boundaries of the earlier theoretical framework around text, media and narrative.

In schools, electronic games most often are accessed as computer games. Because this dissertation was concerned with the educational use of electronic games, the term computer games was frequently employed. It should be noted, however, that most computer games also can be accessed as video games; the reverse also is true.

Computer games often are classified into six major categories: (1) educational games; (2) games of action, adventure, or fantasy violence; (3) games that include fighting or human violence; (4) sports; (5) strategy games including puzzle, chess, blackjack, and backgammon; and (6) simulations, which are problem-based units of learning that are set in motion by a particular task (Gredler, 1992, p. 16). Many games often fit into more than one category.

According to Gredler, participants in simulation games carry out functions associated with their roles and the settings in which they find themselves. The outcomes of simulations are not determined by luck or chance but by the actions of the participants. As an example of a simulation, Gredler cites a virtual-reality dig by students. Simulations allow the student "archeological teams" to feel as though they are sifting through soil and analyzing discovered fragments. The goal is to determine the nature of the ancient civilization that left the artifacts.

As Kafai (1996) notes, the categories of computer games are by no means exhaustive or exclusive. Many games fall into several categories at the same time. For example, an adventure game in which pirates chase merchant ships across the seas could also be designed to be an educational game on the subject of geography.

There are many elements in computer games that can make the games unique and distinct from other media. These elements can include: interaction; level of activity; visual and audio themes and/or effects; the presence of a goal; and realism. A combination of these elements can make computer games exciting, fun, and addictive.

Interactivity is a vital element in which the gamer interacts with a computer game. Through physical movements, gamers try to control the characters on the computer screen. The interaction can lead to a strong relationship between the gamer and the computer-game characters. Some gamers get so involved in the action of the game that they get scream or become upset.

Computer games can engage the gamer psychologically and emotionally. In addition, cognitive and personal skills are reflected in the characters of the game that a gamer is playing. In other words, the success or failure of a character in a computer game can be completely dependent on the skills and performance of the gamer.

From the Arcade to the Classroom: A Brief History of Electronic Games

Electronic games came into use during the late 1960s as the off-hours recreation of computer engineers who played games among themselves on computers. Hand-held electronic games and other video games began appearing in the early 1970s. Coin-operated games, first released in the mid-1970s, had displaced the earlier pinball games in popularity by the 1980s. The new games were played, as pinball games had been, in drinking establishments, transportation centers, and amusement arcades. Most of the manufacturing industry for the games was located in the United States and Japan.

Electronic games soon became a preferred leisure activity of children—and many adults. Around the world, video and computer games have become a popular form of entertainment. In the early 1990s, the Internet opened up a new avenue for electronic game-playing; children and adults could play their favorite games on-line, choosing from such titles as PacMan, Mortal Kombat, and Star Trek. The primary differences between the “old” and “new” generation of electronic games are in the complexity of interactions, thematic embedding, and narration (Kafai, 1995).

Recently, a new dimension of realism, 3-Dimension Live Motion Capture (3DLMC), has been introduced in electronic games. In 3DLMC, game producers are able to capture real physical movements of real players. For example, with the virtual reality of 3DLMC, gamers can have a real sense of being on the court or on the playing-field with their sport heroes.

Most of the major manufacturers of commercial computer games have adopted the Entertainment Software Rating Board (ESRB) system. This rating system was implemented in September 1994. ESRB ratings appear on the packages of products sold in the United States and Canada. Games are classified into five age-based categories based on the games' levels of sex, nudity, violence, and strong language.

The ESRB ratings are designed to give consumers information about the content of an interactive video or computer entertainment title and for which age group the title is appropriate. The ESRB ratings are not meant to inform consumers what to buy or rent or to serve as the only basis for choosing a product. Rather, consumers should consider the ESRB ratings in conjunction with their own tastes and standards when purchasing or renting a video game.

As computer games moved into the classroom, it became necessary to make some distinctions between commercial computer games and educational computer games. Gredler (1992, p. 170) writes that the primary differences are: (1) educational games require the application of curriculum-based knowledge and skills; (2) educational games eliminate luck or chance as a basis for winning or reaching a goal; and (3) educational games focus on teams and cooperation rather than individual competition.

Ito (1998) writes that the question of educational value and video games is generally framed around a model of intentional learning versus incidental learning. Educational video games differ from commercial video games in terms of purpose, content, and concept of winning. The educational games require specific knowledge tied to school-like subject matter or particular course content. Educational video games can be suitable for any subject and for any learning setting that addresses intellectual skills. The scope of learning activities involved in classroom video games is limited by the knowledge and/or skills demonstrated by players.

According to Gredler (1992, p.28), educational video games can be used for any of four general academic purposes: (1) to practice or refine knowledge or skills already acquired; (2) to identify gaps or weaknesses in knowledge or skills; (3) to serve as a summation or review—for example, before a major test; and (4) to develop new relationships among concepts or principles. These purposes, continues Gredler, are not necessarily independent; an educational video game might serve as a review while also developing new relationships among concept.

Discussions of the possible effects of computer games on children's affective, social, and cognitive well-being have engendered much controversy. Some studies suggest the nature of computer games leads to aggression and sexism, while other studies have looked to the potential benefits of game playing, suggesting that computer games can be a boon for education. A number of researchers have questioned whether, due to the nature of computer games, such games can appeal equally to girls and to boys and whether girls and boys can receive equal educational benefit from the games.

As noted by Hart (1996-97), it is readily apparent to any researcher that the majority of characters in the commercial computer-game universe are male and that the majority of the games are specifically designed to appeal to boys. A 1989 *Newsweek* article described commercial electronic games as speaking to "something primal and powerful in (the boys') bloody-minded little psyches, the warrior instinct that in another culture would have sent them out on the hunt or on the warpath" (March 6, 1989, p. 67).

Researchers at the University of British Columbia have designed computer games for mathematics education in grades 4 to 8 (Klawe, 1999). The interactive games included exploration, puzzles, challenges, scoring, and graphics, as well as music and other sound effects. The game designers paid particular attention to gender issues in order to develop games that would appeal to both girls and boys. Klawe, the lead researcher, writes:

> Our field studies have repeatedly revealed gender differences in students' use of and attitudes toward interactive multimedia learning activities. Girls and boys have shown different preferences and levels of performance in activities and interactive styles. Girls often spend more time exploring and communicating with partners, while boys often make faster progress through the activities, completing more levels and puzzles. Despite completing more puzzles and levels, boys have not shown greater achievement in the assessments of mathematical understanding. During classroom observations, boys have been more aggressive in seeking or demanding access to computers and in their behavior while engaged in the activities, but minor interventions, such as occasional girl-only play or discussions have resulted in enthusiastic and sustained engagement of the girls with the prototype software (Klawe, 1999, p. 3).

Purpose of the Study

The growing popularity of computer games in the classroom has raised issues of gender equity. Traditionally, commercial computer games had been designed by males for use by other males. As educators took note that the same gender bias had made its way into educational games, educational software developers began designing games specifically oriented toward girls, as well as games termed gender-neutral that were intended to appeal to both girls and boys. But some theorists (e.g., Graner Ray) have argued that because there are no gender-neutral people, gender-neutral games appeal to no one.

This study was an attempt to examine student preferences for and performance on gender-oriented versus gender-neutral educational computer games. This study also attempted to answer the specific question of whether an educational computer game could, at the same time, make math interesting to students and be gender-neutral in its orientation.

Researchers such as Sedighian and Sedighian (1996) have noted that students often find mathematics boring and irrelevant to their lives. As a secondary purpose, this study looked at the issue of whether educational computer games can affect girls' and boys' perceptions of the study of mathematics and the subject's relevance to their lives.

More empirical data is needed on girls' and boys' perceptions of gender-neutral computer games. In addition, more empirical data is needed on the affect of educational computer games on girls' and boys' perception of the subject of mathematics.

To that end, this researcher's study was an attempt to answer the following research questions:

1. Are games' gender classifications consistent with students' preferences?

2. How do participants perform on the three computer games?

3. Do participants report positive and/or negative reactions to specific game imagery, game format, or other game aspects?

4. Do participants perceive the games as being oriented toward certain players?

5. Do participants perceive the subject of math to be relevant to their daily lives?

6. Does playing computer games affect students' perception of the subject of math (i.e., do students report liking math more after playing the games)?

Significance of the Study

This study is significant because it adds to the literature on gender issues in educational theory and practice and to the literature on motivational factors in the study of mathematics. Computer technologies, including educational computer games, have been in a period of rapid transition and continue to undergo changes. In addition to affecting the sophistication and interactivity of computer games, these transitions (including the introduction of computer games with a female-orientation) are affecting who plays the games. More and more girls are becoming active game-players. This study is significant because it examines student perceptions within a specific timeframe. This study may find that student attitudes toward computer games have changed along with the technology.

Basic Assumptions

A number of assumptions provide a basis for the study. Those assumptions are:

Students involved in this study have had exposure to computers through their own personal and/or educational experiences.

Students will perform to the best of their abilities despite any preferences for or against any particular computer game.

Technical information about computer games, their software and/or hardware, such as the type or make of the computer, computer capacities, and cost are topics that are coincidental to the main theme of the study.

The specific pre-selected computer games might not persist. Computer games might be discontinued or replaced by better or updated version; however, the methodology of designing an instructional game needs to be investigated, particularly within the constructivism context.

Gamers and participants in this study will provide honest responses to the items on the survey and/or questionnaire.

Delimitations

The following were the delimitations of the study:

1. The results may vary depending upon the content of the computer game and the interaction with other members in the groups, as well as familiarity with the computer game.
2. The study used specific software carefully chosen to optimize the gender orientation or gender neutrality of the computer game. However, other software choices could have led to different results.
3. This study might not be generalizable to other population groups or age groups in the same or other schools.
4. Findings from this study might not be generalizable to other studies.

5. It is possible students reacted indifferently to the activities of this researcher since their performance did not affect their grades.

Theoretical Perspective

Computer technologies have the potential to help students construct and produce their own personal knowledge, writes Kurubacak (1997). By employing constructivist principles, video and computer games can become tools through which students construct their own knowledge—instead of memorizing the knowledge of their teachers. One of the leaders in the field of education s D.H. Jonassen who favors a situated-learning paradigm that has as its basis in constructivism (1991).

Jonassen criticizes symbolic learning for reducing the learner to a 'sponge.' In symbolic learning, the teacher typically imparts knowledge to the learners to absorb it. The learner's role is to remember and reproduce the knowledge that is transmitted by the teacher. According to Jonassen, symbolic learning is abstract, product-oriented, and objectivist. Situated learning, on the other hand, is authentic, process-oriented, and constructivist.

In constructivism, knowledge is a function of how the individual creates meaning from her or his experiences and not a function of what someone else says is true. Based upon our unique experiences, each of us conceives of external reality somewhat differently. Constructivist teachers want to engage learners so that the knowledge learners create is not inert but usable in new and different situations. Constructivist teachers embed learning in real-life situations in which learners function as part of a community trying to solve real-world problems.

Jonassen (1995) adds that the basic principles guiding the constructivist learning environment are context, construction, collaboration, and conversation. Jonassen writes that the constructivist learning environment: emerges from authentic tasks; engages the learners in meaningful, problem-based thinking; and requires negotiation of meaning and reflection on what has been learned. Computer-mediated communication and a computer-based intentional learning environments—including video games—can support constructivist learning, notes Jonassen (1995).

Methodology

Population and Sample. The target population for this study was the two fourth-grade classes at a Midwestern elementary public school in Columbus, Ohio. The school serves a population that ranges in economic status from low-income to moderate-income. The majority of students in both fourth-grade classes were African-Americans.

There were five available computers in the school library, so five participants played a game during each session. Participants were grouped in sessions according to gender (girls played in groups of five, and boys played in groups of five).

Research Design. In this study, the fourth-grader students were asked to play three computer games related to the study of math: a female-oriented game, a male-oriented game, and a gender-neutral game. Prior to playing the games, the students were asked to complete a short questionnaire about their previous experiences with video and computer games and with math. Each student played each game on three different occasions. After playing the games the third and final time, the children were interviewed by this researcher regarding their preferences and attitudes towards the three games and toward math. A researcher-designed questionnaire was utilized in the interviews to collect data.

Data Collection. The preliminary collection of data began right after the study was approved. Data collection encompassed four weeks in the spring of 2003. After receiving a brief orientation on how to operate the equipment involved, the subjects were presented with instructions on how to use the computer games needed for the study.

Each participant played each of the three games three different times. In order not to tire the participants, they played only one game per day. This means that in order to play each of the three games three different times, each student played a game on nine different days over a period of three weeks.

Data Analysis. This study employed both quantitative and qualitative data analyses. Quantitative and qualitative data, collected through interviews, were transcribed and analyzed by the researcher using procedures for analyzing qualitative data as described by Miles and Huberman (1994). As suggested in Miles and Huberman, quantitative and qualitative data can be linked in order to enable corroboration of each other and to elaborate on the analysis by providing richer detail. Miles and Huberman write that qualitative data can help the quantitative side of a study during analysis by validating, interpreting, clarifying, and illustrating the quantitative findings.

Both qualitative and quantitative data were analyzed using the SPSS statistical package program (SPSS version 11.5).

Summary

Commercial computer games have become an entertainment phenomenon attracting many fans--particularly boys. With research showing that computer games typically elicit complete mental involvement from participants, help participants focus attention, and make subjects like math seem less abstract, a number of educators have called for expanded use of educational computer games in order to enhance student engagement and motivation. As educational computer games have grown in popularity, efforts also have been made to develop gender-neutral games that will "level the playing field" and appeal equally to girls and to boys.

This study examines student experiences with math-related computer games--including whether students have preferences for gender-neutral or gender-oriented games and whether those preferences affect performance on the games. The study also examines whether the students perceived the games as making math more relevant to their lives and increasing their self-perceived math skills.

The following chapter of this dissertation provided reviews of related literature. Chapter 3 offers a detailed description of the methodology used in this study, including research design and methods of data collection and data analysis. Chapter 4 presents the data and its analysis, while Chapter 5 examines findings and implications of the research.

CHAPTER 2

REVIEW OF RELATED LITERARTURE

The purpose of this study was to investigate fourth-grade students' preferences in gender-oriented and gender-neutral educational computer games related to the subject of mathematics. A second purpose of this study was to investigate performance by gender on the computer games by comparing girls' and boys' scores on the female-oriented, male-oriented, and gender-neutral computer games. Several areas of professional literature were pertinent to this study. To give this study context, the literature review begins with a section on the history of computer games in education.

The section on gender roles includes a discussion of game-element preferences of girls and boys. The discussion guided this researcher's formation of categories of gender-related game imagery, game format, and social/psychological gaming aspects used in the selection of computer games for this study. These categories are discussed further in Chapter 3.

The final section of the literature review discusses new directions in educational computer games; including gender-neutral games and E-GEMS. The literature on gender-neutral games provided the fundamental impetus for this researcher's decision to examine student perceptions of a gender-neutral game versus gender-oriented games.

And the literature on the E-GEMS projects informed this study's examination of computer games as motivational tools for the study of mathematics.

Computer Games in Education

Video games and computer games have assumed a prominent role in the culture of American children. With commercial computer games now an integral part of contemporary life, educators have looked to computer games as a way to motivate students or promote learning. Educational computer games can fit into the educational setting in a variety of ways, ranging from total learning systems that take over most of the job of the instructor to instructional aids that serve as components in a more traditional learning environment. In the latter case, which currently accounts for the predominant use of computer games in education, games are only a tool in the classroom experience, adding realism and depth to discussions, as well as giving support to the teacher.

Commercial computer games are designed for recreational and entertainment purposes. Although the commercial games require strategy or other intellectual skills, those skills can also be transferred to similar game situations. Educational games, on the other hand, require specific knowledge in a defined subject area or discipline such as mathematics, history, geography, biology, or literature. Moreover, the intellectual skills required by educational games can be referenced beyond the game itself to particular course content.

Gredler (1992, p. 170) explains the primary differences between educational and commercial games as: (1) educational games require the application of curriculum-based knowledge and skills; (2) educational games eliminate luck or chance as a basis for winning or reaching a goal; and (3) educational games focus on teams and cooperation rather than individual competition.

Ito (1998) writes that the question of computer games having educational value is generally framed around a model of intentional learning versus incidental learning. Educational computer games differ from commercial video games in terms of purpose, content, and the concept of winning. The educational games require specific knowledge tied to school-like subject matter or particular course content. Educational computer games can be suitable for any subject and for any educational setting that addresses intellectual skills.

According to Gredler (1992, p.28), educational computer games can be used for any of four general academic purposes: (1) to practice or refine knowledge or skills already acquired; (2) to identify gaps or weaknesses in knowledge or skills; (3) to serve as a summation or review—for example, before a major test; and (4) to develop new relationships among concepts or principles. These purposes, continues Gredler, are not necessarily independent; an educational computer game might serve as a review while also developing new relationships among concepts.

In addition, writes Gredler, the playing of educational computer games can be used to reward students for working hard or doing well on a lesson. "A version of *Twenty Questions*," she notes, "in which the task is to guess the author, historical event, and so on is particularly appropriate for this purpose (p. 28)."

Betz (1995-96) discusses the educational uses of computer games and simulations to enable students to become more effective problem-solvers and thinkers and to make connections across the curriculum. A study conducted at the State University of New

York at Farmingdale used the computer game *Sim City 2000*. The game stresses cooperation and goal attainment and includes elements of architecture, urban planning, sociology, economics, political science, environmental science, mathematics, history, management, computers, and demographics. This simulation, using “real world” conditions and phenomena, is designed to allow students to plan and build a city. The game is not about winning but is about setting goals and trying to accomplish them.

Such games, Betz contends, illustrate interactive whole systems, organize and integrate complex skills, and show how individual actions affect whole systems. The author adds that computer games enhance learning through visualization, experimentation, and creativity of play.

Druin (1999) also believes that computer games provide opportunities to rehearse new skills in a realistic and interactive simulated environment, while allowing the players to see the end result of every choice they make. Players like this combination of interactivity, entertainment, story line, engaging characters, fantasy, challenge, decision-making, feedback, repetition, and duration, as well as the privacy the games can afford, writes Druin (p. 87). Druin concludes that the students who used the computer game learned more than students who only studied the material through readings or traditional learning methods.

Dorman (1997) writes that the positive aspects of computer games in education include: the games offer children the opportunity to choose different solutions to a problem and see the effects these different solutions have; computer games have great appeal to children; and many games can be adjusted to the skill levels or motor abilities of the player.

Computer Games and Constructivist Education

Many educational researchers have called for a re-emphasis on the development of intellectual skills. This interest, according to Hansen (1990), has been articulated in the call for academic programs that develop critical thinking, inquiry-oriented learning, interdisciplinary learning, and collaborative learning. The shift in emphasis was primarily a reaction against the knowledge-acquisition paradigm of teaching (Ennis, 1962; Baron and Sternberg, 1987). The newer approaches, including constructivism, put more responsibility on the learner who is seen as an active participant in the process of learning. Constructivism entails a reconfiguration of the role of the teacher into that of a facilitator of learning rather than as a dispenser of knowledge.

In constructivism, Jonassen, et al, (1995) knowledge is a function of how the individual creates meaning from her or his experiences and not a function of what someone else says is true. Based upon our unique experiences, each of us conceives of external reality somewhat differently. Constructivist teachers want to engage learners so that the knowledge learners create is not inert but usable in new and different situations. Constructivist teachers embed learning in real-life situations in which learners function as part of a community trying to solve real-world problems. Because constructivist theory views learners as the builders of their own knowledge, the process of learning happens best when students are building external and shareable artifacts such as computer programs, machines, or games (Kafai, 1996).

According to research by Harter (1981), the intrinsic interest in learning of elementary and middle school students is hampered by school systems that fail to foster challenge, curiosity, and independent mastery. Tzeng (1999) writes that with the proliferation of microcomputers in schools and homes, the computer has become a popular medium to provide alternatives to traditional methods of learning and teaching. Among those alternatives, continues Tzeng, engaging students in computer gaming activities appears to be an effective strategy to amplify motivation and cognition.

According to Tzeng, educational benefits from the use of computer games include: the games typically elicit complete mental involvement from participants; the games have concrete goals and rules that help focus attention and direct action; the games usually require a high degree of player interaction and provide immediate feedback; well-designed games often incorporate variable levels of challenge to keep players involved as their skills increase; the games enhance recall and transfer of knowledge; the mental imagery evoked by game environments or "worlds" facilitate the retention of educational materials embedded in the game; and well-designed games are fun to play.

Doolittle (1995) maintains that cognitive flexibility, the ability to generate several categories of possible solutions to problems, is a crucial aspect of creativity training. Students need to be aware of the kinds of solutions they generate. This self-monitoring or metacognition is a vital element in becoming a better problem-solver. In a quasi-experiment, word tables, computer games, and riddles were used to help college students develop cognitive flexibility. The author discusses computer programs that offer creative-fiction experiences in which the user participates in the story. The preliminary results of Doolittle's study indicate that such methods are effective in enhancing students' creative and critical- thinking skills.

Within the educational domain, computer gaming serves as a model in two senses (Schwartzman, 1997, p. 3). First, as an objective model, it cultivates values of personal responsibility and mutual obligation to learning/teaching processes. Second, as a subjective model, gaming simulates patterns of ongoing human interaction and situated learning. Jonassen writes that situated learning is part of a constructivist-learning environment that emerges from authentic tasks, engages the learners in meaningful problem-based thinking, and requires negotiation of meaning and reflection on what has been learned.

Computer Games and Controversy

Discussions of the possible effects of computer games on children's affective, social, and cognitive well-being have engendered much controversy. Some studies suggest that the nature of computer games leads to aggression and sexism. Violence is a major theme in many of the commercial computer games. Some research suggests that playing computer games, especially the commercial games, affects children's physical and emotional functioning. Physical effects can include increased heart rate, increased blood pressure, tendinitis; and, on rare occasions, seizures (Dorman, 1997). Emotional effects, writes Dorman, can include hostile feelings, aggressive thoughts, and a pathological preoccupation with computer games.

Commercial or entertainment games often use the scenario of an anonymous character performing an aggressive act against an anonymous enemy. Provenzo (1991) found that the majority of the top Nintendo video games are based on a theme of an autonomous individual working alone against an evil force. He quotes Terri Toles on video arcade games:

> The games overwhelmingly involve destruction of some sort, be it a piece of technological equipment, an alien from space or unusual monsters. Destruction of a technological artifact serves as the most common object: spaceships, aircraft, robots, missiles, ground targets, or simply "The Base" all act as suitable targets. Destruction of unidentified enemies, often from another planet, is the second most common theme; monsters, aliens or enemy soldiers attacking in hordes must be repelled (p. 119).

In a study of fifth-graders by Cooper and Mackie (1986), the researchers found that girls experienced more activity and aggressive free play after having played aggressive computer games; the games did not affect the free play of boys. However, research by others (including Scott) suggests that playing violent video games has no effect on a child's aggressiveness. Gail (1996) writes that studies linking game-playing with increased aggression are inconclusive. And Dorman (1997) suggests that the playing of video games can have a cathartic effect, giving children a safe way to act out hostile feelings and thereby achieving lower levels of actual aggressive behavior.

Dorman notes that frequent criticisms by educators of the use of computer games in the classroom include: the games may stress autonomous action rather than cooperation; the games may make children believe that all education has to be "fun"; the games may be ruled by luck or chance; and the games may stress competition or winning rather than cooperation. Dorman suggests that most of these potential problems can be overcome if teachers review the games to be used in the classroom.

Gender Roles and Electronic Games

A major controversy in computer games revolve around issues of gender and sexism. The most common charges made against commercial computer games are that they are sexist and violent. Electronic games typically have been designed by males for use by other males, writes Kafai (1996). A number of researchers have questioned whether, due to the nature of computer games, such games can appeal equally to girls and to boys, and researchers also have questioned whether girls and boys can learn equally well from computer games.

Sexism and Electronic Games

As noted by Hart (1996-97), it is readily apparent to any researcher that the majority of characters in the computer-game universe are male and that the majority of the games are specifically designed to appeal to boys. A *Newsweek* article describes the video-game craze as "a madness that--like most--strikes hardest at adolescent boys and their younger brothers; 60 percent of Nintendo players are males between 8 and 15 (March 6, 1989, p. 67)." The reporter adds that computer games "speak to something primal and powerful in (the boys') bloody-minded little psyches, the warrior instinct that in another culture would have sent them out on the hunt or on the warpath."

When researcher Margaret Kinder asked children if video games like *Teenage Mutant Ninja Turtles* appealed equally to boys and girls, a seven-year-old boy replied emphatically, "Just boys...because boys like turtles and girls don't. Girls won't play them, they like Barbies...disgusting! (Kinder, 1991, p. 102)." Kinder notes that by as early as kindergarten, both boys and girls view computer games as more appropriate for boys. According to Gailey (1992), preadolescent boys are the target market for commercial video and computer games. Although there has been a recent trend to develop computer games for girls, the most popular commercial games still display intense gender antagonism. The depiction of women in these games is consonant with a range of masculine fantasies, writes Gailey. The female characters in commercial video games typically are shapely and attired in skimpy clothing. The female characters rarely are lead characters and rarely have active roles; instead, they might be "prizes" for the male "hero" who successfully performs brave and daring, often violent, acts.

While males are, by far, the predominant characters in commercial video games, the industry recently has introduced a number of female heroines as well. Lara Croft is the most famous of these female figure; others are Lucy Clarkson, Rhonda Mitra, and Nell McAndrew. Unfortunately, notes Huntemann in *Game Over: Gender, Race, and Violence in Video Games*, these new female characters were not introduced as role models for girls but as fantasy sexual objects for boys and men.

According to Huntemann, there is a contradiction in how these female characters are being depicted in video games--they are strong, empowered women, but at the same time, they are voluptuous sex kittens. In the Lara Croft video game *Tomb Raider: The Last Revelation,* the Croft character is highly energetic, highly aggressive, and 36D-24-34. Although Lara Croft challenges the traditional role of female characters in commercial video games--she does not need to be rescued--she remains a sexual image.

Charges of sexism also have been made against educational electronic games. DeVaney (1998) notes that the best-selling Where in the World is Carmen Sandiego? features a curvaceous and sexy Latin “dark lady.” DeVaney is particularly concerned with the ethnic stereotyping of the game, writing that most instructional designers still conceive of student users as a culturally unified group. According to DeVaney, gender and multicultural issues still need to be addressed in the design of educational software.

Griffiths (1997) conducted a survey on the frequency, type, and reasons for playing computer games. The participants were 147 11-year-old school children attending a summer camp. Fifty-one percent were males, and 49 percent were females. Most of the boys played computer games, especially amusement arcade games, more frequently than their female counterparts. Also, the boys played games that were more violent and included more sports simulations than did girls. The girls preferred platform games and puzzles. However, both genders said they played computer games for the following reasons: fun, challenge, competition, excitement, to pass time, for the visual appeal, for educational reasons, and because their friends did.

Morlock's study (1985) concluded that the role-playing games and puzzle games preferred by females are more whimsical, less aggressive, and less demanding than the games preferred by males. Hart (1996-97) responds that such conclusions are tragic misinterpretations of data. Hart writes that the violent games preferred by boys do not typically incorporate a great deal of strategy or critical thinking but do require quick reflexes. On the other hand, the role-playing games preferred by girls require patience, strategy, critical thinking, and memorization, while the puzzle games require strategy and logic. Hart concludes that girl games are not less demanding than boy games but are simply demanding in different ways.

What Girls Want/What Boys Want:
Game Preferences by Gender

‘Kid culture,’ writes Koch (1995), is a phenomenon that remains stubbornly sex-segregated. From an early age, girls and boys express different preferences and interests through their choices of toys and games. Observations of children at play, writes McDonnell (1994) suggest that girls are interested in friendship, fairy princesses, and talking animals, while boys are interested in good guys and bad guys, blood and gore, fighting and death.

These differential preferences have been found to hold true in educational computer games. Researchers with the E-GEMS project at the University of British Columbia designed computer games for mathematics education in grades four to eight (Klawe, 1999). The interactive games included exploration, puzzles, challenges, scoring, and graphics, as well as music and other sound effects. The game designers paid particular attention to gender issues in order to develop games that would appeal to both girls and boys. Still, the researchers found that most girls, especially those 10 and older, seemed less interested in playing the games than did boys; the girls also were less interested in using computers in general. Klawe writes:

> Our field studies have repeatedly revealed gender differences in students' use of and attitudes toward interactive multimedia learning activities. Girls and boys have shown different preferences and levels of performance in activities and interactive styles. Girls often spend more time exploring and communicating with partners, while boys often make faster progress through the activities, completing more levels and puzzles. Despite completing more puzzles and levels, boys have not shown greater achievement in the assessments of mathematical understanding. During classroom observations, boys have been more aggressive in seeking or demanding access to computers and in their behavior while engaged in the activities, but minor interventions, such as occasional girl-only play or discussions have resulted in enthusiastic and sustained engagement of the girls with the prototype software (Klawe, 1999, p. 3).

One of the ground-breaking studies on game-element preferences and gender was Kafai's 1993 Game Design Project. For the innovative project, fourth-grade students were asked to design educational computer games about fractions for third-graders. A 1996 article by Kafai discusses the gender differences the researcher observed during the game-construction process. Kafai found definite differences in the types of games and the types of game feedback chosen by the girls and by the boys. Themes in the games created by the boys included space exploration and rescuing a princess. The types of feedback chosen by the boys for a wrong answer to a math problem included sending the on-screen characters to fry in the underworld, kicking the on-screen characters to the moon, and turning the characters into ice.

Themes in the games created by the girls included skiing and collecting pieces of a map. The types of feedback chosen by the girls for a wrong answer included having the player start from the top of the ski slope again, requiring the player to speak French, and not allowing the player to receive a portion of the magic power.

Kafai's major findings include the following: 1) The adventure game was the most popular game format for girls and for boys; 2) The games were organized around different spaces with the girls typically choosing familiar places such as the classroom or a ski slope and boys typically choosing fantasy spaces; 3) Most boys assigned to the game player a fantasy character persona, while most girls addressed the game player with the more personal "you"; 4) Narratives were a popular element in both the girls' and the boys; games; and, 5) In the games programmed by girls, the feedback provided to the game player was of a nonviolent nature and allowed most players to continue, whereas the feedback for a wrong answer in the boys' games typically was violent and usually terminated the game.

In a 1996 paper, Wilcox, a sixth-grade teacher, discusses the attitudes of her female students toward computers and computer games. Wilcox writes that the female students perceived computers and computer games in light of present and future relationships. Some of the games, Wilcox continues, were considered potentially harmful by the girls because of the games' possible negative effects on other people, society, and the girls themselves. One student mentioned a boy who, after killing one of his friends, said it was just like playing a video game.

While the girls typically were repulsed by the violence found in many computers, they also tended to dislike the commercially-produced girl games, such as the Barbie video game that emphasizes cosmetics and clothing. One female student's response: Give me a break! Just because some girls don't want to play a game where you go around collecting points for every head you blow off, doesn't mean we want to sit around putting make-up on a Barbie face (p. 3).

Another female student suggested that the Barbie computer game was so stereotypically girlish that it must have been created by a man. "If you want to make a Nintendo game for girls," the student noted, "I suggest you get a GIRL to think up ideas" (p. 3).

Some of the features that the girls told Wilcox they would like to see in computer games are non-violence; helping the environment; female main characters, including female spies and heroes; and thoughtful, purposeful problem-solving. One girl suggested a game where instead of getting points for killing things, you get points for how long you can keep the flowers in a field growing. In addition to disliking the violence, the girls also disliked the repetitive nature of many boy-oriented games.

Miller, Chaika, and Groppe (1996) conducted a focus group with 30 adolescent girls to investigate their preferences in computer games. The findings indicated that the female participants: liked to explore the game environments in an unstructured way; believed the games textural qualities of music and sound were important; wanted the game to be challenging but not frustrating; did not view winning as a necessary objective; wanted supportive feedback; and liked 'dreamy-boy' scenarios.

Sheri Graner Ray is the founder of Sirenia Software, a company that develops computer games specifically with girls in mind. In a 2001 interview, she discusses her findings on the game preferences of girls. The findings—which she notes are broad generalizations that do not apply to everyone—include the following: girls appreciate visual stimuli but do not experience the same physiological response that boys do; boys want to resolve conflict in a head-to-head confrontational manner and want to win, whereas girls prefer non-confrontational methods on conflict resolution and want emotional resolution rather than victory; and, girls want to know how a game works before playing it while boys prefer to learn by doing.

Swanson (1996) investigated elements of gender preferences in video games as perceived by second-grade schoolchildren (30 girls and 30 boys). Swanson writes that boys are thought to be attracted to elements of aggression, violence, competition, fast action, and speed in electronic game-playing, while girls are drawn to social aspects of the games such as an understanding of character relationships. Swanson writes that the literature indicates girls also tend to prefer games with familiar environments, games that allow the players to work together, puzzle-solving, games that have more than one way to win, and games in which characters do not die.

Swanson's major findings from her own study indicated that boys and girls differed significantly in their preferences for many game features with boys' preferences typically tied to the game's action and the girls' preferences typically tied to the game's leading characters.

Images are a major component of computer games, and according to Rogers (1995), the images preferred by girls and the images preferred by boys differ in visual characteristics. Rogers writes that close examination of the actual imagery produced by children (using any medium) reveals certain differences in subject matter graphically presented by girls and by boys. After examining more than 1,800 drawings by 26 children, McNiff (1982) found that girls favored images of people and the human face, holiday imagery, plants, animals, and detailed landscapes. Boys most often drew images of conflict and power struggles, sea animals, exotic locations, and sports scenes. McNiff argued that the differences in the art of girls and boys may originate in ancient traits within the species and which are most manifest in childhood.

Rogers (1995) cites a 1993 presentation by Jacobsdottir and Krey in which gender-oriented guidelines were proposed for computer graphic design based on a review of imagery studies in instructional design and art education. The guidelines are summed up as follows: 1) Girls have high interest in: detailed images of people, plants, and animals; the use of a variety of colors; female characters; and peaceful images. 2) Boys have high interest in: images implying action, including images of vehicles; male characters; and images of suspense, danger, and rescue.

Gender and Visual/Spatial Skills

Another issue of controversy in the use of computer games in education is whether the games favor boys because of claims that boys demonstrate greater ability at iconic spatial representations than girls. But Greenfield et al. (1992) cite studies which demonstrate that the playing of computer games can help girls catch up with boys in visual-spatial skills. Greenfield writes that there is an urgent need for widely available computer games that make as firm contact with the fantasy lives of girls as with those of boys.

New Directions

Amid increasing criticisms of a male gender-bias in electronic games, the electronic gaming industry began looking at ways to appeal to the largely untapped female market. DeBare (1996) writes that for years industry executive had simply concluded that girls don't play electronic games. But in the 1990s, women within the industry began challenging that conventional wisdom that girls are adverse to the games. It also was argued, DeBare notes, that electronic games often are the gateway to computer literacy for children; and because girls also need to be computer literature in the 21st century, electronic games that appeal to girls needed to be developed.

Female-Oriented Computer Games

In recent years, big corporations as well as tiny start-up companies have made serious efforts to design games that will attract and inspire girls (DeBare). Janese

Swanson, who wrote her doctoral dissertation on gender issues in computer games, has begun producing a line of games for girls.

Writer and designer Sheri Graner Ray started Sirenia Software with a goal of producing computer games that girls really want to play and not games people think girls should play. In a 2001 interview, Ray, who produced the girl-oriented game "Vampire Diaries," said that there seems to be a misconception in the gaming industry that boy-oriented computer games can be nothing but fun, while all girl-oriented games need to be educational.

Jean Parrent, a Seattle multimedia consultant, also has started a company to produce computer games for girls. In 1993, Sega of America—one of the country's top-selling producers of commercial computer games—developed a girls' task force.

But, DeBare writes, many companies are drawing fire for the new female-oriented games being produce. In 1995, Her Interactive, the newly formed division of American Laser Games, released a game called McKenzie & Co. which billed itself as a role-playing game with real-life moral and social dilemmas set in a high school. But DeBare writes that much of the game boils down to getting dressed up and attracting boys. DeBare adds that players can mix and match 400 clothing items and try out different makeup looks. "Each player starts by choosing her dream date from a roster of several good-looking guys, and the game ends with a formal prom portrait of the couple" (DeBare, p. 3).

Sega vice-president Michealene Cristini Risley told DeBare that game such as McKenzie & Co. are destroying girls by telling them that the most exciting thing in their lives is choosing a boyfriend. "We have a responsibility to offer them more than that," said Risley (in DeBare, p. 3). Gail Rubin, a Her Interactive spokeswoman, responded, “We have found a girl yet who doesn’t like this game,” (in DeBare, p. 3).

Other game producers are trying different strategies to appeal to girls. According to DeBare, some simply are adding girl characters to existing games. For example, a new version of Nintendo’s popular Donkey Kong Country supplements the cast of boy gorillas with a spunky girl gorilla who can launch cannonballs with her ponytail. Other companies, notes DeBare, are venturing into new kinds of high-tech toys such as electronic diaries; still other companies are looking for new ways to market video games to girls who tend to avoid traditional outlets like software stores. McKenzie & Co., for example, had promotional tie-ins with cosmetics and clothing companies, and also was promoted via a shopping-mall tour by rock bands whose songs are featured in the game.

A 2001 report from the research group Children Now states that when it comes to computer games, girls seem to be forever associated with sugar and spice. According to the report, games for girls—most notably the line of Barbie computer games from the Mattel toy company--tend to focus on physical appearance or fashion style. The report states that most computer games marketed to girls do not actively engage them in developing skills or testing their abilities. The report praises the new electronic game “Mia Hamm Soccer 64” and bemoans the fact that there are no computer games starring members of the WNBA (Women’s National Basketball Association) or women from the arena of extreme sports. Some of the other commercial computer games for girls that were praised by the group are: “Nancy Drew: Stay Tuned for Danger,” a detective story from Her Interactive that challenges players to find clues and solve puzzles: “You Can Be an Engineer,” a game from Cascade Press that looks at NASA and space exploration;

and, “Ecco, the Dolphin,” a fantasy-adventure game from Sega that takes place in the ocean and challenges players to help Ecco save the world from environmental disaster.

Gender Neutral Computer Games

Rather than producing games specifically targeted for girls or for boys, some companies are attempting to produce games that will appeal to both genders by blending female-oriented and male-oriented game characteristics. These games often are referred to as gender-neutral games.

The gender-neutral games have added more controversy to the debates on computer-game orientation. Some researchers believe that by being gender-neutral the games will have high appeal to no one. Rogers (1995) writes that although educators have sought to develop non-stereotypic methods and media, students may be better served by emphasizing rather than neutralizing gender differences. Rogers cites a 1994 study by Jacobsdottir, Krey, and Sales in which female-oriented and male-oriented imagery characteristics were blended to develop images that would theoretically appeal to females and males equally. In their study, Jacobsdottir, Krey, and Sales found that girls rated female-oriented images as having high appeal, and boys rated male-oriented images as having high appeal. But the gender-neutral images did not hold high appeal for girls or for boys.

According to Rogers, educational materials and media containing vivid images are easier for students to comprehend and remember than those that are abstract or not image-arousing. It follows, continues Rogers, that the more evocative the images, the richer the educational experience. Writes Rogers (p. 16), “If gender-based preferences in imagery evoke vivid images, we may well wish to develop instruction geared specifically for males or females."

Sheri Graner Ray, a computer-game software developer, said in a 2001 interview that there should be girl-oriented and boy-oriented computer games just as there are "chick flicks" and "guy flicks." Ray said that before quality games can be developed for girls, developers must accept the fact that girls are drawn to different characteristics in a game than boys. Although Ray believes that a market exists for gender-neutral games, she fears the gaming industry will pass over the development of girl-oriented games in favor of the development of gender-neutral games. "I believe girls' games have an artistic and commercial validity all their own" (p. 3).

Ray also said she prefers the term "gender-inclusive" over "gender-neutral" because there are no gender-neutral people, but there can be computer games that include elements which appeal to both genders.

E-GEMS

E-GEMS: Electronic Games for Education in Math and Science is an interdisciplinary team of researchers, teachers, and computer-game designers interested in designing electronic games for education in math and science (Klawe, Upitis, Inkpen, and Koch, 1995). The primary goal of E-GEMS--which was formed by Maria Klawe, a professor of computer science the University of British Columbia in 1992—is to increase interest and achievement in mathematics and science. Because the researchers believe that a disproportionate number of girls lose interest in math and science between the ages of 10-14, the E-GEMS team has place special emphasis on developing computer games with math and science content that are attractive to girls.

According to the researchers (Klawe et al, 1992), the question of how to design computer games that girls like to play has received a great deal of attention in the popular media in recent years, but few games have succeeded in meeting the challenge. E-GEMS has conducted studies on children's playing of commercially available computer games and found that substantial gender differences in what children liked in the games. E-GEMS has used those findings as a guide in developing a prototype math-oriented computer game called "Phoenix Quest." The following section of this dissertation contains further information on E-GEMS and other projects focusing on the development of math computer games.

Computer-Based Mathematical Games

Many students do not want to learn mathematics, write Sedighian and Sedighian (1996). Children often find the subject difficult to learn, irrelevant to their lives, and boring, the authors continue. Sedighian and Sedighian have been involved in long-term research on children, the study of mathematics, and computer games, and they designed a game called Super Tangrams aimed at helping sixth-graders learn 2-dimensional transformation geometry. The Sedighians also have been a part of the E-GEMS project.

Motivation plays a key role in any learning activity, the researchers write. It has been suggested, continue Sedighian and Sedighian, that computer games enhance children's motivation toward school subjects. Sedighian and Sedighian believe that computer-based mathematical games can not only provide children with a context in which the children find learning mathematics meaningful and useful, the games can also provide researchers with a rich medium from which to gain new insights into the psychology of learning mathematics.

Sedighian and Sedighian spent six month observing the members of a sixth-grade class play the Super Tangrams computer game. The researchers findings included the following:

1) Situating mathematical learning in a computer-game environment brings greater relevance to the subject for children. Student commented that when they are doing math out of a book, they just want to get it over with—but when they are using a computer math game, "you are wanting to do it and you're having fun with it so you can concentrate on doing instead of just getting it over with"
(p. 3).
2) The computer math games provided the participants with a goal or set of goals to achieve.
3) Accomplishing those goals provided the participants with a sense of success.
4) The participants did not become bored because they found the games challenging. The participants particularly liked games that would progressively become more challenging.
5) The computer games enabled the participants to associate mathematics with pleasure. (pp. 3-5)

In a 1997 paper, Sedighian writes that the problems in helping children to learn mathematics are twofold: 1) to motivate them to want to spend time and engage in mathematical activities, and 2) to aid them cognitively to construct mathematical knowledge. Because computer games are an integral part of children lives, Sedighian write, well-designed computer-based mathematical games may be able to address these two problems.

Sedighian proposes a model for a computer-based mathematics learning environment designed to engage children in the learning process through challenge-driven, goal-directed activities. The model suggests that:

1) Game activity should be highly goal-driven and have clear rules of play so that children are at all times intensely focused on achieving the goals of the game:
2) Children should continuously receive feedback that is directly linked to the goals of the game:
3) The game should gradually become more challenging and reflective while at the same time providing an instructional component in order to sustain the flow experience;
4) To prevent frustration and boredom, the dynamics between the game and the instructional component should be fine-tuned so that children receive appropriate instruction for the type and level of the mathematical problems they are solving. (p. 8)

Rubin, Murray, O'Neil, and Ashley (1997) write that popular culture offers little outside-of-school support for children's mathematical learning with one exception—computer games. The researchers are part of a project called Through the Glass Wall: Computer Games for Mathematical Empowerment, a project that is looking at the role computer games could play in math education.

In a study, the researchers observed third-, fourth-, and fifth-graders playing the computer game "Logical Journey of the Zoombinis" in an urban after-school program. According to the authors, "Zoombinis" is a gender-neutral game that encourages mathematical and strategic thinking. The game challenges players to lead as many oppressed Zoombinis as they can to Zoombiniville, a new homeland where the characters can be safe and free. Zoombinis are small blue creatures, and players choose the characters' hair, noses, eyes, and modes of transportation. To save the Zoombinis, players must solve math-related puzzles. The game contains minimal violence, and the Zoombinis never die.

In the analyses of their observations, the researchers concentrated on identifying characteristics of the game that contributed to girls' and boys' engagement in the game because the researchers believe that engagement over time with a game is a necessary prerequisite for learning. The researchers found that that the game "Zoombinis" offered several types of opportunities for engagement over time: narrative connection and puzzle connection.

According to the researchers, the narrative connection was evident in the way the participants talked to and imitated the characters. Some children formed attachments to individual Zoombinis and worried about their progress in particular. Some participants gave individual Zoombinis greater dimensionality by adding characteristics such as age and gender—for example, by referring to one Zoombini as “a baby Zoombini.”

Other participants were primarily engaged by a puzzle connection, write the researchers. These participants were interested in developing strategies for solving the puzzles simply for the sake of solving the puzzles and not for the sake of saving the Zoombinis. These participants spent little time designing the faces of their Zoombinis, preferring instead to move through the puzzles. According to the authors, these participants often dominated the mouse and talked about “beating” the game or winning.

Rubin (et al) write that the game also afforded opportunities for communication, and participants often gathered in groups around a single computer to watch and chat, and to offer advice to the person holding the mouse. The researchers write that the game easily allows for communication because, since the game is not timed, there is no time pressure that could preclude conversation. According to the authors, this game appears to: 1) have appeal to both girls and boys; and, 2) encourage and support strategic thinking.

Summary

This literature review discussed both commercial and educational computer games, examining advantages and disadvantages of the games. Although a number of educators believe computer games can play a potent and positive role in student learning, computer games still remain controversial because of: the traditional sexism in commercial games; findings that indicate boys enjoy playing video games more than girls; the visual-spatial skills required to play the games--which also may favor boys; and the anti-social nature of sitting alone and playing the games.

On the other hand, educational computer games offer a number of benefits including: the games typically elicit complete mental involvement from participants; the games have concrete goals and rules that help focus attention and direct action; the games usually require a high degree of player interaction and provide immediate feedback; well-designed games often incorporate variable levels of challenge to keep players involved as their skills increase; the games enhance recall and transfer of knowledge; the mental imagery evoked by game environments or "worlds" facilitate the retention of educational materials embedded in the game; and well-designed games are fun to play.

Some researchers—in particular the researchers at E-GEMS—have been developing educational computer games especially designed to appeal to girls, as well as games designed to be gender-neutral. Another recent focus of educational computer-game designers has been mathematics. Computer-based mathematical games are meant to provide children with a context in which the study of mathematics is meaningful and useful.

This study investigated gender preferences in educational computer games related to the subject of mathematics as perceived by fourth-grade students. The researcher examined the girls' and boys' perceptions of a game designed with an orientation for girls, a game designed with an orientation for boys, and a game designed with an orientation that is gender neutral. The next chapter provides a detailed discussion of the methodology that was used in this study.

CHAPTER 3

METHODOLOGY

Purpose of the Study

The purpose of this study was to investigate fourth-grade students gender-related preferences in educational computer games related to the subject of mathematics. The researcher examined the girls' and boys' perceptions of three games; a game designed with an orientation for girls, a game designed with an orientation for boys, and a game designed with an orientation that is gender neutral. In this study, girls' and boys' preferences were compared on stated and observed preferences.

A second purpose of this study was to investigate gender-related performance on the computer games by comparing girls' and boys' scores on the female-oriented, male-oriented, and gender-neutral games. Performance data also was used to determine if there was a relationship between game preference and game performance. The study also investigated the effects of game playing on mathematics (i.e., do participants report linking the subject of math more after playing the games, and do participants report finding the subject of math more relevant to their daily lives after playing the games.)

The study was designed to answer the following research questions:

1. Are games' gender classifications consistent with students' preferences?

2. How do participants perform on the three computer games?

3. Do participants report positive and/or negative reactions to specific game imagery, game format, or other game aspects?

4. Do participants perceive the games as being oriented toward certain players?

5. Do participants perceive the subject of math to be relevant to their daily lives?

6. Does playing computer games affect students' perception of the subject of math (i.e., do students report liking math more after playing the games)?

Study Population

The target population for this study was the two fourth-grade classes at a Midwestern elementary public school in Columbus, Ohio.

The District provided this researcher with a list of 15 elementary schools as possible sites for the research project. Only six schools expressed their interest and willingness to grant the researcher access to their facilities in order to carry out the research project. One school was selected as the most appropriate site for the research project. This school was chosen because it encouraged the integration of technology into the curriculum, especially in the area of math. In addition, the students had enough experience with computers to operate the computer games. The school was equipped with fairly up-to-date hardware and software necessary to run the educational computer games used for this study. There were five PC computers in every classroom. The fourth-grade teachers and their students used these computers in their curriculum and extra-curricular activities. Prior to the study the researcher volunteered at the school as a way of gaining access and also returning value to the school. In addition, the researcher observed math lessons in both fourth-grade classes every other day, for four consecutive months. During that time, the researcher developed a professional relationship with the teachers and their students.

The researcher contributed to the match curricular activities by helping the students solve arithmetic and algebraic math problems, by playing traditional math games, and by administering math quizzes. There were 42 students in the two classes; however, the researcher was aware from the start that some of the students would drop out of the research project before it was completed.

Research Design

In the study, the fourth-graders were asked to play three computer games related to the study of math: a female-oriented game, a male-oriented game, and a gender-neutral game. Prior to playing the games, the students were asked to complete a short questionnaire about their previous experiences with video and computer games and with math. Each student played each game on three different occasions. After playing the games the third and final time, the children were interviewed by this researcher regarding their preferences and attitudes towards the three games and toward math. A researcher-designed questionnaire was utilized in the interviews to collect data.

The children's scores on each game also were recorded by the researcher. Scores were automatically tabulated on the computer during game play. The students played each game three times; the first time was considered practice, and scores were not recorded.

Game Selection

The researcher selected three math-related computer games for use in this study—one as a female-oriented game, one as a male-oriented game, and one as a gender-neutral game. The criteria used in the selection process were culled from an in-depth study by this researcher of the body of literature on gender-related characteristics of computer and video games. This researcher divided the relevant characteristics into three categories: game imagery; game format; and social and psychological aspects of the games. It should be noted that there is some degree of overlap among the three categories.

The characteristics for game imagery were specifically informed by these studies: female/male characters (Rogers, 1995); other images (McNiff, 1982; Rogers, 1995; Swanson, 1996); color and sound (Miller et al., 1996; Rogers, 1995; Swanson, 1996; Wilcox, 1996). The characteristics for game format were informed by: story line (Rubin, et al., 1997); repetition and purposeful problem-solving (Wilcox, 1996); competitive format and character development (Swanson, 1996); creative play and quick progress to goal (Klawe, 1992 & 1999; Miller et al., 1996)l character abilities (Rogers, 1995); attainable challenges and game-playing rules (Miller et al, 1996); scoring lots of points (Ray, 2001). The characteristics of social and psychological aspects of the games were developed from: challenge (Griffiths, 1997; Miller et al., 1996) adventure and mystery

(Kafai, 1996; Wilcox, 1996); social relevance and fantasy (Kafai, 1996; Wilcox, 1996); unharmed characters and violent consequences (Kafia. 1996; Ray, 2001; Swanson, 1996; Wilcox, 1996); cooperative play (Swanson, 1996; Klawe, 1992 & 1999); winning (Miller, 1996; Ray, 2001); fantasy characters (Kafai, 1996); identification with characters (Swanson, 1996); scoring lots of points (Klawe, 1992 & 1999); and, emotional resolution (Ray, 2001).The characteristics of the categories are listed by gender in the three charts that follow.

Game Imagery

Girls	Boys	Gender-neutral
• Female characters • Detailed images of people, plants, and animals • Peaceful images • A variety of colors • Sound effects (e.g., music)	• Male characters • Images of suspense, danger, and rescue • Images implying action • Vehicles • Sound effects (e.g., explosion, and/or loud noise)	• Combination of female and male elements (e.g., a game with both female and male lead characters); and/or minimizing of female and male elements (e.g., a game with a lead character of non-specific gender)

Table 3.1: Game Imagery

Game Format

Girls	Boys	Gender-neutral
• Story line, narrative format • Purposeful problem-solving • Creative play, time to explore • Character development • Attainable challenges • Flexible and minimal game-playing rules	• Repetitive sequences • Competitive format • Quick progress to end goal • Characters with a variety of physical abilities (e.g., strength, ability to fly); athletes • Scoring lots of points • Rigid and numerous game-playing rules	• Combination of female and male elements; and/or minimizing of female and male elements.

Table 3.2: Game Format

Social/Psychological Aspects of Game

Girls	Boys	Gender-neutral
• Social relevance (real life) • Characters who are not harmed • Cooperative play/ communication • Identification with lead characters • Emotional resolution	• Fantasy (futuristic; science fiction) • Violent consequences • Winning • Fantasy characters • Scoring lots of points	• Emphasis of elements that are appealing to both girls and boys and/or de-emphasis of gender-oriented elements. Elements appealing to both girls and boys include challenge, mystery, and adventure.

Table 3.3: Social and Psychological Aspects of Game

Games Used in the Study

The three games selected for use in this study were Phoenix Quest, NFL Math (second edition), and MindTwister Math. This section provides a description of each game.

Phoenix Quest, 2001 (female-oriented computer game). This game was created by E-GEMS specifically to interest and involve girls in mathematics. The game, for ages 9 and up, is played in the context of a complex story in which Julie, an adolescent girl, embarks on a quest to find the Phoenix feather and thus prevent the world from turning dark. During the quest, Julie must solve math puzzles --with the player's assistance--. Julie is the game's central character. Another female character, the mysterious Saffron, plays a significant role in the game—as do two male characters, Darien and the Keeper of the Phoenix Feather.

The game's conversation net allows players to communicate with the characters via electronic postcards. The characters respond to the postcards by writing back. For example, while trying to solve the robot puzzle, players might write Julie asking her the meaning of the Chinese symbols on the beads; Julie will answer with helpful hints.

The puzzles address a wide variety of math topics—including geometry, fractions, number sequences, and simple programming. One of the game's puzzles asks players to calculate the angle and distance at which to cast a line in order to catch a fish. Solving the puzzles often involves exploring and keeping track of multiple possible approaches.

In summary, the game includes vivid colors, a strong story line, a lead female character, a situation that puts players in a helping role, a minimum of violence, and communication possibilities with the characters. Because there are is little time pressure, many opportunities exist for collaborative gaming. Although players may receive cards for solving the math puzzles, the ultimate goal of the game is to help Julie save the world from darkness. The accomplishment of this goal provides an emotional resolution to the game. The game has a preponderance of elements that have been found to appeal to girls.

NFL Math, 1996 (male-oriented game). This game allows players to guide their favorite National Football League teams down the field by answering math questions.

The game's math questions are all football-related. The game uses 3D-rendered realistic graphics, animation, and sound to realistically represent NFL football games.

For children ages 8 and up, the game was developed by the California company of Sanctuary Woods, NFL Math challenges players to win a series of games on the road to the Super Bowl. Along the way, gamers contend with mental math (addition, subtraction, multiplication, and division), word problems, charts and graphs, and an abundance of NFL trivia.

To discourage guessing the answers, the game allows three "time-outs" during each quarter of play. With the clock turned off, players can visit the Coach's Corner for on-screen math tutorials.

In summary, all the game's characters—NFL team members, coaches, and sports announcers--are male. However, action takes precedence over character development in this football-oriented math game. The game is designed to appeal to those with an interest in and knowledge of football. (Gamers can even print out stats of their favorite NFL team members.) There is a small amount of football-related violence. A player can earn an NFL Math Super Bowl ring by being victorious over a string of opponents. The goal of this game is to score points and win. The game has a preponderance of elements that have been found to appeal to boys.

MindTwister Math, 1999 (gender-neutral game). Designed for third-and fourth-graders by Edmark, this computer game covers mental math, story problems, place values, time and money, probability, geometry, decimals, and fractions. Using a clever game-show format, one-to-three gamers can play at a time. Gamers "ring in" with their answers to the math challenges.

In the game's UFO section, a problem is shown at the top of the screen. Different answer choices "fly" across the screen, and players ring in when they see the correct answer. The Number Line section allows players a chance to practice their estimation skills and deductive reasoning; a number line is shown, and players ring in and identify the number marked by the pointer. Points are awarded for correct answers and deducted for incorrect answers.

Another game section, called Cooperation Break, requires players to take a break from the game-show competition and work cooperatively to help the Vacusaurus vacuum up the numbers that fit a given rule.

In summary, MindTwister Math is a challenging game that has been called the electronic equivalent of flash cards. The game makes a point of fostering both competitive and cooperative play. At times, the game requires purposeful and creative problem-solving; at other times, the game requires quick response. Players can select game pieces from a group that includes a wacky alien, a monster truck, a sweet kitty-cat, and other colorful images. The game appears to have been designed with the interests of both girls and boys in mind.

Instrumentation

Drawing on the instrumentation used in previous and related studies, particularly the study done by Janese Swanson in 1996, this researcher developed a questionnaire designed for use during interviews with the study participants. (See Appendix B and C) The questions relate to the participants' preferences among the three computer games used in this study. In addition, the questions asked about participants' perceptions of specific elements or aspects of the three games, as well as the participants' perceptions as to which gender/genders enjoyed playing each of the games. Additional questions asked for participants' attitudes toward math.

A short questionnaire was administered prior to any game play also was designed to gather demographic information.

Data Collection

The researcher contacted the principal of the elementary school in Columbus, Ohio, to obtain permission to conduct a four-week study with the school's fourth-graders (Appendix E). About 42 students were in the two classes; however, the researcher was aware that some of the students may drop out of the research project before it was completed. A letter was sent to the parents of the fourth-graders to obtain permission for the children's participation in the study (Appendix D). The students were asked to complete a brief questionnaire requesting demographic information before any game playing began.

Each participant played each of the three games three different times. In order not to tire the participants, they played only one game per day. This means that in order to play each of the three games three different times, each student played a game on nine different days over a period of three weeks. Below was the schedule:

- *Week One*
  - *Day One*: Each participant played the gender-neutral game.
  - *Day Two*: Each participant played the gender-neutral game.
  - *Day Three*: Each participant played the gender-neutral game.

- *Week Two*
    - *Day One*: Each participant played the game oriented to own gender (i.e., girls play female-oriented game. and boys played male-oriented game).
    - *Day Two*: Each participant played the game oriented to own gender.
    - *Day Three*: Each participant played the game oriented to own gender.

- *Week Three*
    - *Day One*: Each participant played the game oriented to opposite gender (i.e., girls play male-oriented game, and boys play female-oriented game).
    - *Day Two*: Each participant played the game oriented to opposite gender.
    - *Day Three*: Each participant played the game oriented to opposite gender.

Each session of play began with a brief orientation on how to operate the equipment and the computer-game software. The sessions were not timed. Participants took as long as needed to complete each game (which typically took 10 to 15 minutes). However, some of the games themselves include timed sections.

There were five available computers in the school library, so five participants played a game during each session. Participants were grouped in sessions according to gender (girls played in groups of five, and boys played in groups of five). If some participants completed a game before other participants, those who were done chose to play a computer game of their choice, read a book, study, or rest until all five participants in that session had completed the specified game.

This allowed the researcher to observe whether a participant who had finished the specified game early chooses to replay that same game, chose a different game to play, or played no game at all in her/his free time. Should a participant choose to replay the same game, only the score from that session's first game was recorded by the researcher.

In the fourth and final week of the study, the researcher interviewed each student separately about her or his perceptions toward and preferences in the three games, as well as about perceptions toward the games as tools for improving math skills. During the interview, the three games were displayed on three computer screens in case a participant needed help recalling specifics of a game.

Data Analysis

This study employed both quantitative and qualitative data analyses. Quantitative and qualitative data, collected through interviews, were transcribed and analyzed by the researcher using procedures for analyzing qualitative data as described by Miles and Huberman (1994). As suggested in Miles and Huberman, quantitative and qualitative data can be linked in order to enable corroboration of each other and to elaborate on the analysis by providing richer detail. Miles and Huberman write that qualitative data can help the quantitative side of a study during analysis by validating, interpreting, clarifying, and illustrating the quantitative findings.

Both qualitative and quantitative data were analyzed using the SPSS statistical package program (SPSS version 11.5). Frequency counts and percentages were used to describe the demographical information and the distribution of participants in the study.

The following is a description of the statistical analyses that were used to accomplish each of the research objectives of the study:

1. Frequency counts and percentages were used to describe whether games' gender classifications are consistent with students' preferences.
2. Means, standard deviations, and ranges were used to describe participants' performance on three computer games: gender-neutral game (MindTwister Math), male-oriented game (NFL Math), and female-oriented game (Phoenix Quest).
3. Miles and Huberman (1994) procedures for analyzing qualitative data were used to describe the participants' positive and/or negative reactions to specific game imagery, format, or other game aspects.
4. Frequency counts and percentages were used to describe the subjects' perceptions as to whether the games they played were oriented toward boys, girls, or both boys and girls.
5. Miles and Huberman (1994) procedures for analyzing qualitative data were used to describe participants' perceptions of the subject of math and its relevance to their daily lives?
6. Frequency counts and percentages were used to describe changes in subjects' preference for math after playing math computer games. In addition, Miles and Huberman (1994) procedures for analyzing qualitative data were used to describe whether the participants liked the subject of math more, less, or the same as they did before playing the three computer games.

CHAPTER 4

FINDINGS

Introduction

This study employed both quantitative and qualitative data analyses. Qualitative data (collected through interviews) were transcribed and analyzed by the researcher using procedures for analyzing qualitative data as described by Miles and Huberman (1994). Both qualitative and coded quantitative data were analyzed using the SPSS statistical package program (SPSS version 11.5). Descriptive statistics were used to describe various elements presented in the study, including the research sample, the degree to which subjects preferred the games played, subjects' game performance, subjects' perceptions of game orientation, and changes in subjects' preference for math. Linear correlation analysis was used to describe the relationship between computer game preference and game performance.

Study Population

The target population for this study was the two fourth-grade classes at a Midwestern Elementary Public School in Columbus, Ohio. The rate of response to the letter requesting parents'/guardians' permission for their children's participation in the study was 85.7%. Thirty-six of 42 students (17 girls and 19 boys) were given permission by their parents/guardians to participate in the study. Four subjects dropped out of the study before it was completed, bringing down the total number of subjects to 32, as presented in Table 4.1 below:

		N	Percentage
Subjects	Girls	17	53.1
	Boys	15	46.9
Total		32	100.0

Table 4.1: Distribution of participants in the study

Demographic Information

Various demographic variables were included in this study using pre- and post-game-play interviews (Appendices B and C). One pre-game-play interview was administered prior to the game sessions. One post-game-play interview was administered in the final week of the study. Data related to participants' age; gaming skills; preference for math; perception of their math skills; and preference for computer/video games are presented below. Also presented below are data related to whether subjects had played computer/video games prior to their participation in the study, along with a description of the frequency with which subjects play computer/video games:

Age

Data related to subjects' age is presented in Table 4.2. As this table shows, the mean age of the subjects who participated in the study was 9.6 years.

Population	N	Mean	Std. Deviation	Maximum	Minimum
Fourth-Grade Students	32	9.6	.42	10.0	9.0

Table 4.2: Age of study participants

Prior Experience with Computer/Video Games

Data related to whether subjects had played computer or video games prior to their participation in the study is presented in Table 4.3.

	Prior Experience with Computer/Video Games	
	Yes	No
Girls	10 (59%)	7 (41%)
Boys	14 (93%)	1 (7%)

Table 4.3: Subjects' prior experience with computer/video games

As shown in Table 4.3, more boys than girls had played video or computer games prior to their participation in this study. These results may be explained by the fact that electronic games are typically designed by males for use by other males (Kafai, 1996); a number of researchers have questioned whether such games can appeal to girls and to boys equally. Moreover, parents tend not to encourage girls' interest in electronic games.

Frequency with which Games Are Played

Data related to the frequency with which subjects play computer/video games is presented in Figure 4.1.

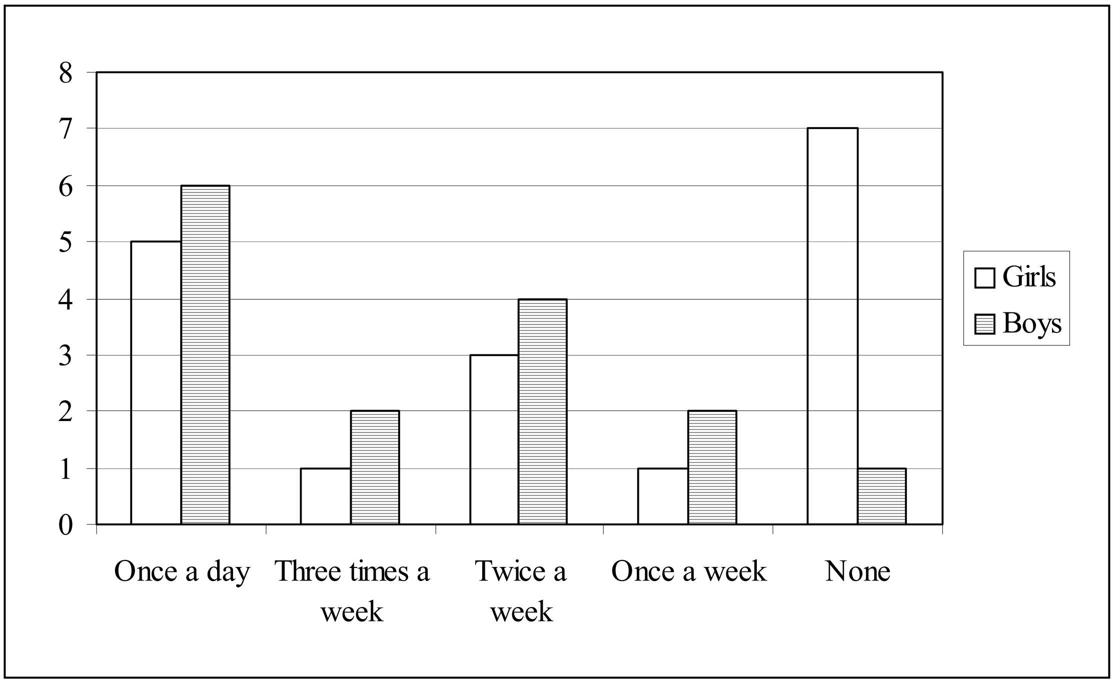

Figure 4.1: Computer/video game play frequency

As Figure 4.1 shows, most boys and girls play electronic games on a regular basis. But although the raw data suggests that girls and boys play with approximately equal frequency, the *proportion* of girls who play computer/video games on a regular basis is noticeably lower than the proportion of boys who do so. That is, 40% of the boys play computer/video games at least once per day, while only 29% of the girls do so; 13% of the boys play computer/video games approximately three times a week, while only 6%

of the girls do so; 27% of the boys play computer/video games approximately twice a week, while only 18% of the girls do so; and 13% of the boys play computer/video games approximately once per week, while only 6% of the girls do so. Finally, while 25% of all subjects do not play computer/video games at all, the majority of these subjects are girls (88%). These results are consistent with Griffiths (1997), who found that most boys play computer games, especially amusement arcade games, more frequently than their female counterparts.

Gaming Skills

Data related to subjects' perception of their gaming skills is presented in Figure 4.2. (Note that the eight subjects who do not play computer/video games on a regular basis did not respond to this question; data was collected from 24 subjects.)

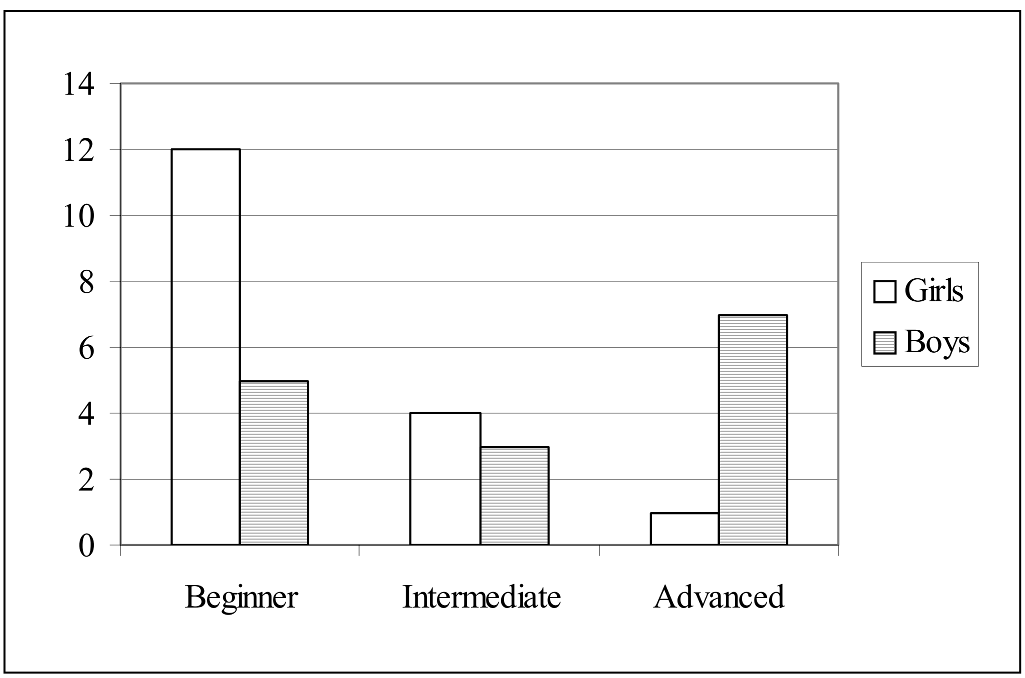

Figure 4.2: Subjects' perception of their gaming skills

As Figure 4.2 shows, most boys who play computer/video games on a regular basis perceived their gaming skills to be at the advanced or intermediate levels (47% and 21%, respectively). In contrast, most female subjects who play computer/video games on a regular basis perceived their gaming skills to be at the beginner or intermediate levels (70% and 24%, respectively). Only one girl (6%) perceived her gaming skills to be at the advanced level. These results are consistent with the fact that most girls (41%) do not play such games on a regular basis.

Math as Favorite Subject

Data related to changes in subjects' perception of math as their favorite subject is presented in Figure 4.3.

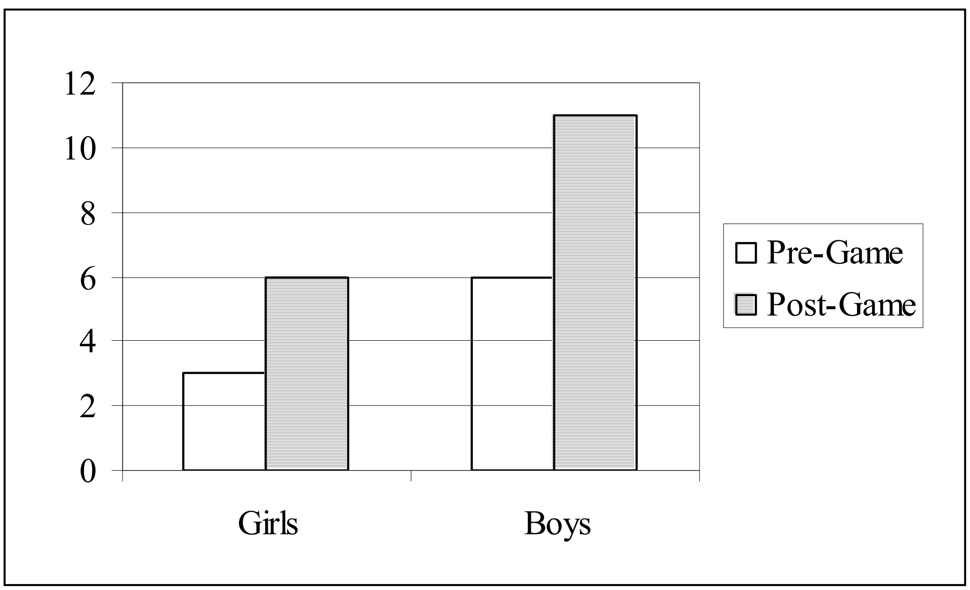

Figure 4.3: Changes in subjects' perception of math as their favorite subject

As Figure 4.3 shows, prior to subjects' active involvement with the games used in this study, 18% of the girls and 40% of the boys reported that math is their favorite subject in school. In contrast, responses to the post-game-play interview revealed that 35% of the girls and 73% of the boys found math to be their favorite subject. These results are consistent with those presented in the discussion of Research Question 6 and support the statement that computer games can "provide children with a context in which the children find learning mathematics meaningful and useful" (Sedighian, 1996). Subjects' preference for math appeared to increase as a result of their experience with the math computer games used in this study.

Perception of Math Skills

Figure 4.4 presents data related to subjects' perception of their math skills (i.e., whether they consider themselves to be "very good," "kind of good," "OK," "not very good," or "not good at all" at math).

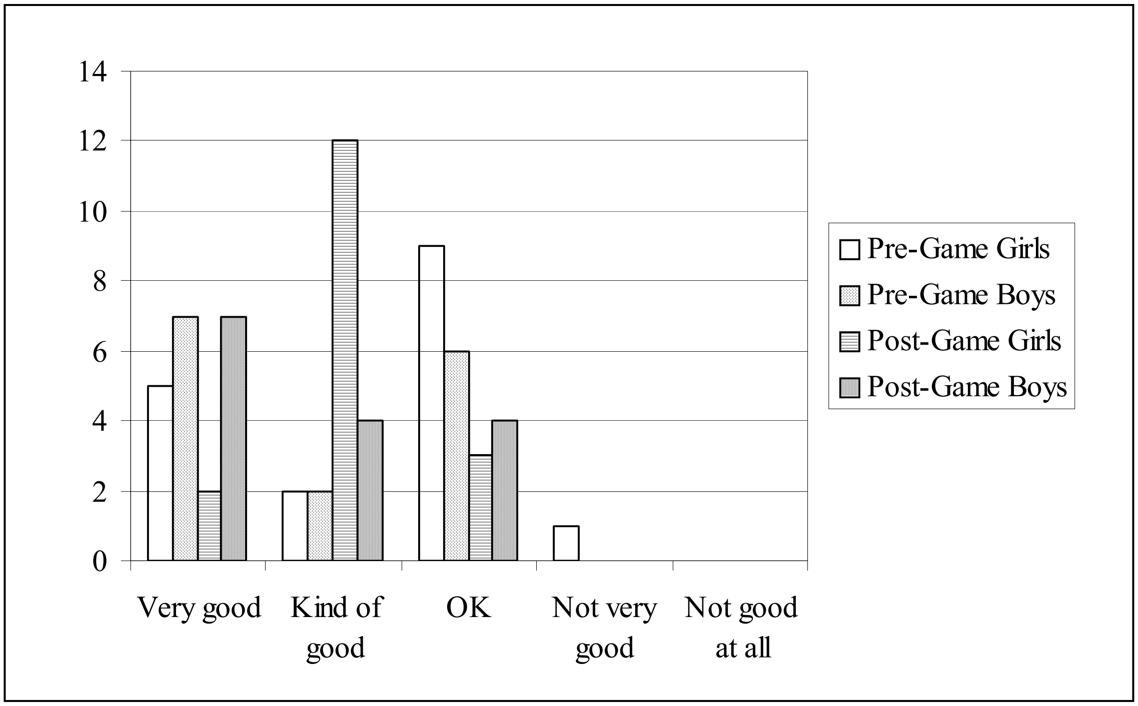

Figure 4.4: Subjects' perception of their math skills

As Figure 4.4 shows, prior to their active involvement with the games used in this study, 47% of the boys and 29% of the girls stated that they were "very good" in math; 13% of the boys and 12% of the girls stated that they were "kind of good" in math; 40% of the boys and 53% of the girls stated that they were "OK" in math; and one girl (6%) stated that she was "not very good" at math. None of the subjects stated that they were "not good at all" at math prior to their involvement with the games used in the study.

For the most part, subjects' perception of their math skills appeared to have changed during the study period. Responses to the post-game-play interview indicated that while the same number of boys (47%) perceived themselves to be "very good" in math, only 12% of the girls stated that they were "very good" in math. Twenty-seven percent of the boys and 71% of the girls stated that they were "kind of good" in math.

Twenty-seven percent of the boys and 18% of the girls stated that they were “OK” in math. None of the subjects stated that they were “not very good” or “not good at all” at math once they had participated in the study.

Interestingly, although both boys’ and girls’ preference for math appeared to increase as a result of their experience with the math computer games used in this study (see above; also see Research Question 6), fewer girls described themselves as “very good” at math during the post-game-play interview. On the other hand, most changes in subjects’ perception of their math skills occurred in a positive direction. That is, while the number of subjects who stated that they were “very good” or “OK” at math decreased during the study period (from 38% to 28% and 47% to 22%, respectively), the number of subjects who perceived themselves to be “kind of good” at math increased substantially (from 13% to 50%), and there was no subject who considered him- or herself to be “not very good” or “not good at all” at math once he/she had participated in the study. It appears that most changes in perception of math skills occurred such that perceptions categorized as “kind of good” increased while other perceptions decreased. Thus, while fewer subjects (girls) assigned themselves the highest rating possible (“very good”) once they had participated in the study, more subjects assigned themselves higher ratings (decreasing the number of perceptions categorized as “OK” and “not very good”).

<u>Preference for Computer/Video Games</u>

Data related to whether subjects like playing computer games, video games, and/or both is presented in Figure 4.5.

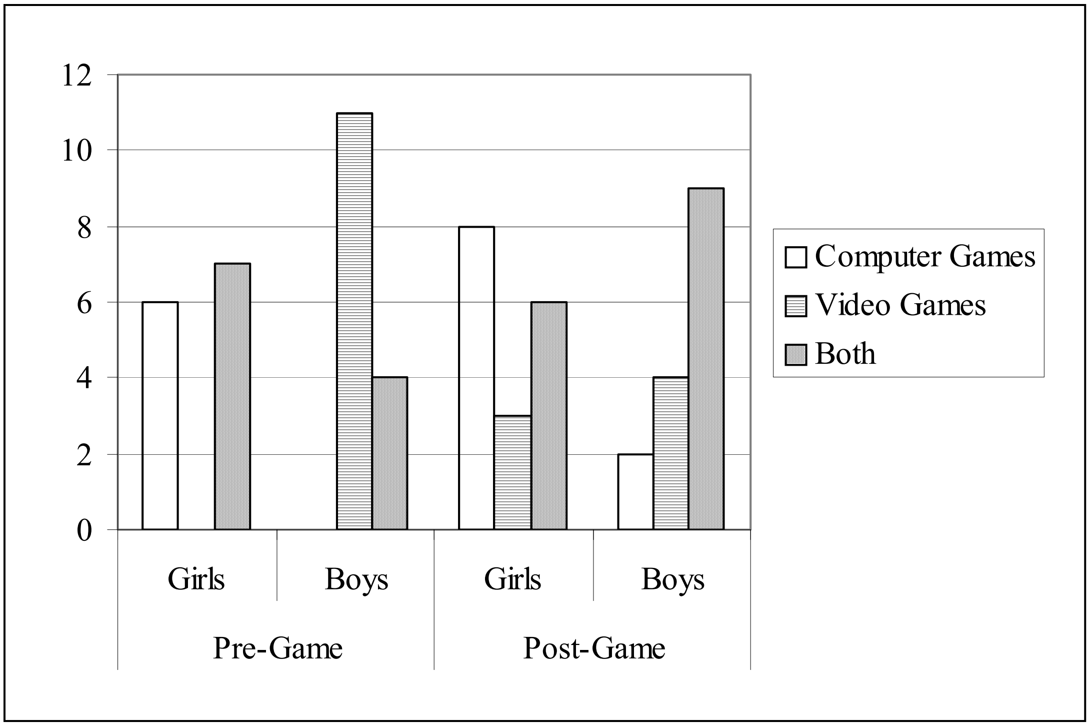

Figure 4.5: Subjects' preference for computer/video games

As Figure 4.5 shows, prior to their active involvement with the games used in this study, 19% of the subjects (six girls) reported that they liked playing computer games; 34% of the subjects (11 boys) reported that they liked playing video games; and 34% of the subjects (41% of the girls and 27% of the boys) reported that they liked playing both computer and video games. Thirteen percent (4 girls) stated that they did not like to play computer/video games.

In contrast, 31% of the subjects (47% of the girls and 13% of the boys) reported a preference for computer games during the post-game-play interview, while 22% (18% of the girls and 27% of the boys) reported a preference for video games and 47% (35% of the girls and 60% of the boys) reported a preference for both computer and video games. All subjects stated that they liked to play computer games, video games, or both during the post-game-play interview. Moreover, both boys and girls gained an appreciation for computer games during the study period. Again, only 19% (six girls and no boys) reported a preference for computer games prior to their involvement with the computer games used in the study, while 31% of the subjects (eight girls and two boys) reported a preference for computer games during the post-game-play interview. The increase in the number of subjects who reported a preference for both computer and video games (from 34% to 47%) provides further evidence that subjects gained an appreciation for computer games once they had participated in the study.

Subjects were asked to report what they like about computer/video games in both the pre- and post-game-play interviews. Below are examples of subjects' responses:

Girls

- "You can have fun and learn stuff…and study less.
- "Mostly I don't play video games…[they're] boring. Computer games can teach you a lot of stuff so when you go to class you'll know it."
- "[I like] video games, because you can control 'em."
- "[I like computer games,] because they teach you more stuff than PlayStation would."
- "When you are mad or stressed out…you know…if you play [you can] get your mind off something."
- "[Games are] fun to play. I like the graphics, characters, and music in computer games."
- "It's easier to play computer games."
- "With PlayStation, you don't need to do math all the time, just play and have fun."
- "They're not like PlayStation or any thing like that, computer games are about education and real fun. But I like 'em both."

Boys

- "I like to play computer games because they are better than the teacher."
- "I like video games because they are fun and all my friends wanna play them."
- "I like the sound, music, and characters [in the games]."
- "I like video games, because they give more of an adventure. Computer games are about math and stuff like that. I like adventure games better."
- "The games…are fun."
- "I like PlayStation games because I play with my Dad, and I like education games because they teach me somethin'."
- "I like the sound and graphics."
- "I like video games [because you have] adventure, race, speed."
- "With education games, you always have to stress to get somethin' right. But if you play video games you have a lot of games like soccer games, or football, or [you can] shoot things like aliens. But education…all they got is math, reading, and that's kinda boring because when we are at school we are bored, I don't wanna go home and play it."
- "Both [computer and video] games have a lot of action, adventures, music, and sounds."
- "I like to play video games because you don't need to push certain buttons or type the answer. With a Joystick it is easier to play games."
- "I like the adventure in video games. I also like graphics, images, characters and stuff like that."
- "I like education games because they teach you stuff and the video games are challenging, and the reason I am really smart is because of computer games."
- "Video games are easy to play, but computer games are hard because of typing and stuff."

Results of the Study

Research Question 1:

Are games' gender classifications consistent with students' preferences?

In the first section of the post-game-play interview (Appendix H), subjects were asked whether they had any favorite of the three computer games they played for the research project (Phoenix Quest, MindTwister Math, and NFL Math). Their responses are illustrated in Figure 4.6.

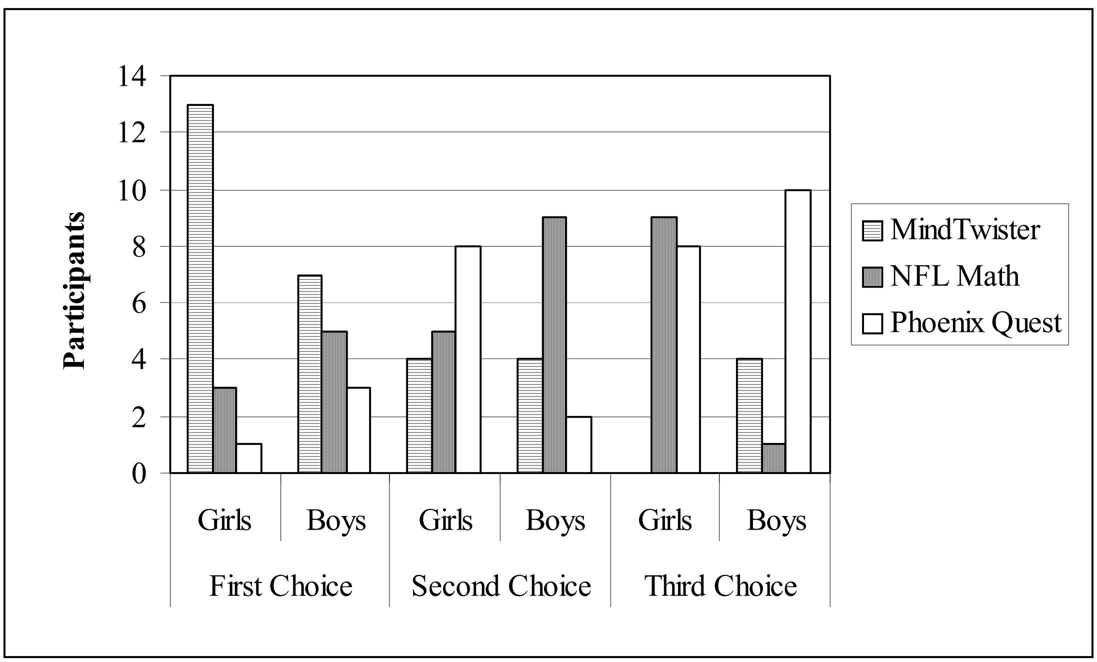

Figure 4.6: Subjects' identification of three computer games as first-, second-, or third-favorite

As Figure 4.6 shows, most subjects (n = 10, 63%) identified MindTwister Math as their favorite game, and girls identified the game as their favorite to a greater extent than did boys (76% vs. 47%). NFL Math was the game most often identified as subjects' second-most-favorite; 44% (60% of the boys and 29% of the girls) referred to NFL Math as their second-most favored game. Phoenix Quest was the game most often identified as least favored by both boys and girls. Fifty-six percent of all subjects (67% of the boys and 47% of the girls) identified Phoenix Quest as their least favorite game.

The data show mixed results concerning the consistency of games' gender classifications with subjects' preferences. First, both boys and girls identified MindTwister Math, the gender-neutral game, as their favorite game. With regard to the remaining two games identified by boys and girls as their favorite, subjects' choices did not appear to correspond to gender to any significant degree. Although more boys (33%) than girls (18%) identified NFL Math (the male-oriented game) as their favorite, fewer girls than boys identified Phoenix Quest (the female-oriented game) as their favorite (6% and 20%, respectively).

A correspondence of game gender classification with subjects' preferences becomes more apparent when considering the games subjects identified as their second- and third most favored games. Significantly more boys (60%) than girls (29%) identified NFL Math, the male-oriented game, as their second-favorite, while significantly more girls (47%) than boys (20%) identified Phoenix Quest, the female-oriented game, as their second-favorite. This pattern is also seen with the games least favored by subjects. Significantly more girls (53%) than boys (7%) identified the NFL Math, male-oriented game, as their least favorite, and more boys (67%) than girls (47%) identified Phoenix Quest, the female-oriented game, as their least favorite.

Research Question 2:

How do participants perform on the three computer games?

Data related to subjects' game performance was collected to provide insight as to whether or not boys and girls perform better on games corresponding to their own gender. This data is presented in Table 4.5. (Game scores were adjusted such that subjects could earn a maximum of 100 points per game session. With regard to MindTwister Math, since it was possible to earn up to 3000 points while playing this game in the allotted time period, final scores were divided by 30. There was no need to adjust scores earned while playing NFL Math; i.e., each game was worth 100 points and it was possible to play only one game per session. With regard to Phoenix Quest, selected activities were assigned a value of 10 points each by the researcher, and subjects could complete up to 10 activities per session.)

Game	Gender	Session	Mean Adjusted Score
MindTwister	Girls	1st	32.88
		2nd	40.94
		3rd	54.00
	Boys	1st	42.53
		2nd	54.53
		3rd	57.80
NFL Math	Girls	1st	79.88
		2nd	73.53
		3rd	77.18
	Boys	1st	83.73
		2nd	78.47
		3rd	86.40
Phoenix Quest	Girls	1st	26.47
		2nd	51.76
		3rd	67.06
	Boys	1st	44.67
		2nd	68.00
		3rd	74.00

Table 4.4: Participants' performance on three computer games

As Table 4.5 shows, game performance varied depending on the game played. Both boys and girls obtained their highest scores while playing NFL Math and obtained lower scores while playing Phoenix Quest and MindTwister. This trend suggests that game performance, rather than corresponding to the gender of the player, instead is related to game gender-orientation. That is, each game's scoring system is based on whether the game is male-oriented, female-oriented, or gender neutral; thus, the male-oriented game (NFL Math) yields the highest scores and the female-oriented (Phoenix Quest) and gender-neutral (MindTwister) games yield lower scores. (Again, the female-oriented game actually yields no scores, and scores associated with this game were assigned by the researcher.) A direct statistical comparison of subjects' performance on the three games is therefore impossible and each game must be considered separately.

With regard to subjects' performance on the gender-neutral game, scores improved across game sessions for both boys and girls, with boys obtaining higher scores in all sessions. This trend was also observed in subjects' performance on the female-oriented game. With regard to subjects' performance on the male-oriented game, while boys obtained higher scores than girls in all sessions, the scores of both boys and girls dropped at the second session and then improved at the third session. (Girls obtained their highest scores the first time they played this game, while boys obtained their highest scores in the last session.) Trends in subjects' game performance are consistent with the literature. Girls tend to be less concerned with obtaining high scores than boys (Klawe, 1999), and the fact that both girls and boys improved with practice suggests that the playing of video games can help girls "catch up" with boys in skills where there performance may be lower (Greenfield et al., 1992).

The fluctuation in scores associated with the male-oriented game suggests that this game was particularly difficult for both boys and girls because they had to "know football" in order to play. The higher scores associated with this game's first session can be explained by the fact that subjects were always especially enthusiastic during first sessions (new games). The fact that scores dropped in the second session and then rose in the third session is consistent with the proposal that subjects found the game difficult;

i.e., subjects' scores improved with practice. Interview data also indicates subjects were challenged by NFL Math: As one female student stated, "Even though it was pretty easy for me, I didn't understand it as much as the other games, because football is not my sport."

Finally, although each game's unique scoring system makes it impossible to analyze subjects' performance across all game sessions, at face value the data nonetheless "indicate" that game performance is unrelated to game preference. Again, subjects obtained their highest scores in the male-oriented game. Moreover, overall, subjects obtained higher scores in the female-oriented game sessions, whereas most subjects identified the female-oriented game as their least favorite, and the lowest scores across all game sessions tend to correspond with subjects' favorite game. These findings support the assertion that game performance is related to game gender-orientation, and not the gender of the player.

Research Question 3:
Do participants report positive and/or negative reactions to specific game imagery, game format, or other game aspects?

During the post-game-play interview, subjects were asked to report their positive and/or negative reactions to specific imagery, format, or other aspects associated with the games played in this study. The researcher took notes during the interviews and sometimes asked additional questions in order to verify information or to ask for clarification. A representative sample of subjects' reactions is provided below:

Positive Reactions

- "It has mazes and things to do, like put stuff together; it is just like an adventure game." *(girl) (Phoenix Quest)*

- "…the music was cool." *(girl) (NFL Math)*

- "Matt and Nina who talked to you when you play the game, were funny and I like 'em." *(girl) (MindTwister Math)*

- "You can have fun and learn stuff about math and study less." *(girl) (MindTwister math)*

- "I like the questions, they make it easy for you; they are not pressuring you too much." *(girl) (Phoenix Quest)*

- "You don't have to do all that hand stuff with math, you can do it using the mouse and the keyboard." *(girl) (NFL Math)*

- "It's like … when you get something wrong you don't have to worry about it because you are not gonna die or stuff like that; but, PlayStation when you make a wrong move or something…'O, man, I shouldn't have done that,' then and you can't go back." *(girl) (all games)*

- "They're not like PlayStation or any thing like that, computer games are educational and real fun. I like 'em both." *(boy) (all games)*

- "NFL Math was challenging, fun to play and a fun way to learn math." *(boy) (NFL Math)*

- "I love football and love math." *(boy) (NFL Math)*

- "It doesn't rush you to answer questions." *(boy) (Phoenix Quest)*

Negative Reactions

- "…you're timed and pressured" *(boy) (MindTwister Math)*

- "…it asks the question too quick and don't let you think that much." *(boy) (MindTwister Math)*

- "…I don't like math and you don't get much time plus you have to press the letter and then the number." *(girl) (all games)*

- "It is not as fun as MindTwister." *(girl) (Phoenix Quest)*

- “It’s hard and I couldn’t understand it.” *(boy) (Phoenix Quest)*

- “When I click on an answer it sometimes wrong and it’s kinda hard for me to get it.” *(girl) (NFL Math)*

- “I don’t really like football that much.” *(boy) (NFL Math)*

- “Even though it was pretty easy for me, I didn’t understand it as much as the other games, because football is not my sport.” *(boy) (NFL Math)*

Following numerous readings of individual interview protocols, an analysis of interview responses suggested subjects’ reactions to the games were based on the following themes: “fun” (whether the game is fun to play); presence (or absence) of pressure to perform; interest in game format; interest in subject matter (math); facilitation of learning in math; and degree of difficulty (of either the game itself or the math problems therein). For the most part, subjects reacted positively to the games when they found the games were fun to play; facilitated learning in a fun way; and did not include pressure to perform. Conversely, subjects generally reacted negatively to the games when they felt a certain pressure to perform or when they did not appreciate the games’ focus (e.g., math, football).

Research Question 4:

Do participants perceive the games as being oriented toward certain players?

In the post-game-play interview, participants were asked to report their perceptions as to whether the games they played were oriented toward boys, girls, or both boys and girls. These results are presented in Figure 4.7.

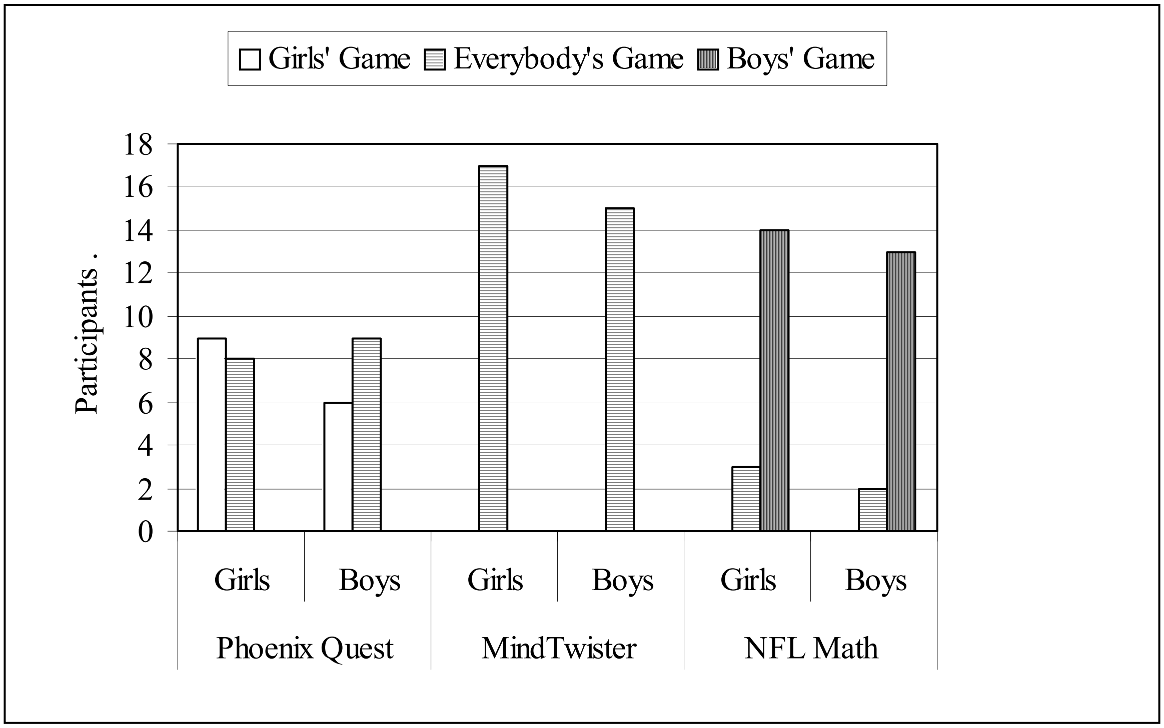

Figure 4.7: Participants' perception of game gender orientation

As illustrated in Figure 4.7, subjects' perceptions of the three games' gender orientation appeared to be consistent with the games' gender classifications as determined by the researcher. All subjects (100%) perceived MindTwister Math to be gender-neutral. Moreover, there was no subject who perceived Phoenix Quest to be oriented toward boys and no one perceived NFL Math to be oriented toward girls. A significant majority of subjects, 82% of the girls (n = 14) and 87% of the boys (n = 13), perceived NFL Math to be male-oriented; however, while many subjects (53% of the girls and 40% of the boys) perceived Phoenix Quest to be female-oriented, these subjects were in the minority. A small majority of subjects (47% of the girls and 60% of the boys) perceived Phoenix Quest to be gender-neutral.

Two additional findings are of interest: First, girls identified the male-oriented game as gender-neutral to a greater extent than did boys (18% vs. 13%, respectively). Second, boys identified the female-oriented game as gender-neutral to a greater extent than did girls (60% vs. 47%, respectively). The latter finding is consistent with research suggesting that Phoenix Quest is popular with boys as well as girls (Klawe et al., 1997). That is, when a game that is obviously geared toward females is one boys can appreciate, these boys may be more likely to classify the game as gender-neutral than as female-oriented (boys tend not to admit to preferring female-oriented material).

Research Question 5:

Do participants perceive the subject of math to be relevant to their daily lives?

In both the pre-game play and post-game play interviews, boys and girls were asked whether math is important in "real life" and whether people use math in their daily lives. All subjects answered this question affirmatively in both interviews. Below are examples of subjects' responses:

Girls

- "If you go to the store, you need to know how much you should pay for something."
- "You need to know how to count money and stuff. You also need to know measurements like a quarter, gallon and stuff like that."
- "You have to count your money when you go to store."
- "You have to tell time, count money. See how much money is left."

- “If you work at McDonald’s you have to figure out how much you have to give back a person. If you take a $20 bill and they only pay for something that costs $15. Other things, like my mom works at BankOne in a big building and she does a lot of math stuff.”

- “Ya, like you have to know how to count money and things like that.”

- “Yes, because there is a lot of stuff you need math for like buying stuff, buying a house, counting money.”

- “Because if you are a person working at store, you have to count money.”

- “Say I wanna work at the store and somebody wants you to ring ’em up for a certain amount and they give you more than that, you need to figure out how much you give them back. Ya, we use math in every thing in life.”

<u>Boys</u>

- “If you don’t know math you won’t be able to tell time or count money or you won’t get a job.”

- “We use math in everyday life; when you go to the store, you see how much cash you need, and if you go to school you’ll need to see how much time you need to get there.”

- “Ya, because if you wanna buy something and somebody cheat you up and make you pay what you shouldn’t pay; and you don’t know because you can’t count or anything, and that’s why you need to know math and stuff.”

- “In sports you need math to count scores and all that, and in car games, like subtract, add points, and like that.”

- “Yep, at the store when you get your change. Or when you drive a car you need to see the mileage on your car, and stuff like that.”

- “Ya, when you get old you need to know how to write checks and count your money when you go to store to buy candy and how much you should pay to the cashier.”

- “Ya…it’s important because you need to know how to count your money and stuff.”

- “Of course, if you don’t have math, let’s say you go to the store, you wouldn’t find how much money this is and how much money is that. If you buy

> something for $7 and you give them $10, they won't give you anything back if you don't know math."

As can be seen in the examples listed above, overwhelmingly, subjects perceptions of math's relevance centered on "counting money." In turn, most of these responses (n = 10) focused specifically on buying, while a minority were concerned with selling (n = 3) or with counting money in a general sense (n = 3). Some subjects made reference to the relevance of math for other measurements such as that of time, mileage, or sports scores. One response shown above referred to math's relevance to work, or "getting a job." Not surprisingly, subjects (fourth-graders) did not seem aware of the relevance of math to advanced functions such as construction, marketing, hypothesis testing, etc.

Research Question 6:

Does playing computer games affect students' perception of the subject of math (i.e., do students report liking math more after playing the games)?

In the post-game-play interview, participants were asked to report whether they liked the subject of math more, less, or the same as they did before playing the three computer games used in this study. The results are presented in Table 4.5.

		Like Math More Now	Like Math The Same as Before	Like Math Less Now	Total
Subjects	Girls	13 (76%)	4 (24%)	0	17
	Boys	11 (73%)	4 (27%)	0	15
Total		24	8	0	32

Table 4.5: Changes in subjects' preference for math after playing math computer games

As Table 4.5 shows, most subjects gained an appreciation for math once they had played MindTwister, NFL Math, and Phoenix Quest. No subjects reported liking math less, and some subjects reported no changes in their preference for math. Boys' preference for math remained unchanged to a greater extent than did girls' (27% vs. 24%, respectively). Examples of subjects' responses are presented below:

<u>Girls</u>

- "Before I played the games it [math] was kinda difficult, but now once I played the games on the computers it is much easier for me."
- "…it's like easier for me to learn, I got to do it myself and I like working on the computers."
- "…they [games] are easier for you to understand and fun. Math is a little more fun now than before."
- "Yes, I like math more now. Because they [games] help me learn more…like, before, I got C or B, but after I started playing 'em I started getting A."
- "I like math more; because, first I didn't know even the meaning of math and when I played the game I got into it. I know how to do math now."
- "Yes, I like it more now than I used to; math makes more sense."

- "I like math more. Because you can see different sides instead of being boring…with games you have fun when you do it."

- "I like it a little more. It's much easier."

- "I like math more now because it's fun and easy."

- "I like math more because it's more fun and educational. It's [the games are]…like real easier than math books, trying to learn it out that way."

<u>Boys</u>

- "I like math way more. Because it [games] teach you more and when you play these games you learn math."

- "I like math more. [The games] kinda help me understand better."

- "Ya, I like math more. The games teach me lots of stuff about math."

- "I always like math. But my math grade is up after playing the games."

- "I like math more because before all these games when math used to come I used to get a headache and didn't like math. These games made it easier for me."

- "I like math more. Because, I just think…like…math was boring until I saw how fun it can be and stuff."

- "I like it more. I didn't know that math could be that fun. I like math more now."

- "Yes, math is more fun now. It's better than books."

<u>Statements of No Change in Math Preference</u>

- "I like math the same I did before." *(girl)*

- "I like math the same. I am not into math." *(girl)*

- "I still don't like math." *(girl)*

- "I like math about the same as I did before." *(boy)*

- “I am darn interested in math and these games didn’t teach any thing new. I am really smart.” *(boy)*

- “I like math about the same as I did before; this [the games] just added a little more fun to math.” *(boy)*

- “No, I still don’t like math.” *(boy)*

As can be seen in the examples listed above, themes in subjects’ explanations concerning increases in their preference for math centered on their perceptions that math was more easily learned once the games were played; or math was more fun or more interesting once the games were played. Most responses suggested that subjects generally found math to be difficult prior to playing the games used in this study. That one student who “always like[d] math” found his math grade to be “up after playing the games” suggests that even those subjects who tend to enjoy certain academic subjects can still benefit from electronic games oriented toward those same subjects. Finally, with regard to those subjects whose math preference did not change, some of their responses are reminiscent of responses presented in the discussion of Research Question 3: a minority of subjects found math to be aversive such that presentation of the subject in the (presumably fun-filled) game context made no difference in their preference for math.

Summary

Of the three games played by the participants in this study, the gender-neutral game (MindTwister Math) was that which was most favored. A correspondence of game gender classification with subjects’ game preference became apparent only when considering the games subjects identified as their second- and third most favored games.

Game gender classification did not appear to impact subjects' game performance. Boys obtained higher scores than did girls in all game sessions, including sessions corresponding to the female-oriented game (Phoenix Quest). Moreover, both boys and girls obtained their highest scores in game sessions corresponding to the male-oriented game (NFL Math). The lowest scores across all game sessions tended to correspond with subjects' favorite game.

Several themes appeared in subjects' reactions to the games they played, including "funness" (whether the game is fun to play); presence (or absence) of pressure to perform; interest in game format; interest in subject matter (math); facilitation of learning in math; and degree of difficulty (of either the game itself or the math problems therein). Subjects' perceptions of the games' gender orientation appeared to be consistent with the games' gender classifications.

Data analysis revealed a very weak relationship between game preference and game performance. Data collected from the female subjects were consistent with the observation that, in general, subjects obtained the lowest scores when they played their favorite game: Their game preference was negatively related to game performance. Boys' game performance appeared to be positively related to game preference, although this latter result was negligible. Girls' performance data is consistent with the literature showing that girls tend to take a more exploratory approach to computer games, being less concerned than boys with completing the games and/or obtaining high scores (Klawe, et al., 1997).

All subjects felt that math is relevant to "real life," especially in situations involving money. Most subjects gained an appreciation for math after playing the games used in this study. This study's results will be discussed further in the next chapter.

CHAPTER 5

SUMMARY, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

This chapter is organized into four sections: the summary of the study; conclusions and discussion; and suggestions for further study.

Summary of the Study

The purpose of this study was to investigate fourth-grade student preferences for and performance on gender-oriented versus gender-neutral educational computer games. The researcher examined the girls' and boys' perceptions of three computer games: a game designed with an orientation for girls; a game designed with an orientation for boys; and a game designed with an orientation that is gender neutral. Performance was examined by comparing girls' and boys' scores on the three games. Performance data also were used to determine if there was a relationship between game preference and game performance. The study also investigated the issue of whether educational computer games can affect girls' and boys' perceptions of the study of mathematics and the subject's relevance to their lives.

A descriptive-correlation research design combined with a qualitative research data collection approach (i.e., pre-game and post-game interviews) was used to guide the objectives of the study.

The objectives of the study were as follows:

1. To determine whether games' gender classifications are consistent with students' preferences.

2. To measure participants' performance on the three computer games.

3. To describe participants' reactions to specific game imagery, game format, and other game aspects.

4. To identify participants' perceptions of the games as being oriented toward certain players (i.e., oriented toward girls, boys, or everybody).

5. To determine whether participants perceive the subject of math as being relevant to their daily lives.

6. To identify the effect of playing computer games on student perceptions of the subject of math (i.e., Do students report liking math more after playing the games?).

Prior to data collection, approval was obtained from The Ohio State University's Human Subject Review Committee, the principal of the Midwestern public elementary school where the study was conducted, and the parents/guardians of the participants. Data collection encompassed four weeks in the spring of 2003.

The target population for this study were the two fourth-grade classes (n=42) at an urban Midwestern elementary school. The school serves a population that ranges in economic status from low-income to moderate-income. Thirty-six of 42 students were given permission by their parents/guardians to participate in the study. Four subjects dropped out of the study before it was completed, bringing the total number of subjects to 32 (17 girls and 15 boys). The majority of students in both fourth-grade classes were African-Americans.

This Midwestern elementary school was chosen because it encourages the integration of technology into the curriculum—especially math—and the students had sufficient experience with computers to operate the computer games. Every classroom, including the two fourth-grade classrooms where the research project was conducted, was equipped with five computers with fairly up-to-date software and hardware components. The fourth-grade teachers and administration were helpful and supportive of the research project.

The researcher selected three math-related computer games for use in this study—one female-oriented game (Phoenix Quest); one male-oriented game (NFL Math); and one gender-neutral game (MindTwister Math). The criteria used in the game selection process were culled from an in-depth study by this researcher of the body of literature on gender-related characteristics of computer and video games. The researcher then divided the relevant characteristics into three categories: game imagery; game format; and social and psychological aspects of the games.

Drawing on the instrumentation used in previous and related studies, particularly the study done by Janese Swanson in 1996, this researcher developed pre-game-playing and post-game-playing questionnaires designed for use during interviews with the study participants. The questions related to the participants' perceptions of the three computer games used in this study. Additional questions asked for participants' perceptions of math. (See Appendix B and Appendix C.)

Quantitative and qualitative techniques were used to analyze the data collected. Descriptive statistics were used to analyze the data collected through the game playing sessions and interviews. Statistical results were calculated using the SPSS/PC version 11.5 for Windows software program. Qualitative data (pre-game-playing interviews and post-game-playing interviews) were analyzed according to guidelines suggested by Miles and Huberman (1994).

Discussion

Objective 1 – *To determine whether games' gender classifications are consistent with students' preferences.*

When asked to name their favorite among the three computer games, only one of 17 girls selected Phoenix Quest, the female-oriented game as the favorite game, and five boys out of 15 selected NFL Math, the male-oriented game, as their favorite game. Surprisingly, a majority of both the girls and the boys named MindTwister Math, the gender-neutral game, as their favorite game.

Citing studies that indicate girls and boys have specific image preferences, Rogers (1995) and other theorists have suggested that educational media should emphasize rather than neutralize gender differences in order for the media to engage the attention of students. Similarly, it has been suggested that the "neutralization" of computer games makes the games appealing to no one. The findings of this study suggest, on the contrary, that gender-neutral games not only interested the participants of the study but were chosen by both girls and boys as their favorite game.

However, when the students were asked to name their second-favorite game, the selections were along gender lines. The girls most frequently selected the female-oriented game, Phoenix Quest, as their second favorite, and the boys most frequently selected the male-oriented game, NFL Math, as their second-favorite game.

This gender-related pattern also was seen when participants named their least favorite computer game. The girls most often named NLF Math as their least favorite (but only by one vote), while the boys overwhelmingly selected Phoenix Quest as their least favorite. This finding was in agreement with previous studies that suggest girls are likely to accept male-oriented games, while boys are likely to reject female-oriented games.

The popularity enjoyed by MindTwister in this study may be due to several reasons. In some ways, MindTwister is gender neutral. As one male participant said, MindTwister didn't have sports stuff and it didn't have girly stuff. For example, there is no involved storyline which girls traditionally like, and there is no violence which boys traditionally like. In other ways, MindTwister is gender-inclusive. For example, there are two narrators, a girl and a boy; the game is fast-paced which boys traditionally like but there are step-by-step instructions on how to play the game which girls traditionally like. In observing the participants at play, this researcher noted two major characteristics of the game that appealed to both genders—immediate feedback and challenge. In this game, students are presented a variety of challenges in math activities where each game level progresses in difficulty. The fast pace, the user-friendly format, as well as the interactivity, graphics, music, and narrators offering immediate feedback appeared to make MindTwister successful as a gender-neutral game.

Objective 2 – *To measure participants' performance on the three computer games.*

Boys obtained higher scores than did girls in all three of the game-playing sessions and on all three of the games. This is not surprising given the game-playing experience levels of the girls and the boys. In the pre-game-playing interviews, almost half of the boys rated themselves as advanced game players; only one girl did. Seven of the girls said they had never previously played video or computer games; only one boy had not previously played computer games.

Although girls scored lower on all three games in all three game-playing sessions, the girls showed considerable improvement over time. This improvement was most notable with the female-oriented game, Phoenix Quest. In the first session, the mean score for girls playing Phoenix Quest was 26.47 (for boys, 44.67); in the final session, the mean score for girls was 67.06 (for boys, 74.00). The girls improved by more than 40 points; the boys improved by 29 points.

The only game in which the girls did not improve over time was NFL Math. Interestingly, the girls actually scored lower (77.18 mean score) during the final session than in the first session (79.88). One girl, who perceived herself as a very good math student, said she did not like playing NFL Math because "football is not my sport."

The girls also improved considerably over time on the gender-neutral game, MindTwister. For the girls, a pattern was established showing improvement on same-gender (female-oriented) and gender-neutral games, while the girls' mean score declined over time on the other-gender (male-oriented) game.

For the boys, there was no pattern of improvement related to specific gender-orientated games, although the mean scores of the boys did improve over time on all three of the games.

<u>Objective 3</u> – *To describe participants' reactions to specific game imagery, game format, or other game aspects.*

In general, there was a general pattern of both girls and boys being aware of certain game imagery or other game aspects as being gender-oriented. And generally speaking, the girls and boys liked game aspects identified in the literature as being oriented to their own gender and disliked the game aspects identified in the literature as being oriented to the other gender. For example, boys criticized the female-oriented game, Phoenix Quest, for using "girl" colors and having a girl as the lead character. However, a number of subjects said Phoenix Quest fun to play because it had both girl and boy characters. Girls liked the fact that Phoenix Quest had a leading female character and also enjoyed being able to write postcards to this character and receive answers back. A number of girls and a number of boys responded negatively to Phoenix Quest because they believed the game was hard. Both girls and boys said they liked the adventure in this game.

Similarly, many girls responded negatively to the football imagery used in the male-oriented game, NFL Math. A number of girls said they just didn't like football (two boys also said they did not like football). Many boys responded positively to NFL Math because they said the game allowed them to score lots of points.

Most of the participants were aware the gender-neutral MindTwister was a "fun game for boys and girls." Girls often responded positively to being able to choose an animal as a game piece, while boys often responded positively to being able to choose a truck as a game piece.

<u>Objective 4</u> – *To identify participants' perceptions of the games as being oriented toward certain players.*

All subjects perceived MindTwister Math to be gender-neutral. Moreover, there was no subject who perceived Phoenix Quest to be oriented toward boys and no one perceived NFL Math to be oriented toward girls.

Two additional findings are of interest: First, girls identified the male-oriented game as gender-neutral to a greater extent than did boys. Second, boys identified the female-oriented game as gender-neutral to a greater extent than did girls. The latter finding is consistent with research suggesting that Phoenix Quest is popular with boys as well as girls (Klawe et al., 1997). That is, when a game that is obviously geared toward females is one boys can appreciate, these boys may be more likely to classify the game as gender-neutral than as female-oriented (boys tend not to admit to preferring female-oriented material).

Objective 5 – To determine whether participants perceive the subject of math as being relevant to their daily lives.

In both the pre-game-playing interview and the post-game-playing interview, all participants said math was relevant to their daily lives. Most responses included statements that math is relevant to daily life because math helps you make change or count money. Researchers such as Sedighian and Sedighian (1996) have noted that children often find the subject of mathematics difficult, irrelevant to their lives, and boring. Many of the participants in this current study did find math difficult and even boring, but they did not find the subject irrelevant to their lives.

Objective 6 – To identify the effect of computer games on student perceptions of the subject of math (i.e., Do students report liking math more after playing the games?).

Playing educational computer games related to the subject of mathematics had a significant effect on participants' perceptions of the subject of math. In the pre-game-playing interviews, three girls identified math as their favorite school subject. After playing the games, six girls identified math as their favorite school subject. Interestingly, the three girls who named math as their favorite subject after playing the games had identified math as their least favorite subject prior to playing the games.

Among the boys, six identified math as their favorite school subject prior to playing the computer games. After playing the games, 11 boys named math as their favorite school subject.

In the post-game-playing interview, participants were asked to report whether they liked the subject of math more, less, or the same as they did before playing the three computer games. Seventy-six percent of the girls and 73 percent of the boys reported liking the subject of math more than they had before playing the games. None of the respondents reported liking math less after playing the games. A higher percentage of boys than girls reported liking math prior to game-playing, and a higher percentage of boys reported liking math after game-playing. In fact, the percentage of boys who liked math increased more with game-playing than did the percentage of girls.

Conclusion

In recent years, there has been a rapid expansion of interest in the use of computer games in education. The uses of computer games have significant potential to enhance children's motivation and amplify cognition. Sedighian and Sedighian (1996) have been involved in long-term research on children, the study of mathematics, and computer games, and they designed a game called Super Tangrams aimed at helping sixth-graders learn 2-dimensional transformation geometry. The Sedighians also have been a part of the E-GEMS project.

Sedighian and Sedighian (1996) believe that computer-based mathematical games can not only provide children with a context in which the children find learning mathematics meaningful and useful, the games can also provide researchers with a rich medium from which to gain new insights into the psychology of learning mathematics.

Sedighian and Sedighian spent six month observing the members of a sixth-grade class play the Super Tangrams computer game. The researchers' findings included the following:

1) Situating mathematical learning in a computer-game environment brings greater relevance to the subject for children. Students commented that when they are doing math out of a book, they just want to get it over with—but when they are using a computer math game, "you are wanting to do it and you're having fun with it so you can concentrate on doing instead of just getting it over with."
2) The computer math games provided the participants with a goal or set of goals to achieve.
3) Accomplishing those goals provided the participants with a sense of success.
4) The participants did not become bored because they found the games challenging. The participants particularly liked games that would progressively become more challenging.
5) The computer games enabled the participants to associate mathematics with pleasure. (pp. 3-5)

In a 1997 paper, Sedighian writes that the problems in helping children to learn mathematics are twofold: 1) to motivate them to want to spend time and engage in mathematical activities, and 2) to aid them cognitively to construct mathematical knowledge. Because computer games are an integral part of children lives, Sedighian writes, well-designed computer-based mathematical games may be able to address these two problems.

Sedighian proposes a model for a computer-based mathematics learning environment designed to engage children in the learning process through challenge-driven, goal-directed activities. The model suggests that:

1) Game activities should be highly goal-driven and have clear rules of play so that children are at all times intensely focused on achieving the goals of the game;
2) Children should continuously receive feedback that is directly linked to the goals of the game;
3) The game should gradually become more challenging and reflective while at the same time providing an instructional component in order to sustain the flow experience.

To prevent frustration and boredom, the dynamics between the game and the instructional component should be fine-tuned so that children receive appropriate instruction for the type and level of the mathematical problems they are solving. (Sedighian and Sedighian 1996, p. 5)

Tzeng (1999) writes that the educational benefits from the use of computer games include: the games typically elicit complete mental involvement from participants; the games have concrete goals and rules that help focus attention and direct action; the games typically require a high degree of player interaction and provide immediate feedback; well-designed games often incorporate variable levels of challenge to keep players involved as their skills increase; the games enhance recall and transfer of knowledge; the mental imagery evoked by game environments or “worlds” facilitate the retention of educational materials embedded in the game; and well-designed games are fun to play.

This current study supports the research of Sedighian and Sedighian and of Tzeng discussed in the preceding paragraphs. The participants' performance on the educational computer games related to the subject of mathematics improved over time in all three of the game-playing sessions and on all three of the games. Prior to the participants' involvement in the study, math was not perceived as a favorite subject for the majority of the participants, and the subject generally was perceived as difficult and/or boring. Participants' exposure to the games played in the study helped the participants to gain an appreciation for math, presumably because math became associated with the pleasure they experienced while playing the games. While participants did not state explicitly that they found the games to be "meaningful," they did say that they found the games to be "fun" and "challenging." Participants also noted that they appreciated the immediate feedback provided by the games.

This study supports the assertion that well-designed computer-based math games can motivate children to spend time studying or practicing math (Tzeng, 1999). The study further suggests gender-neutrality can be a principal component of those games that are well-designed.

Suggestions for further study

Based on the findings of this study and the review of literature, the following suggestions for further study are made:

1. This study used fourth grade students in an urban Midwestern elementary school, as a model to investigate gender-related preferences and performance in

educational computer games used mainly for educational purposes. The majority of students in this school were African-American. Replicating this study in a different setting where the majority of students are European-American would be beneficial. The results of the studies can be compared and contrasted. By replicating this study, more insight and understanding would be achieved about the issues of gender, race, and computer games use in education.

2. Teachers might have passive attitudes toward "educational" computer games as an educational tool in the classroom and/or in their curriculum instructions. Since "educational" computer games as an educational tool strongly affects students, research should examine the attitudes of teachers toward the use of the computer games in the curriculum.

3. Future studies should investigate the extent to which "educational" computer games are used as an instructional tool, along with the degree to which teachers find educational computer games to enhance and/or support their instructions.

4. This study used, to a large extent, a quantitative methodology to investigate fourth-grade students' gender-related preferences in educational computer games. Qualitative research aims to provide in-depth information that quantitative research might not be able to access. Conducting additional qualitative studies at different and/or higher grade levels might provide more understanding of the gender issues in educational computer games.

5. Qualitative data indicated that time constraints (teachers' lack of time to sift through technology to find appropriate materials) was the most frequently mentioned teacher-related limitation inhibiting the use of technology, including educational computer games, in their curriculum. More studies are needed to investigate time-constraint limitations, as well as teachers' and schools' priorities.

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APPENDIX A

Entertainment Software Rating Board (ESRB)

What is the Entertainment Software Rating Board?

The ESRB is an independent, self-regulatory entity that provides comprehensive support services to companies in the interactive entertainment software industry. Established in 1994, the ESRB is the nation's leading non-profit, entertainment software rating body. Today, after rating over 7,000 game titles, the ESRB has evolved into a dynamic organization. It provides services not only for rating software titles, but also for rating Websites and online games, for ensuring online privacy protection, and for reviewing advertising created by the interactive entertainment industry.

What the Ratings Do

The ESRB ratings are designed to give consumers information about the content of an interactive video or computer entertainment title and for which ages it's appropriate. The ESRB ratings are not meant to tell you what to buy or rent or to serve as the only basis for choosing a product. Rather, consumers should use the ESRB ratings in conjunction with their own tastes and standards when purchasing or renting a video game.

What to Look For

Ratings: Consumers should look on the front of the package for the ESRB rating symbol, which gives information on ages for which the product is appropriate.

Content Descriptors: In addition to the rating, consumers should check for important content information (also called "descriptors") in the black-and-white box on the back of the package. These content descriptors give more details about the product in terms of violence, sexual themes, language, and other areas that may be of interest to some consumers.

How Are the Products Rated?

Each product is rated by three independent, trained raters. The raters represent a wide range of backgrounds, races, and ages and have no ties to the interactive entertainment software industry. Raters include retired school principals, parents, professionals, and other individuals from all walks of life.

Attention all game publishers: The ESRB also rates Online Games. If you would like more information on how to get your game rated quickly by the world's foremost interactive rating board, please contact us at info@esrb.org.

For more information on the Entertainment Software Rating Board, please write to 845 Third Avenue, New York, NY, 10022. Email: info@esrb.org; Web site: www.esrb.com

Rating Categories

Early Childhood Interactive

Websites and online games rated "Early Childhood Interactive (ECi)" have content that may be suitable for persons ages three and older.

Everyone Interactive

Websites/webpages and online games rated "Everyone Interactive (Ei)" have content that may be suitable for persons ages six and older. These sites will appeal to people of many ages and tastes. They may contain minimal violence, some comic mischief (for example, slapstick comedy), or some crude language.

Teen Interactive

Websites/webpages and online games rated "Teen Interactive (Ti)" have content that may be suitable for persons ages 13 and older. Sites in this category may contain violent content, mild or strong language, and/or suggestive themes.

Mature Interactive

Websites/webpages and online games rated "Mature Interactive (Mi)" have content that may be suitable for persons ages 17 and older. In addition, these sites may include hate speech, more intense violence and language and more mature sexual themes, than products in the Teen category.

Adults Only Interactive

Websites/webpages and online games rated "Adults Only Interactive (AOi)" have content suitable only for adults. These sites may include graphic depictions of sex and/or violence. Adults Only sites are not intended to be viewed by persons under the age of 18.

APPENDIX B

Pre-Game-Play Interview Instrument

PRE-GAME-PLAY INTERVIEW INSTRUMENT

Participant's Name ____

Gender ☐ Girl ☐ Boy

Age _____ years old

1. Have you ever played video or computer games before?
   How often do you play? Do you play at home?

2. How would you describe yourself as a player?
   A beginner? An intermediate player? An advanced player?

3. Do you like to play video or computer games?
   What do you like about them?

4. What subject do you like most in school?

5. What subject do you like the least?

6. What about math? Is it one of your favorites?
   One of your least favorites?
   Or is it a subject you don't care about one way or the other?

7. What kind of math student do you think you are?
   Very good? Kind of good? OK?
   Not very good? Not good at all?

8. Do you think math is important in real life? Is math something people use in their everyday lives?

APPENDIX C

Post-Game-Play Interview Instrument

Participant's Name: ____

PART 1 THE THREE COMPUTER GAMES

1. Did you like the computer games you played for my research project?
   What did you think of:
   MindTwister? NFL Math? Phoenix Quest?
   Did you have any favorites? Were there any you didn't like?

2. Why did you like (or why didn't you like) MindTwister? Would you like to play this game again? Why? Was it important to you to do well when you played this game?

3. Why did you like (or why didn't you like) Phoenix Quest? Would you like to play this game again? Why? Was it important to you to do well when you played this game?

4. Why did you like (or why didn't you like) NFL Math? Would you like to play this game again? Why? Was it important to you to do well when you played this game?

5. Who do you think MindTwister was made for? Do you think it was made for everybody to play? For girls to play? For boys to play? Why?

6. Who do you think Phoenix Quest was made for? Do you think it was made for everybody to play? For girls to play? For boys to play? Why?

7. Who do you think NFL Math was made for? Do you think it was made for everybody to play? For girls to play? For boys to play? Why?

8. In the future, would you like to play more math computer games?

PART II BACKGROUND INFORMATION

1. Do you like to play video or computer games? What do you like about them?

2. What subject do you like the most in school?

3. What subject do you like the least?

4. What about math? Is it one of your favorites?
   One of your least favorites? Or is it a subject you don't care about one way or the other?

5. What kind of math student do you think you are?
   Very good? Kind of good? OK? Not very good?
   Not good at all?

6. Do you think math is important in real life?
   Is math something people use in their everyday lives?

7. Do you like math more now than you did before you played the three computer games? Do you like it less now? Do you like it about the same as you did before?

APPENDIX D

Parent/Guardian Letter of Consent for Participation

5270 Timberline Road
Columbus, OH 43220

March 14, 2003

Dear parent/guardian:

The purpose of this letter is to ask your permission for child to participate in nine 30-minute game sessions and respond to two short interviews as a part of a research study of gender-related preferences in educational computer games related to the subject of mathematics.

I am conducting this study to complete my Ph. D. program at The Ohio State University under the direction of Professor Suzanne Damarin.

The educational computer games to be played in this study are 1) MindTwister Math, 2) Phoenix Quest, and 3) NFL Math (second edition). I will simply ask students to play the three games to the best of their ability. Game sessions will not involve manipulation or introduction of stress on my part. Once students have completed the game sessions, I will analyze their game scores to determine whether their game performance is higher or lower in Mathematics depending on the game they played. Each student interview should take no more than 15 minutes to complete. Interviews will not address any personal or sensitive issues; they will focus entirely on the educational video game use and preference.

Finally, students' names and any other information that could identify them will be kept confidential. Related to this, I will be using codes not names when recording individual participants' questionnaire or game results in my research. Please also be advised that students' participation in this study is voluntary and they may withdraw from the study at any time.

Please complete and mail the attached letter to Midwestern Elementary School, only if you do not wish your child to participate in my study. If you have any questions or would like to receive a summary of the research results, please contact me at the above address, by e-mail at kmubireek@yahoo.com, or by telephone at (614) 451-0360. Thank you very much for your consideration.

Sincerely,

khalid al mubireek

Khalid Mubireek, Ph.D. Candidate
School of Educational Policy and Leadership, College of Education

The Ohio State University

PARENT/GUARDIAN LETTER OF CONSENT FOR PARTICIPATION IN SOCIAL AND BEHAVIORAL RESEARCH

Principal Investigator: **Khalid Al Mubireek**

I consent to my child's participation in the academic study entitled **Gender-Oriented vs. Gender-Neutral Computer Games in Education**, conducted by **Khalid Al Mubireek** of The Ohio State University.

The investigator has explained the purpose of the study, the procedures that will be followed, and the amount of time it will take. I understand the possible benefits, if any, of my child's participation.

I know that my child can choose not to participate without penalty to my child. If I agree to participate, my child can withdraw from the study at any time, and there will be no penalty.

☐ **I consent to the use of educational video games. I understand how these educational video games will be used for this study.**

☐ **I do not wish my child to participate in this study.**

I have had a chance to ask questions and to obtain answers to my questions. I can contact the investigator, Khalid Al Mubireek, at 5270 Timberline Road, Columbus, OH 43220, Phone: 451-0360, email: kmubireek@yahoo.com. If I have questions about my child's rights as a research participant, I can call the Office of Responsible Research Practices at (614) 688-4792.

I have read this form or I have had it read to me. I sign it freely and voluntarily. A copy has been given to me.

Print the name of the participant:

____

Date: ____________________________

Signed: ________________________
(Participant)

khalid al mubireek

Khalid Al Mubireek (Principal Investigator)

Signed: ________________________
(Child's parent/Guardian)

HSBSS version 1.0
Behavioral & Social Sciences IRB Application Form, Revised February 2002
Approved by the Policy Coordinating IRB on April 19, 2001

APPENDIX E

Permission Letter for Principal

5270 Timberline Road
Columbus, Ohio 43220

March 14, 2003

Principal
Midwestern Elementary School
5220 Avalon Avenue
Columbus, OH 43210

Dear Madam/Sir,

As you know, I am conducting a doctoral study to investigate fourth-grade students' gender-related preferences in educational computer games related to the subject of mathematics. I have provided you with a copy of my research proposal, which explains that I wish to recruit 40-45 fourth-grade students to participate in nine 30-minute game sessions and respond to two short interviews.

I will simply ask students to play the three games to the best of their ability. Game sessions will not involve manipulation or introduction of stress on my part. Once students have completed the game sessions, I will analyze their game scores to determine whether their game performance is higher or lower in Mathematics depending on the game they played. Each student interview should take no more than 15 minutes to complete. Interviews will not address any personal or sensitive issues; they will focus entirely on the educational video game use and preference.

Finally, students' names and any other information that could identify them will be kept confidential. Related to this, I will be using codes not names when recording individual participants' questionnaire or game results in my research. Please also be advised that students' participation in this study is voluntary and they may withdraw from the study at any time.

If you are willing to allow the fourth-graders at Midwestern Elementary School to participate in my study, please complete the Participant Consent Form below. If you have any questions or would like to receive a summary of the research results, please contact me at the above address, by e-mail at kmubireek@yahoo.com, or by telephone at (614) 451-0360. Thank you very much for your important contribution to this study.

Sincerely,

Khalid Mubireek, Ph.D. Candidate
School of Educational Policy and Leadership, College of Education
The Ohio State University

Participant Consent Form

Project Title: Gender-Oriented vs. Gender-Neutral Computer Games in Education

I have read and understand the information about Khalid Mubireek's study entitled Gender-Oriented vs. Gender-Neutral Computer Games in Education. I agree to allow the 46 fourth-graders attending Midwestern Elementary School to participate in this study if their parents consent provided. I understand that this consent is voluntary and can be withdrawn without penalty at any time.

____________________________________ Date: / / 2003

Principal

Midwestern Elementary School