"We Have Never-Forgetful Flowers In Our Garden:" Girls' Responses To Electronic Games

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Abstract

Electronic Games for Education in Math and Science (E-GEMS) is a large-scale research project designed to increase the proportion of children who enjoy learning and mastering mathematical concepts through the use of electronic games. This paper describes one piece of research that examines how girls interact within an electronic games environment. Three interrelated questions are addressed in this paper: What interest do girls show in electronic games when the games are presented in an informal learning environment? How do girls play and watch others play? How does the presence of others in the immediate vicinity influence the ways that girls play?

The research described was conducted at an interactive science museum, Science World BC, during the summer of 1993. Children were observed while they played with various electronic games, both video and computer. In addition, interviews were conducted with the children and *timed samplings* were recorded. Our observations and interviews show that girls have an interest in electronic games and enjoy playing. Girls were particularly interested when given the opportunity to socially interact with others. In addition, they indicated a preference for playing on computers over video game systems.

Introduction

Electronic games, both for video game systems and for computers, constitute an important role in the popular culture of many children (Provenzo, 1991). Some play with mild interest; others spend hours engaged in the playing of electronic games. But very few children play electronic games at school. Like television and rock videos, electronic games are not welcomed in most classrooms. However, many educators make a convincing argument for including the popular culture of children in school settings (Fiske, 1987, 1989; Leggo, 1993). As Leggo (1993) states, television and other forms of electronic media "deserve our attention in school because to

ignore popular culture is to erect a high wall of exclusion around our schools" (p. 3).

But we need to do much more than invite the popular electronic games culture of children inside the classroom walls. Welcoming children's lived experience as grist for the curriculum mill also brings with it the responsibility to become more responsive consumers, generating questions and challenges while interacting with the technological medium. If educators are to include electronic games as part of the curriculum -- and, as we propose, for mathematics and science teaching -- then we need to be more aware of the phenomenon as it exists in the popular culture. How do children behave in an electronic games environment? What learning takes place? How do issues of gender and socialization affect children's interests and skills?

The research described here represents one aspect of a large-scale study on Electronic Games for Education in Math and Science (E-GEMS). This paper describes research that took place over a two month, seven day a week study at Science World BC, an interactive science museum in Vancouver, Canada. Here, both children and adults were observed while they played and interacted within an electronic games environment. The E-GEMS project, involving a collaboration amongst scientists, mathematicians, educators, professional game developers, classroom teachers, and children, has been designed in an effort to increase the proportion of children who enjoy learning about and using concepts of math and science, by exploring electronic games in conjunction with pencil-and-paper activities and hands-on constructions. The E-GEMS project involves research on existing electronic games as well as the design and development of new games incorporating specific groups of mathematical and scientific concepts. The present paper describes research on existing games, focusing specifically on how *girls* respond to an electronic games environment.

Our reasons for focusing on the behaviour of girls are several. Perhaps the most important reason is that girls are less likely to pursue math and science courses than arts and humanities in high school. In addition, girls commonly do not choose careers in technical fields that involve math and science (Campbell, 1986; Keller, 1985; Linn & Hyde, 1989; Woods & Hammersley, 1993; Yeloushan, 1989). This is a serious problem in both social and economic terms. Many futurists have predicted a shortage of skilled specialists in professions involving math and science, a shortage that will be critical as environmental and economic issues necessarily become of the utmost importance over the next decade (*Educating Girls and Women for the 21st Century: Its Significance to Canada's Economy,* 1990; *Shortchanging Girls, Shortchanging America,* 1992).

But another, equally critical, issue is at stake: by systematically discouraging girls from entering the fields of math and science, a way of approaching those fields that may be qualitatively different from the approach taken by males is also lost. Women are needed as engineers, scientists, and technologists. They are needed for their numbers; they are needed for the fresh outlook they may bring to these professions.

This fresh outlook will only occur if there are enough women in traditionally male professions. Many women who have pursued math and science related careers have described how they have been expected to modify their behaviour and thought to fit the standard practices of a given profession. It has been argued that these professions will only experience a transformation if more women choose to enter the profession, not working twice as hard and developing a thick skin to accommodate to a male profession, but rather dealing with issues of equity and discrimination in ways that allow individuals and systems to change (Ellis, 1986; Franklin, 1990; *More Than Just Numbers,* 1992; Starkman, 1986; Tavris, 1992; *The Better Idea Book*, 1992).

Generating interest in math and science for a greater proportion of girls is a goal for many educators, scientists, mathematicians, psychologists, and sociologists (Bazler & Simonis, 1990; Eichler & Lapointe, 1985; Franklin, 1990; Gilbert & Pomfret, 1991; Holmes, 1991; Kleinfeld & Yerian, 1991; Linn & Hyde, 1989; Poole & Smyth, 1986; Skolnick, Langbort, & Day, 1982; Turkle, 1984; Wingate & Woolis, 1992). The members of the E-GEMS project share this goal, and the contribution of the present paper towards realizing this difficult and complex goal is a modest one. We propose to describe ways that girls interact and respond to an electronic games environments in an informal learning setting. With that understanding, we expect to be in a better position to design new games that not only incorporate concepts of math and science, but also resonate with the ways that girls deal with the popular culture of electronic games.

Related Literature

Two bodies of literature have been used to frame our research questions and methods and to analyse our findings: the interaction between gender and electronic games, and the socialisation of girls in educational settings.

Gender and Electronic Games

A number of researchers have already considered the interaction between gender and ways of playing electronic games. Only a few of these studies will be discussed in the present paper.

In an extensive study conducted by Braun & Giroux (1989), boys and girls were observed playing games at several video arcades. The researchers described the features of the most popular games, and also noted boys outnumbered girls by a ratio of 8 to 1. This finding is of relevance to the present study, since our research also took place in an informal setting where the flow of participants was not controlled. However, our research setting of a science museum, Science World BC, was qualitatively different from a video arcade: Science World BC is recognized as an informal learning environment, while video arcades are generally thought of as places for entertainment rather than learning. As well, the exhibit at Science World BC offered other activities besides electronic games and was peopled with researchers interested in children's

thinking. Would these differences in the Science World BC environment make the games more attractive to girls?

Researchers have also pointed to the gender stereotyping in video games, where women are portrayed as prizes and victims, and have shown how aggression and violence are integral to many popular video games (Provenzo, 1991, 1992). Some researchers have presented evidence that indicates that the playing of video games with violent aspects may lead to aggressive behaviour (Silvern & Williamson, 1987). These findings are of considerable importance in terms of the present work, as we seek to study not only girls' behaviour in an electronic games environment, but to ultimately influence their views of themselves as mathematicians and scientists. If young girls see female figures in electronic games as problem solvers and skilled thinkers, would their views of their own abilities also change?

Thus, like researchers before us, we are interested in girls' responses in an electronic games environment in terms of their behaviour, their views about the representation of females in the video games, and how the platform (video games or computer games) affects their responses. Our research has an added component, however, to the studies described above. Most research on electronic games has been conducted in classrooms, controlled laboratory settings, or in video arcades. Our researchers worked in an informal learning environment, where, like a classroom or a home, more options were available than electronic games alone, and where there was a complex interaction between platform (video games or computer games), gender, and the learning environment.

Socialization of Girls in Education

The task of describing how girls are socialized in educational settings is a difficult one, as the socialisation process is exceedingly complex. However, this is an important task, given that we are advocating the use of popular electronic games in schools. It is also critical in that many of the teachers girls will encounter in their elementary years will be women. The attitudes and skills of their women teachers have also been shaped by similar processes. Thus, the success of incorporating electronic games into classroom settings will depend, in large part, on the characteristics of the teachers making use of the games.

There is a plethora of research indicating that girls, on the whole, behave differently in educational settings than do boys, as both boys and girls are shaped by their respective roles in the institutions of the family and the school (Belenky, Clinchy, Goldberger, & Tarule, 1986; Grumet, 1988; Lewis, 1993; Luke & Gore, 1992; *The AAUW Report: How Schools Shortchange Girls,* 1992; Woods & Hammersley, 1993). Belenky et al. (1986) show that women's ways of knowing have more to do with relations with others than with separation or independence, while the opposite holds for men. Grumet (1988) explores the gender difference between men and

women and theorizes about their implications for curriculum. Traditional school settings cater more to men with emphasis on the individual -- the student working in isolation at his or her desk. The American Association of University Women Educational Foundation Report, *How Schools Shortchange Girls* (1992), describes the ways in which the prevailing educational system does not adequately meet the needs of girls and presents strategies to make formal education more relevant to the lives of girls, such as emphasizing real-life situations and employing hands-on experience. Especially pertinent to our research, statistical studies reveal that in the classroom, boys show more interest in computers and use the equipment more than girls ("Sex Bias", 1984). Jones (1986) suggests that this may be because computers are perceived as belonging "to the male domains of mathematics, science, electronics, and machinery" (p. 61).

The research we have described is an important foil as we examine how girls respond to an electronic games environment. The findings on gender and video games and the general effects of socialisation on learning have shaped both the content and form of our research questions, which are outlined below.

Research Questions

We are sensitive to the work of Tavris (1992), where she demonstrates how girls and women are measured in terms of boys and men, in education, law, medicine, and other disciplines. She argues that

> [m]en and women are not simply considered different from one another, as we speak of people differing in eye color, movie tastes, or preferences for ice cream. In every domain of life, men are considered the normal human being, and women are "ab-normal," deficient because they are different from men. Therefore, women constantly worry about measuring up … because male behavior, male heroes, male psychology, and even male physiology continue to be the standard of normalcy against which women are measured and found wanting. (Tavris, 1992, p. 16-17)

Therefore, we have *not* framed our questions and findings in a way that compares the performance of girls to boys, where boys are used as the yardstick of comparison. Rather, we seek to describe, in a holistic way, how girls react to an electronic games environment, complete with games, a wide variety of people to interact with, pen-and-paper activities, and hands-on construction opportunities. Another E-GEMS paper (Lawry et al., 1993) compares the observed behavior of boys to the stereotypical behavior of boys as depicted by commonly held beliefs in our society.

Our research involves the examination of three interrelated questions. First, what interest do girls show in electronic games when they are presented in an informal learning setting? Second, how do girls play with the games and watch others play? And finally, how does the presence of others in the immediate vicinity influence the ways that girls play?

Research Setting

Our research took place at Science World BC, at an exhibit called the *Electronic Games Research Lab*. Science World BC is an interactive science museum, where children and adults explore various science concepts through hands-on activities and experimentation. Permanent exhibitions include a "Search Gallery" for natural sciences, optical illusions and light, and a music gallery. Recent traveling exhibits have included Backyard Insects, Mind Teasers, and Robots. There are six half-hour shows daily, held in a small amphitheatre in the centre of the first floor. These shows feature such concepts as motion, elasticity and temperature. Science World BC also houses an Omnimax Movie Theatre. Participants at Science World BC expect to be actively involved in this informal learning environment. While many visitors move from one exhibit to another, others may stay at one exhibit for many hours. Visitors to Science World BC are free to explore the offerings at Science World BC as they wish.

Members of the research team, along with educational consultants and designers at Science World BC, and game designers at Electronic Arts Canada, designed the *Electronic Games Research Lab*. The collaborative design emerged over a four-month period, beginning in February of 1993 (Anderson et al., 1993). The research area was designed to create an informal learning environment for children of all ages. The exhibit included two types of electronic game platforms: video games and computer games. Within these categories, there were two video game units, a Sega Genesis and a Super Nintendo Entertainment System, and two computers, a Macintosh and an IBM-compatible PC. Games for each of the four machines were run for one- or two-week periods. Games included those from the popular culture, as well as ones that had been newly released. Some games, such as *The Incredible Machine, Operation Neptune*, and *New Math Blaster Plus*, were designed as educational games. Others were created primarily for entertainment, such as *Sonic the Hedgehog, Lemmings*, and *Mario World*. However, we found that some games designed for entertainment often embedded educational features.

A design station was also constructed. This area included a Velcro wall with several manipulatives (such as balls, tubes, ribbons, blocks, elastics, gears, string, fabric, and trolls), many of which could be attached directly to the wall. Clipboards, paper, pencils, and markers were also available for writing and drawing. A kiosk was located near the design station where children could display their work. Another kiosk posted research news, gathered as the summer progressed. Another table had a Macintosh-based survey on electronic games, which could be filled out by children or adults if they so chose.

The exhibit was supported by eleven researchers and several volunteers. We assisted the children while they were playing games, provided materials at the design station, conducted interviews, gave directions to the washrooms, answered questions about the research aims and methods, arranged turn-taking systems during busy periods, and played electronic games ourselves. In other words, the researchers and Science World BC volunteers were active and

involved participants on many levels.

Method

The research was conducted over the summer months of July and August, 1993. Several types of both qualitative and quantitative data were collected over this time period. The qualitative data were gathered using researcher observations, interviews, artifacts from children, and intervention studies. The quantitative data were gathered using the Macintosh survey and timed samplings. (for a further discussion of research tools, see Anderson et al., 1993).

Researchers made general observations and conducted many interviews with visitors to the exhibit. The observations and interviews examined such issues as the attractiveness of particular games and platforms, gender issues, social interactions, watching and playing styles, attitudes and perceptions of adults towards electronic games, and children's learning in general. Data were recorded using field notes, audiotapes and videotapes. Artifacts produced by the children were also collected. These artifacts included drawings made by the children of game characters and design features, as well as photographs of constructions made on the Velcro wall.

Quantitative data were recorded using two methods: the electronic survey and timed samplings. The survey invited participants to describe themselves in terms of age, gender, life-style habits, likes and dislikes in terms of school subjects, as well as asking specific questions related to electronic games. We include the survey to support a number of our findings in this paper, but it is important to treat these findings with caution since not all participants at the exhibit completed the survey.

The timed samplings were used to record the number of people at each area of the exhibit. Every fifteen minutes, one of the researchers would note the number of children and adults at each of the game stations, the design station, and the survey station. These observations were further classified by gender and by type of participation -- playing or watching. During the first ten days of research, two researchers completed the timed samplings until at least 95% interrater reliability was achieved. For three days, five-minute intervals were used. For the same three-day period, the total number of children who came into the exhibit area was tabulated by gender.

Intervention studies were designed to investigate learning which we suspected was occurring while the children were playing the games. All of the interventions involved asking children to perform pencil-and-paper games or activities. The pencil-and-paper activities tested specific concepts incorporated in the games. The results from the intervention studies are described in another paper (Sedighian et al., 1993).

Researcher observations and interviews along with the timed samplings and survey results are used in the present paper to address the research questions outlined earlier.

Findings

A Typical Scene at the Electronic Games Research Lab

It is 2:00 in the afternoon, and there is a large group of children crowded around two television sets. There are about ten boys gathered around each television, all waiting for a turn. There is a girl with her little sister and mother playing *Scooter's Magic Castle* at the nearby computer, and at another computer two boys are playing *Lemmings*. The Velcro wall and large table, resembling an art centre in an elementary school, is also occupied. Several parents are pointing out things to their toddlers, and encouraging their children to try sticking blocks and cylinders to the Velcro wall. Four other girls are sitting around the table, drawing pictures of flowers, butterflies, and princesses.

Meanwhile, another boy has just entered the exhibit. He glances over at *Sonic*, one of the video games, then quickly darts over to *Sonic* and jumps down on the floor. After watching for a while he asks the boy who is currently playing if he may have a turn. Soon after, the game control is passed over, and he begins his turn. A girl has entered at approximately the same time. She glances at all of the stations and walks towards the computer with the *Lemmings* game. She stands nearby to watch the boys who are currently playing. She continues to watch, remaining very quiet, while they solve several puzzles.

Girls' Interest in Electronic Games

Over the course of our research it was apparent that girls enjoyed playing electronic games. Some of them commented they had video game platforms such as Super Nintendo at home which they played, while others talked about computer games on their family's home computer system. For instance, Jane talked about her home Nintendo system and said that she played on weekends. Fay explained she had both Sega Genesis and a computer at home, but she preferred to play computer games. Of course, the interest level varied between individuals but several trends emerged.

As indicated in the typical scene we described above, girls visiting the exhibit were more interested in computer games than in the video games. In addition, the timed samplings along with the interviews and observations, indicate that proportionally more girls were attracted to the computers than to the video game stations (see Table 1).

Table 1. Proportion of Girls Observed at Computer Games Versus Video Games

	Number of Children			
Game	Total	Girls	Proportion of Girls	*z*
Computer	2536	672	26.5%	10.4*
Video	5973	998	16.7%	

Note. Counts were collected every day for a two month period.
*p < 0.1

Girls also enjoyed the design station (see Table 2). Their use of the design station, however, was not necessarily related to the design of video games. Even though visitors were encouraged to use the Velcro wall, markers, and paper to express their ideas and suggestions for the design of new electronic games, girls often drew pictures or created sculptures that were unrelated to the games.

Table 2. Proportion of Girls Observed at the Design Station and Electronic Games

	Number of Children			
Station	Total	Girls	Proportion of Girls	*z*
Design Table	1555	812	52.2%	27.4*
Electronic Game	8509	1670	19.6%	

Note. Counts were collected every day for a two month period.
*p < 0.1

In our discussions with girls, there appeared to be a difference between those girls who had a computer at home and those whose families owned a video game unit. Of the girls who visited the E-GEMS exhibit over the summer, those with home computers tended to be more enthusiastic about playing electronic games. In addition, many girls whose families owned both a computer and a video game unit stated that they preferred to play on the computer. Often they expressed the view that the computer was more "worthwhile," and proceeded to describe various spelling or

math games. One girl explained how she enjoyed playing both video and computer games, switching back and forth, depending on whether she wanted to learn or take a break:

> Julie: Well, those *mindless* games [points at the Nintendo video game], I play them after playing these *mind* games [indicates the *Carmen San Diego* computer game].

Another girl who played computer games explained why she did not enjoy playing video games:

> Jane: When I play video games, I feel that I have done nothing. If anyone asks me what I was doing, I have nothing to show for it.

The girls we talked with and observed seemed to have an interest in electronic games, but the depth of that interest was not as high as their interest in other activities. For example, many girls expressed they would rather read, play with their friends, or go to the mall than play electronic games. This view was also evident during our research at Science World BC. Many girls would enter the exhibit, look around, and then leave. Some would stay if they saw a free machine or if a group of girls were playing a game. Few girls would approach if a large crowd of children were clustered around a particular game. During a discussion with a researcher, one girl tried to explain why girls might not stay and play at the exhibit:

> Mutindi: Do girls really like playing video games?
>
> Diane: Most girls play video games.
>
> Mutindi: That doesn't seem to be the case here though.
>
> Diane: Well, we [Diane and her friend] were playing but I think girls play at home, in privacy.
>
> Mutindi: Why?
>
> Diane: I think they are shy.

Many girls who came through the exhibit left if they were unable to play or get a space at the design station. This is clear when the total number of girls who visited the exhibit is compared with the female counts of the timed samplings. The timed samplings appear to indicate that a substantially fewer number of girls came to the exhibit while the total count shows that this was not the case (see Table 3).

Table 3. Number of Girls Recorded at the Electronic Games Research Lab

	Number of Children			
Count	Total	Girls	Proportion of Girls	*z*
15-minute Interval	904	262	29.0%	5.42*
Constant	1450	578	40.0%	

Note. Counts were collected for a three day period.
15-minute interval count represents the sum of children, observed at each station on 15 minute intervals.
Constant count represents the number of children who entered the exhibit.
*p < 0.1

For almost all girls who visited the exhibit, the depth of their interest in electronic games did not extend to talking about and reading game magazines, trading games, or expressing pride in the number of games they owned. The enjoyment of playing was enough to satisfy their interest.

Social Aspects of Electronic Games

Many girls who played electronic games at home could not name the games they played, how many games they owned, or even the name of their favourite games. However, they were quick to verbalize many social aspects of the games: they could name a myriad of characters, describe storylines, and describe the relationship between characters in the games. Those girls who responded to the questions about game design at the design station often drew existing electronic game characters or created new ones.

Three girls at the exhibit discussed the game *Tiny Toons*. This game was popular amongst these girls, partly, we suspect, because there were several characters involved. In an interview session, each of the three girls had a favourite character and discussed these characters amongst themselves: Karen's favourite character was Taz, Margaret's was Buster , and Lisa's was also Taz, since "he's cute, but not too cute, like Spot."

Lisa offered her opinions about characters on other games. She commented that she would like the video game *Street Fighter II* more if they were "real people instead of monsters," and she would like *Super Mario* more if the princess was prettier.

Many girls identified with characters in other ways. Often they attributed gender to androgenous characters. In a game where two ghosts appeared, Terry, a six-year-old girl, spontaneously exclaimed: "See look! It's a little ghost! I think that one's a girl and the other one

is a boy." Others provided gender roles to the characters in their imaginary games:

> Jenny: You can choose what you want. A boy or a girl troll depending on the skills that you need to get this medicine. The girl troll is good in climbing and in communication skills. The boy troll has very good magic and fighting skills.

Some occasionally saw themselves as characters in the game.

> Terry: I'm going to go upstairs.
>
> Kate: Oh! Is that you?
>
> Terry: Well, no it's him. But I pretend it's me.

Similarly, when Terry was playing *Scooter's Magic Castle*, she spent some time in the Magic Garden. Here she was planting seeds, watering them, and watching the seeds sprout and grow. While playing, she talked about her mother's garden, naming flowers she and her mother had planted: "We have never-forgetful flowers in our garden."

When girls were working at the design station, not only did they draw game characters, but they also tended to work together--talking, sharing markers and paper, and keeping a watch on other parts of the exhibit. As well, when given a choice between creating a new level or task for a game or creating a new character, they almost invariably chose to draw a character.

Ways of Playing and Watching Electronic Games

Girls who play electronic games at home claimed that they rarely played on a regular basis or for extended periods. Their responses to the Science World BC exhibit support their claims. Many played for only a few minutes at a game, without intervention from a parent or a researcher, and moved from one area to another rather than staying at a station for an extended period. Interviews with parents also indicated that girls tended to play for short periods of time: "They just play it for a short time and go off to do other things." Many parents with daughters claimed that they felt no need to regulate or limit their daughters' playing of electronic games. In addition, our results from the survey indicate that only 16% of our female respondents indicated that they played frequently.

Girls in the electronic game environment generally handled turn-taking in non-aggressive ways. Often girls stood in the center of the exhibit or sat behind a player and waited to be offered a turn without ever verbally expressing a desire to play. On many occasions it was only after a researcher approached and offered a turn that a girl would attempt to play any of the games. Those who actively pursued turns usually approached a researcher to ask for a turn, rather than approaching another player directly.

Confidence and Challenge

Confidence is a key issue in the electronic game environment. Many girls indicated that they liked playing electronic games. Often their reasons included the challenge that these games possess: "They all require thinking and that's why I like them," and "I like them because you have to figure out how to work them." Potential success at solving the puzzles also seemed to be important. When asked if she liked working on puzzles, one girl stated, "Yeah, if I can solve them."

Girls' preference for environments in which they felt more confident was also indicated by the researcher observations. Often when girls first entered the exhibit, they would only approach games they were familiar with. In addition, when playing games they were unfamiliar with, girls often made statements like, "Oh, I am terrible at this!" before they had even begun to play.

This issue of challenge is a delicate one. The amount of challenge in a video game appears to be critical to the game's attractiveness. Children enjoyed a challenge in games, but if they found the challenge too "hard" or "frustrating," they would cease playing. On one occasion a girl, Erin, was playing *Math Blaster* with a researcher and seemed very enthusiastic about solving all ten rounds of *Number Recycler*. As the rounds got more and more difficult, her enthusiasm declined until her comment was "This is getting boring ... can I play a different game?" Many children, both boys and girls, were able to articulate the difference between a challenge they were comfortable with and something that was too hard to enjoy. As one child stated,

> challeng[es] take skill and you get a lot of enjoyment from solving the task. Hard is more or less the same thing, but there is little enjoyment.

Terry, an experienced computer game player, explored *Scooter's Magic Castle* with a researcher. She completed a colour mixing game skillfully, when it was set at the easiest level. When the difficulty level was increased, Terry again succeeded, but required several more trials to do so. When the researcher commented that level was harder, Terry responded, "No, it isn't. There! I made that color."

Heidi was another confident and skilled player.

Heidi: When I grow up I want to be a lepidopterist.
Kori: LEPIDOPTERIST! Who told you about that?
Heidi: She. [pointing to her mother]
Kori: What is a lepidopterist?
Heidi: Study butterflies and blow glasses.

Heidi's confidence in not only her play but in herself has given her a very important outlook on girls in math and science. She perceives herself as a future scientist and has a great deal of pride in this aspiration.

On the other hand, thirteen-year-old Natasha was experienced at playing video games but not with computer games. When Natasha began playing *Operation Neptune*, a computer game, she

struggled with the math problems. Every time a problem came up, Natasha made comments like, "Oh, I hate patterns!" or "It's so confusing!" In a discussion about mathematics, Natasha made it clear that she felt she couldn't do mathematics, whether on computer games or pencil and paper activities. She emphatically stated, "It's hard. It's me that cannot do math. I am not smart. I -- Natasha -- not smart."

It seems likely that the confidence levels of these three girls affected their playing abilities, and their willingness to solve problems through trial and error. All were playing computer games, where, unlike the video games, speed was not important. Heidi's and Terry's confidence allowed them to explore the games, while Natasha's lack of confidence was the source of much frustration while she played. Without the intervention of the researcher, Natasha would probably not have continued playing this game. It is important to consider that age may have been a factor in the level of confidence; Natasha was several years older than both Terry and Heidi.

Presence of Others

The presence of others in the electronic game environment appeared to strongly influence the playing patterns of girls. When a particular station was filled with a group of boys, the girls were very hesitant to approach. If they did approach, they would usually watch for a few minutes and then walk away. The girls appeared intimidated by large groups, although it is likely that while watching, they were nevertheless actively involved in thinking about the games. The presence of a researcher appeared to encourage the girls to play more. If the girls saw a researcher monitoring the exhibit, they seemed to recognize that it might be easier for them to secure a turn.

The following scenario illustrates the responses described above. One afternoon in July, a female researcher was playing with a boy and a girl. All three were playing, talking, and drawing pictures. One girl, and later another, approached and joined in the group. Eventually the boy left. The interaction amongst the four remaining participants was highly social. The group discussed everything from characters in the game to different languages each of them could speak. In between turns the girls would talk, draw, and encourage each other. They appeared to be enjoying themselves as much in between turns as when they were playing. These girls stayed for an hour and a half, one of the longest playing times for any girls over the course of our research.

The desire to have someone present while playing was not contingent on skill. Terry was a confident and skilled player, but still wanted a researcher to sit by her as she played:

Rena: Do you want to play by yourself for a while?

Terry: O.K. But do you want to just watch?

The social aspect of just having someone around as company or having someone that the child could demonstrate their skill to was important for girls.

Discussion and Implications for Game Design

Our findings show many girls are interested in electronic games. While they may prefer computer games to video games, given the opportunity, they will play both. However, it is clear that they are more likely to play if certain conditions hold, including ease of access to the game (many girls came into the exhibit, but left if there were others already playing) and the possibility of interacting with others while they play.

We indicated in the previous section that girls tended to prefer the computer game platform to the video game platform. This is consistent with the notion that girls enjoy interacting with others as they play. Many video games, and certainly the ones we featured at the Science World BC exhibit, rely on speed as one of the appealing features. While playing fast-action games, in which speed is a major component, children seem less likely to talk or communicate during the early, learning stages of play. However, skilled and experienced players talk and communicate while playing. This is especially noticeable in the playing of two player games, such as *Street Fighter II* and *Mario Kart*. This is important not only in terms of designing electronic games that appeal to girls, but in terms of use of games in classroom situations with teachers as well. As one teacher noted:

> I think when they're playing a game, they need a chance to verbalize what they're seeing, and that again, is a problem with having a computer in the classroom because I can't constantly be going over and be watching something and be genuine about it too ... if you want to be genuine about it, you have to know what's going on. Where am I supposed to look? The movement is too quick on a video game for me to react in a genuine way -- Mario's falling, and I've missed it. (Kate McCabe, personal communication, August 27, 1993)

When asked about video game design, girls' suggestions were consistent with their ways of playing video games. Given the findings we have reported, it would be expected that game design would emphasize relationships -- including characters, social interactions, stories, and the like. Our evidence supports this conjecture. When we told girls that we were going to design some video games and that we were interested in their views, comments like the following made by six-year-old Terry were common:

Terry: You could maybe start *Beauty and the Beast.*

Rena: What would Beauty and the Beast do?

Terry: They would have to make lots of characters and they would just do the normal thing or maybe some different things.

Rena: What could you make the game do?

Terry: Belle would sing. And the whole village would sing.

Terry continued to describe the characters and the story of *Beauty and the Beast*. She was not distracted by the researcher's questions about features of the game, but steadfastly tried to impress upon the researcher the importance of the story. Similarly, when another girl was asked

about what video or computer game she would like to see developed, she also emphasized the story, characters, and relationships, although she also integrated these relationships into functional aspects of game design. Grace asked:

Grace: What about *Fern Gully*?

Rena: What would happen in *Fern Gully*?

Grace: First she would look for a human and then she found one and his name was Zack. [gives an elaborate rendition of the story of *Fern Gully,* including a description of many of the characters]

Rena: What would Krista do in the game?

Grace: I have to tell you the boy's name, but don't laugh … Pips. They wanted to take Zack on a trip and around *Fern Gully* but he didn't want to go and Krista helped him.

Kate: So what would they all do when they were playing the game? Remember the game we played with Scooter, where he picked up paints and mixed them -- what kinds of things would you do in a *Fern Gully* game?

Grace: Well, one of the boys sits on the bugs and he lifts them up and puts them on one of the other bugs and then he flies and then he helps them off.

Kate: That's a smashing idea! What else would the game do?

Grace: And then Zack, he said he didn't work with the leveler cutting down the trees, but he *lied* to Krista.

Rena: Can you think of anything else Zack could do?

Grace: There would be a machine to cut down trees. I would just like, when, I see Krista and Zack, I would make it like not cutting down trees. I would like to have *Fern Gully* at my house.

This desire for social interaction within the game was also true for older girls. Nine-year old Sandra explained that she did not find video games fun because all you do is jump on guys and kill them. Her idea for a game would be about people on an adventure. These people would travel from city to city and meet different people. These people could be relatives or friends and the object of the game was to deliver packages to people in other towns. She also suggested there would be certain obstacles like ditches, wolves and bears. In order to get by the animals without them eating you, it would be necessary to give the animal a certain kind of food.

Of course, even though social interaction was important for many of the girls we observed and interviewed, some girls certainly found fast games appealing. Our challenge in designing games for math and science education is to accommodate a variety of playing and learning styles, for both genders. Some electronic games (e.g. *Decisions, Decisions*, and *Oh Deer*!) already contain design features that make social interaction not only possible but necessary in order to

successfully play the game. Another approach would be to make fast-action games more collaborative. For example, a game such as Lemmings could be designed to have two players working towards the same goal. In this way, collaboration and cooperation between the players would be encouraged.

Other important issues addressed by members of the E-GEMS team include the characterization of boys playing electronic games (Lawry et al., 1993), parental attitudes towards electronic games in education (Ndunda et al., 1993), and the use of games as interactive learning environments (Sedighian et al., 1993). Given that girls interact in electronic environments as we have described, one current study is investigating the use of cooperative games in education and how both girls and boys respond to this type of play. Another current area of research by the E-GEMS team is to explore how teachers can support and extend the learning that occurs through play of electronic games.

Returning to the goals of the E-GEMS project outlined at the beginning of this paper, while it is important to document and enhance learning of science and math concepts, it is equally important to consider what girls are learning about themselves while they play. Since game characters and relationships with game characters and people around them feature highly for many girls, electronic games should include roles for girls beyond those of the mermaid to be saved or the jungle woman to be kissed. We would like to see girls walking away from electronic games understanding more about whole number operations or laws of physics. But we would also like them to walk away exclaiming, "When I grow up, I'm going to be a lepidopterist" -- or a mathematician, or a marine biologist. In this way, both belief in their abilities and the knowledge to achieve their aspirations can grow in tandem.

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Related Papers

For additional information on work by the E-GEMS team technical reports are available through the Department of Computer Science, University of British Columbia, Vancouver, B.C. V6T 1Z4. The following reports are available:

- Exploring Common Conceptions About Boys and Electronic Games. 1993.
- *The Incredible Machine*: A Computer-Based Interactive Learning Environment Game. 1993.

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