Exploring Common Conceptions About Boys and Electronic Games

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Abstract

Electronic games are an integral part of many boys' lives. Based on observations made over a two-month period at an electronic games exhibit in an interactive science museum in Vancouver, Canada, we examine three commonly held views about boys and electronic game culture: (a) electronic games and boys' behaviour while playing them contain elements of aggression, violence, competition, fast-action, and speed; (b) electronic games encourage anti-social, "loner" behaviour; and (c) boys who play electronic games are susceptible to becoming so devoted to playing the games that they neglect other areas of their lives, such as school, physical activity, and family. Our findings indicate the following: (a) while violent games are popular, many boys prefer games that challenge them mentally; (b) there appears to be little connection between anti-social behavior and electronic game playing; and (c) many boys who play electronic games have interests also in music, programming, reading, and school.

This paper depicts one facet of the first, exploratory phase of the Electronic Games for Education in Math and Science (E-GEMS) enterprise. E-GEMS is an ongoing research project with the ultimate goal of increasing the proportion of children who enjoy learning and using math and science—specifically by engaging children's interest in these subjects through the play of electronic games in the context of existing classroom educational methods. Hence, we also consider some of the implications for educational electronic game design in view of our findings about current commercial electronic games.

Exploring Common Conceptions About Boys and Video Games

Meet Ben.

> Ben is a pleasant, well-mannered twelve-year-old boy who frequently plays video games. He has a SNES at home with 19 games, as well as a Sega that he has borrowed from a friend, together with 14 games. He prefers playing SNES games to Sega games, even though he thinks that the Sega platform has better graphic capabilities. Ben believes that the SNES games are better designed and longer, and

> likes the fact that there are more of them. His favorite game is *Mega Man 5*. He really likes the *Mega Man* series and even draws pictures of Mega Man and several other aspects of the game. Ben is quite knowledgeable about many video games and knows many of the "tricks." He subscribes to three game magazines—including *Game Pro* and a Nintendo magazine. He often trades games and game knowledge with his friends.

Ben is one of the millions of North American boys who play video games—one of the several thousand boys who visited the *Electronic Games Research Lab* exhibit at Science World BC this summer. The *Electronic Games Research Lab* was designed and staffed by members of the Electronic Games for Education in Math and Science (E-GEMS) research team as the first phase of an ongoing research project. The overall goal of the E-GEMS group is to increase the number of children who interact positively with math and science, by means of playing electronic games within the context of existing classroom educational methods. Preliminary research on children's interaction with existing electronic games will eventually support the design and development of games that incorporate mathematical and scientific concepts. E-GEMS team members include mathematicians, scientists, educational and computer specialists, classroom teachers, professional game designers, and children.

We propose to combine video games, concepts from math and science, school, and children—in particular, those children who have lost or might lose interest in math and science. Our hypothesis is that the allure of video games can act as a catalyst for learning math and science. In this paper we focus on boys and their relationship with video games. The attractiveness of electronic games to most boys—including those who have difficulty with math and science—is readily apparent in our culture. Here we consider several of the elements of the magnetism between boys and electronic games, as well as some of the implications for educational game design. For a discussion on girls and video games based on observations at Science World BC during the same research period, see (Inkpen et al., 1993).

Research Setting

The data supporting this paper were gathered at an exhibit titled *Electronic Games Research Lab* at Science World BC in Vancouver, British Columbia during the months of July and August 1993. Science World BC is an interactive museum, with an emphasis on hands-on exhibits that illustrate scientific concepts. Most museum goers are children, brought by parents or, often in the summer months, by caregivers as part of a day camp outing. The *Electronic Games Research Lab* was designed by E-GEMS researchers, Science World BC staff, and game designers from Electronic Arts Canada. Electronic games, a design station, an electronic survey, and a research news kiosk comprised the lab.

Games Four different electronic games were available to visitors to the exhibit, two of which were video games and two of which were computer games. The video game area resembled a family recreation room—colorful, large cushions on the floor surrounding television-like monitors. The computers resided on more formal tables—at their usual desk-like setting. One video game platform was a Sega Genesis unit; the other was a Super Nintendo Entertainment System (SNES). The two computers used were an Apple Macintosh (Mac) and an IBM-compatible PC. Computer and video games generally differ in the way the players provide input to the game: computer games are usually controlled using keyboard keys and/or a mouse; video games are manipulated by a joystick and/or a control pad with several buttons. During the course of the two months, seven sets of four games were run. We chose electronic games that were currently popular or newly released—games considered to be educational and/or entertaining. The Sega Genesis video games were *Spot*, *Sonic*, *Sonic 2*, *Carmen San Diego*, and *Ariel the Mermaid*; the Super Nintendo video games were *Lemmings*, *Super Mario World*, *Mario Paint*, and *Krusty's Funhouse*; computer games played on the Mac were *SimCity*, *Math Blasters*, *Kid Pix*, and *Lemmings*; computer games played on the PC were *The Incredible Machine*, *Operation Neptune*, *Eagle Eye Mysteries*, and *Scooter's Magic Castle*.

Design Station The lab also had a "design station" where children could construct, describe, or explore concepts related to video games by using either a variety of manipulatives (tubes, balls, blocks, elastics, gears, fabric, trolls, velcro wall, fabric) or writing materials (clipboards, paper, pencils, markers). Photographs of children's work or examples of their productions were displayed on a nearby kiosk.

Research News Kiosk A second kiosk held informational items relevant to the E-GEMS project, including a general description of the overall project and pertinent magazine and journal articles.

Electronic Survey Visitors to the *Electronic Games Research Lab* had the opportunity to answer questions about themselves and electronic games by responding to a survey presented on a Mac computer. Game players did not always participate in the survey, and those who answered the survey did not necessarily play games at the exhibit. Roughly, one person filled out the survey for every four to six children who played games.

Method

Eleven researchers and numerous volunteers gathered data in the *Electronic Games Research Lab* at Science World BC during the months of July and August 1993. Qualitative data collected by the researchers included observations, interviews, and artifacts constructed by children. Quantitative data consisted of responses to the Mac survey and *timed samplings*.

E-GEMS researchers wrote fieldnotes or taped the observations and interviews with children and adults. Topics of the conversations included game and platform preference, game knowledge, gender and social issues, and opinions about electronic games. In addition to the researchers' notes and audio and video tapes, qualitative data took the form of children's drawings of game elements and of photographs of constructions at the design station.

Quantitative data were collected by the researchers in the form of *timed samplings* and by way of the Mac in the form of a voluntary survey. The timed samplings were periodic counts of the number of people at each game, the design station, and the survey, which categorized the lab visitors by activity—watching or playing, by age—adult or child, and by gender. In general, timed samplings were made every 15 minutes; though for three days the counts were taken every five minutes. For the first ten days, two researchers filled out the timed samplings simultaneously, until at least 95 percent inter-rater reliability was achieved.

E-GEMS researchers also designed intervention tasks for children to perform before and after playing an electronic game. Each paper-and-pencil task was specific to a particular game, involved a concept used in the game, and attempted to test—in a problem-solving setting—knowledge of the concept.

This paper is primarily based on data from the fieldnotes. All indented quotes written in sans serif font are taken from the fieldnotes.

Three Conceptions About Boys and Video Games

Three commonly held views about boys and electronic game culture emerged through discussions with adults and boys this summer at Science World BC, as well as from the literature on electronic games:

1. Electronic games and boys' behaviour while playing them contain elements of aggression, violence, competition, fast-action, and speed.
2. Electronic games encourage anti-social, "loner" behaviour.
3. Boys who play electronic games are susceptible to becoming so devoted to playing the games that they neglect other areas of their lives, such as school, physical activity, and family.

We examine these three conceptions in the next several subsections. In each subsection, we first consider supporting evidence, then describe observations at Science World BC that show that the behaviour of a significant number of boys belies these commonly held generalizations.

Aggression, Violence, Competition, Fast-action, and Speed

> The world of video games has no conscientious objectors... One must shoot or be shot, consume or be consumed, fight or lose (Provenzo, 1992, p.31).

Provenzo, who has studied how computers and other media influence children and education for the past decade, continues with statistics about violence in popular video games:

> Of the 47 top-rated video games made for Nintendo systems, only seven do not have violence as their major theme. (Provenzo, 1992, p.31).

(For an indepth, critical study of Nintendo games as a social and cultural phenomenon, see (Provenzo, 1991).)

Many educators, researchers, and parents also are concerned with the negative elements that seem to pervade many electronic games. Studies conducted by Anderson and Ford (1986) indicate that playing aggressive video games can produce short-term higher levels of anxiety in the player. Silvern and Williamson (1987) concluded that aggressive behavior increased in children after they played the video game *Space Invaders*.

When asked if she would buy her child a video game, one mother replied,

> "No. My nephews have a Nintendo. It is impossible to get them to do anything else. What do they learn from these games? Nothing. All what it is 'bummh, bummh'—crazy killings. ... [W]hat they are taught is not to negotiate or resolve conflict but to clear your enemies. All these games are designed by men, and maybe that is why they are full of violence. Maybe if women designed video games, they would be different. These video games are not based on real life. 'Campoon,' and you are dead. These games are not real. Maybe video games of the next generation will be different—less killing and more learning."

Bill, a computer systems analyst and one of the adults who stopped by our exhibit, suggested that the current trend in video games towards "explore-n-kill" is a reflection of the traditional male hunter/gatherer instincts.

Indeed, many boys are attracted to the high paced games that contain these worrisome elements:

> One of the boys said that he liked games like *Street Fighter II* , *World Heroes, Mortal Combat.* Any type of shooting games. He explained that "*Mario World* sucks; it is babyish." When I asked him what would make *Operation Neptune* better, he replied that you should be able to shoot and kill the fish. (In the game you don't hurt the enemies, just put them in a cloud of ink for a short period of time.) This boy soon got tired of [*Operation Neptune*] and left.

We often heard competitive, "win/lose" language from boys:

> "I am going to beat this game!"
> "Yeah, I beat this level!"
> "I've beaten the game!"
> " I play a lot of adventure games, and I beat them very easily."
> "...[B]ecause it is hard to win."

Many boys who play popular video games use the phrase "beating a game" to mean playing all the way to the end of the game.

When asked to design their own video game, boys included elements of competition and violence. The following are excerpts from descriptions of games designed by three different boys:

- At the end of the levels Einstein has to beat the mad scientist by answering a science question.
- In order to kill the bosses you have to have collected all the notes and answered all the questions correctly.
- The object of the game is to kill Starhead. Starhead took over Moonland and in order to get onto the next level you must kill him. In order to complete the game you have to kill Super Starhead. Starhead is evil. He lives on an island surrounded by lava. If Hothead cannot beat him and gets hit, then he is placed in a trap. Coolhead has to save him by either killing Starhead or by pulling out a special orange pin.

While our observations support the first conception that boys like electronic games that contain violence, we also noted other important characteristics and features of the games, as well as outright exceptions to the attraction of aggression in games. For example, the same video game designs described above included elements other than competition and violence; they were also process- and goal-oriented. Referring to the orange pin in the previous description:

> This pin makes it nighttime. During this time everything in the game sleeps, so the screen is frozen for ten seconds. During this time you can zap the trap and free the player.
>
> If you come to a mushroom then you get a free life.

> The next two worlds are Starworld and Moonland. In Starworld there are evil *Ninja* stars and in Moonland there are burning hot, spiky moons. When you complete the game, you get to go back to your land.

Ten-year-old Nick designed a game called *The Secret of Life*:

> It is like a story. On the first level you are a human until you find an armour suit. Then you go back in time. The second level you fight other people in order to discover the secret of life. There are 16 levels in all, and every second level you encounter a boss, who gives you a riddle. At the end of the game you put all eight riddles together in order to solve the meaning of life.

Rather than being attracted to violence or explicit competition, many boys liked games that pose a mental challenge. When asked by a researcher why they liked a particular game, boys gave answers such as:

> "It requires more thought."
> "I like figuring things out."
> "Because it's like a design. You have to design something."
> "Because it tests your knowledge."
> ". . . realistic and challenging . . . issues that belong to this world."
> "I like role-playing and strategy games."

In fact, 13-year-old Jared has solved all 87 puzzles in *The Incredible Machine*. He described the last puzzle as being "mega hard." He and a friend spent about 24 hours over the course of four days to come up with a solution—a process that included drawing the machine on paper several times.

Some boys, like 11-year-old Matthew who likes video games, explicitly eschewed violence in the game *Lemmings*.

> In puzzle number six it is necessary to sacrifice at least two lemmings. Matthew looked at his tools and saw that he was able to blow up lemmings. He started to do this but then hesitated. He explained that he didn't want to blow up any but he couldn't figure out how to do it. I explained to him that sometimes it was necessary to blow up some of them. He blew up one and successfully got the lemmings to the second level.

Matthew went so far as to apologize when blowing up the little furry creatures was necessary to complete the level: "Sorry guys."

The Anti-social Player

> There are no team players [in the world of video games]; each man or woman is out for himself or herself. ... Of the 40 [top-rated Nintendo] games that emphasize violence, nearly all are based on the principle of an autonomous individual acting alone. (Provenzo, 1992, p.31)

As Provenzo notes, the subjects of many popular video games operate alone, in anonymity. He claims that playing such games allows children to act independently of social norms. Selnow (1984) suggests that frequent players of video games may be fulfilling their friendship needs with the games. Based on experimental findings that associate going alone to video arcades and low self-esteem in young boys, Dominick (1984) conjectures that playing video games may be a substitute for social relationships, as well as an attempt to raise self-esteem.

However, we observed little or no behaviour to support the conception that electronic games encourage or are associated with anti-social behavior in boys. In fact, we witnessed numerous occasions of collaborative play among boys at Science World BC—even among boys who had not met one another previously.

> Two boys were playing *Spot* and were the only two around the machine. I went over and started talking to them. They both wanted to play, so I suggested that they take turns. Paul was playing at the time. They were enthusiastic and said, "Sure." I said, "Why don't you each play a life," and then Paul suggested that they each do a level. They seemed to enjoy playing together and helped each other while it wasn't their turn. Nate in particular was very vocal with his suggestions. These two boys had not come to Science World BC together and had never met before. Paul had a Sega Genesis game player at home and Nate had a SNES. Both boys enjoyed playing games at home.
>
> Nate mentioned that he wished it was a two-player game—he liked those better. He stated that he has several two-player games at home. I asked him if he liked to play on the same team as the other person or against each other. He said that he liked to play on the same team.

Moderately large groups of boys were able to work out fair ways of sharing a single video game:

> A group of about eight boys, from ages seven to twelve, were gathered around the game *Spot* when I went over. Things seemed to be running fairly smoothly. When I got there I asked the boys if everyone was getting a turn. An older boy explained that they each got two men, then they passed the controller on. I asked who was next and a couple of them explained to me that this boy was next, then this one, etc. They had clearly worked out a system so that everyone got a turn. I watched for about half an hour and this system of "turns" appeared to work smoothly.
>
> When one younger boy in particular was playing he was having trouble jumping onto a ledge. After several failed attempts the others tried to explain to him how to do it.

As illustrated in the two examples above and the one below, more able players often helped the others.

> Two brothers are playing *Spot*. The 11-year-old has played it once at a friend's house, and the 14-year-old has never played it before. They have a SNES at home and both enjoy playing video games. Both boys are taking turns with the controller and are doing very well in the game. There are about five other boys watching. None of the others appears to be frustrated that they are not getting a turn. They seem very interested in watching these two play. They are at levels most haven't seen before and quickly pass levels so there is constant changing of scenery. The boy who has never played before seems to want to play more, and his brother lets him. The younger brother helps him, telling him which direction he should head. When a difficult level appears, the controller is given to the younger brother (the one who had played before) to complete the more difficult task.

A researcher asked 13-year-old Joshua what it took to solve game puzzles successfully. Joshua's response included reliance on friends:

> "One has to think about things before you really get down to doing it. You have to ask yourself questions about what you are doing. I

> enjoy working with friends because you are able to solve problems faster that way. You don't get stuck as you would working alone."

Five-year-old Brian had the following conversation about friends and video games with one of the researchers:

Researcher	:	How often do you play? Everyday?
Brian	:	Sometimes everyday.
Researcher	:	Do you play it by yourself or with your friends, mom and dad?
Brian	:	With friends.
Researcher	:	Which one do you like better, with friends or by yourself?
Brian	:	With friends.

A study by Mitchell (1985) on family dynamics in the context of home video game play indicated that game playing is frequently a family activity. Many boys who visited the *Electronic Games Research Lab* with their parents or another family member also played or watched games with their relatives.

Several boys of ages ranging roughly from seven to fifteen years of age were taking turns playing a video game. A researcher observed the fifteen-year-old offering suggestions to the younger players as they played, thereby actually increasing his own waiting time! The older boy seemed quite happy to help the younger ones improve their playing ability.

Expert game players are readily assisted others:

- I was helping a younger boy (7) play *Lemmings*, and I had to leave for a minute. There was an older boy (13) there who seemed to know how to play. I asked him if he would help the younger boy and he said, "Sure." I watched for a while, and he was doing a very good job helping the younger child play this game.
- Ben [described in the opening scenario] is a very talkative boy who was playing Sonic while I was over there. He is very vocal, talking to me and helping the other kids.

Recall from the earlier description of Ben that he also was very much a part of the video game culture—subscribing to several game magazines and frequently playing and talking about games with his friends. "Being into" video games frequently includes reading and conversing about them, as well as developing some economic notions about the worth of particular games for the purpose of trading and exchanging with other boys.

Living on Video Games Alone

> ...[R]einforcement theory has been applied to the letter by video game designers. This leaves little doubt that individuals susceptible to such conditioning may be at risk ... for developing an obsessive-compulsive attitude to the video games ... (Braun and Giroux, 1989, p.101)

Fearful of the potential for "addiction," many parents restrict their sons' use of video games. For example, eight-year-old Patrick is allowed to play only on the weekends, at night, or on a rainy day. Some parents are willing to buy their children a computer, but refuse to buy a video game unit:

> "[They] tell me that they would rather have a SNES. I asked them why they couldn't have a video game unit, and they explained that their father says that if they got it, [the children] wouldn't do their work, they would just play games."

Parent visitors to our exhibit told of setting schedules to control the amount of time their boys spent playing video games. One parent resorted to hiding the game unit when the restrictions failed to curtail excessive game playing.

Clearly many adults are concerned with the third conception: boys who play electronic games are susceptible to becoming so devoted to playing the games that they neglect other areas of their lives, such as school, physical activity, and family. From our observations, however, many boys who frequently play electronic games also enjoy school and perform well scholastically.

- Two brothers are playing *Operation Neptune* while their parents are watching. ... The mother explains to me that both boys enjoy math and sciences in school, especially the younger one. He really loves the sciences.

- 13-year-old Peter likes writing, English, art, reading, science and recess. He does not like P.E., French, and social studies. He is good at English, writing, reading, music, recess, and science, and enjoys outdoor activities, making things, and playing games. Peter plays video games almost every day for about half an hour.

Alex, who plays video games at home, was playing *Scooter* with his aunt.

Researcher	:	How do you rate yourself—expert, good, or not so good?
Alex	:	I am pretty good at a lot of them. I have completed a lot of games.
Researcher	:	What kind of video games do you have ?
Alex	:	Super Nintendo games—*Street Fighter II* and *Legend of Zelda, Super Scope 6.* On my computer I have lots of games: *Legend Kyrandia, A+10 Tank Killer, Ultim Vi, Kings Quest 5, Sim Earth, Carmen San Diego.*
Researcher	:	What else do you do on your computer?
Alex	:	I draw and write.

Boys play video games within the context of their lives, which includes many other varied activities such as writing, school, music, and programming, as the previous and next observations illustrate. Ten-year-old Kevin and his eight-year-old brother were making music on the Super Nintendo:

Researcher	:	Have you played that game before?
Kevin	:	Yes. I borrowed it from my friend. We got our Super Nintendo recently, a couple of weeks ago.
⋮		
Researcher	:	What made you boys ask to be bought Super Nintendo?
Kevin	:	We did not ask to be bought the game.
Researcher	:	It was bought for you without you asking for it?
Kevin	:	Our report cards!
Researcher	:	What about them?
Kevin	:	They were very good.
Researcher	:	Oh, you did very well in school, and so the Super Nintendo was a kind of a present?
Kevin	:	Yes.
Researcher	:	How much do you play games?
Kevin	:	I don't really spent a lot of time playing games as some people do. I don't spend like five hours playing. I just play a couple of hours.
Researcher	:	You said that before you got the Super Nintendo, you played a lot of computer games?
Kevin	:	Yes.
Researcher	:	How do you compare computer games with say the Nintendo games? Do you have any preference?
Kevin	:	I think I like them both. But, with the computer you can do some programming which you cannot do with Nintendo.
⋮		
Researcher	:	Do you like this game? (To Kevin's brother who was busy making music.)
Brother	:	Yes, I like it very much.
Researcher	:	Any particular reason?
Brother	:	I am into music, and so I enjoy this game.

Discussion

In our concluding remarks, we first consider our observations in light of the three conceptions about boys and electronic games—particularly in view of the overall E-GEMS goal. We then look briefly at game platform—computer or video—before concluding with some comments about the role of mediation in the use of educational video games.

The Three Themes in the Perspective of E-GEMS

Electronic games are an integral part of boys' culture. The E-GEMS research group proposes to develop means for incorporating this familiar medium of play into the school curriculum as a learning tool—one that is particularly effective for children at risk for losing interest in math and science. The observations gathered at the *Electronic Games Research Lab* provide several areas of focus for further research, as well as some necessary context for that research. We now consider the three conceptions, in reverse order of their original statement.

Addiction The addictive power of electronic games is frightening to many adults—parents, teachers, researchers—who are concerned about the potential for imbalance in the lives of boys who play the games. Certainly there exist children (and adults) who have felt consumed by a game at one time or another in their lives. Rather than shy away from this potential for addiction, the E-GEMS team intends to capitalize on the intense magnetism of video games. Turkle (1984, p.14) talks about the strong attraction of video games and computers: "... [H]olding power creates the condition for other things to happen." The attention boys—and some, usually younger, girls—give readily to electronic games provides an opportunity for learning. Certainly the holding power of the games need not skew a player's life, as evidenced by the interest in music, programming, reading, and school that many boys described to researchers at the *Electronic Games Research Lab* this summer.

Anti-social Behaviour Many electronic games are based on a story line in which one "good" character fights the forces of "evil." The single player of the game then assumes the role of the good character. Many of the boys who visited our lab at Science World BC play almost daily video games that are based on this type of theme. We did not see any evidence of abnormally anti-social behaviour in these players. We did see many boys playing collaboratively, older or more experienced players teaching younger or less experienced boys, and boys clearly and enthusiastically expressing their ideas about video games to researchers. Indeed, a video game subculture thrives in the world of boys—one that includes borrowing and trading games, magazines, game-playing parties, and every-day conversations about games. Perhaps a more pertinent issue is whether or not we will lose the interest of boys if we incorporate elements of cooperation and collaboration into an electronic game. Reasons for incorporating cooperation and collaboration into game design include the appeal to girls of games that involve working with others or are otherwise based on relationships (Inkpen et al., 1993). Will boys like games that girls like—ones in which the primary goal is not to "beat" the game or ones that do not pitch good against evil?

Violence Indisputably, many of the most attractive, best-selling video games abound with violence and competition. Will we lose the interest of boys if we leave out the violence in an electronic game? From our work at Science World BC, we certainly know of many boys who seek out games that challenge them mentally rather than games that contain violence. But are these the boys who are susceptible to losing interest in math and science in school? Is it actually the violence that attracts vast number of boys, or is it the challenge of learning and executing game-playing skills that coincidentally are embedded in an aggressive theme?

Video versus Computer Games

Of particular interest to the E-GEMS project is creating an attractive game that has little or no violence. During our two months at Science World BC we encountered many boys who preferred games based on puzzles to those with a violent theme. Many of these "counter-example" boys were observed playing games on the computers, as opposed to the video game units. Some number of these boys also had a computer at home, sometimes in addition to a video game unit. Game platform—video game unit or computer—might be an influential variable in examining the ways in which boys behave in conjunction with electronic games. Will E-GEMS have more success in reaching at-risk boys with an educational game developed for video game units? Is game play on a computer more conducive to collaborative efforts? What are the effects of the user interface differences (keyboard and mouse versus control pad)? Video games are usually played at a faster speed than computer games. How important is this to the attractiveness of the game?

Concluding Remarks

We have considered three common conceptions about boys and electronic games, together with the implications for designing educational video games that boys like. The exploratory research underlying this paper was based on observations of boys whose parents made an explicit, voluntary effort in terms of both money and time to enable their sons to visit a science museum. Given the E-GEMS goal of producing educational video games for children who are at risk for falling behind in math and science, more research is needed on boys in the targeted category. We readily conjecture that these at-risk boys generally like playing video games. We do not know, however, how important a violent or aggressive theme is to the attractiveness of a game, nor the effect of incorporating elements of cooperation and collaboration into game design (Inkpen et al., 1993). Exploring these issues is particularly important, since most girls are interested in games that have little or no violence and include cooperation and collaboration. We believe that it is unlikely that a single type of game will appeal to most at-risk children. In particular, our findings at Science World indicate that a game that appeals to most boys will be quite different than one that appeals to most girls.

Whatever elements are included in an educational electronic game, it is the classroom teacher who is in the position both to mitigate the detrimental effects and to enhance the beneficial effects of the game. The teacher can minimize the addictive aspects, add perspective to the violence, foster cooperative play, and encourage creativity. The role of the teacher is not to stand back and watch, but to mediate as he or she would in a wide variety of learning situations. The development of appropriate curriculum support materials also requires a mediator. Someone needs to articulate the links between electronic games and concepts in math and science, so that the concepts themselves may captivate the interest of children. Ultimately, we are looking for the quality of concentration young people give to video games to transfer to finding the patterns—and beauty—in mathematics and science.

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