Science & Mathematics Education Centre

Design Attributes of Educational Computer Software for Optimising Girls' Participation in Educational Game Playing

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

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ABSTRACT

Recent research on girls in science education in Australian primary schools indicates a participation rate lower than that of boys. This inequality could lead subsequently to reduced opportunities for girls entering the workforce in their adult years. Many studies have attempted to reveal why this situation has arisen and a variety of strategies for increasing girls' participation has been suggested.

A relatively new strategy that does not appear frequently in the research literature is the use of educational computer game software. An important question arises: does the game software used in primary school science education reflect design attributes favoured by boys and, if so, do these attributes actively discourage girls' participation by making them feel uncomfortable or stressed? My case study was designed to identify design features of computer games that girls prefer so that these features can be included in educational computer game software designed for science education, as well as the other Key Learning Areas.

Through interviews, surveys and observations my interpretive study obtained the opinions and views of over 200 children in two suburban Australian primary schools in which I work as a teacher-librarian. In this role I purchase educational computer games and organize special classes for students to play them. From my analysis of the data I make recommendations that reflect girls' preferred design attributes for educational computer games. I also generate a checklist of criteria from my interpretations that may result in the purchase of software that could not only enhance girls' participation and success in primary school science, the curriculum area of greatest personal interest to me, but also in other Key Learning Areas of primary education.

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I wish to acknowledge the support and encouragement I have received throughout this process from my supervisor, Associate Professor Peter Taylor. At all times, Peter's ideas, suggestions, and criticisms have been positive and encouraging. Whenever I was unsure of aspects of my writing he was able to advise me clearly with personal experience or relevant readings. Peter's patience and guidance in the production of this thesis has been invaluable.

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CHAPTER ONE

THE ORIGINS OF MY INQUIRY

Introduction

Robinson (1992) reminds us that our educational environment reflects and reinforces much of the inequities girls and women face in today's society. These inequities are perpetuated through schooling practices and structures that have not changed a great deal in the last 100 years. These inequities have also been evidenced in the outcomes of science education in our school system. Girls do not appear to be either achieving in or enjoying their time spent in science lessons (Barr & Birke, 1994; Bianchini, Cavazos, & Helms, 2000; Mason, 1995). As educators, we may be wondering what we can do to change this situation. How can we have a role in influencing positively girls' attitudes to science and computers, particularly when girls' existing unfavourable attitudes may be shaped by societal influences over which we have little or no control? The first thing that we must reject is a belief that we are incapable of becoming involved.

Educational achievement is the result of many complex factors (Hartel, Walberg, & Weinstein, 1983); too complex, perhaps, on the surface for us to modify or change. But, as Brickhouse (1994) states, although we, as teachers, cannot act directly on the social conditions that surround our schools, we can wield influence by the way we shape our curricula and by the experiences we provide to the children in our care. From this perspective, educators can be directly involved in the selection and provision of gender-inclusive educational software for primary school science.

Origins of My Questions

When writing this introduction I reflected upon the genesis of my research questions and realised that they were first formed as a combination of my teaching experiences and observations at my schools and as a result of postgraduate courses I have undertaken.

In my role as a teacher-librarian in New South Wales public primary schools for over 20 years, I have been able to observe the borrowing patterns of students as well as their use of computers in my schools' computer laboratories. From these observations, I have noticed several things that have laid the foundation for my enquiry.

Reading Preferences of Children

I have noticed that, in general, girls and boys appear to have different preferences when borrowing books from the library. Boys seem to borrow more non-fiction texts than do girls, and girls seem to borrow more fiction books than do boys. The small amount of available literature suggests that this may be widespread and that it may have some bearing on girls' attitudes to science in their later school years (Kahle & Lakes, 1983).

The significance of the relationship between reading preferences and success in school science has been suggested by research as very important (Linn & Hyde, 1989; Murphy, 1995). Murphy maintains that the style of reading a child is familiar and comfortable with can influence their ability to successfully carry out assessment tasks. If boys are more familiar with factual styles of text, typical of written answers in traditional science assessment tasks, then they may have an advantage over girls who prefer literary styles of text. As Gilbert (1988) argues, girls' writing is closely linked to girls' reading, and narratives are not the usual response required in science assessment writing tasks.

Greater interest and experience with factual texts could be a small factor in making the world of science a more comfortable one for males. Keeves and Kotte (1996) reported that, at the 10-year-old level, boys expressed greater interest in science and more favourable attitudes towards science than did girls. Possibly, their greater exposure to self-selected factual texts could play a small but significant part in this positive reaction. This assertion is reinforced by findings discussed by Rhedding-Jones and Atkinson (1991), who believe that the literary genres children become familiar and comfortable with are important to their developing self-images. Hence, if girls are more familiar and comfortable with literary texts than factual texts, they are more likely to miss out on developing attitudes, skills and information that can be gleaned from non-fiction texts, and also have the belief reinforced that they do not belong in the world of science.

Reading Preferences of My Students

The manual library book circulation systems that have I used at my schools has made it impractical to research this observation more fully. However, with the introduction of the OASIS library suite of products, which incorporates a circulation system that records and matches the titles of books borrowed by individual children, I was able to conduct a study which confirmed my informal observations. My study found that, in general, girls and boys borrowed different types of texts: girls were more likely to borrow fiction while boys were more likely to borrow non-fiction (Rich, 1999). Could this be a small but relevant contributing factor to the lack of participation and success in science experienced by these girls in their subsequent high school years? It was this finding that led me to reflect upon other observations I had made over the previous three-to-four years regarding the use of computers in the school computer laboratory which, in turn, led to my research.

Software Choices of My Students

I had noticed when supervising classes in the computer laboratory at one of my current schools that girls often volunteered to work with other girls on a computer, especially when 'doubling up' was required due to lack of computers. Rarely did they elect to work with a boy when they selected their partner. Also, boys rarely volunteered to share a computer with another student, whether boy or girl. These observations led me to wonder whether, in general, girls prefer to work with a partner and boys prefer to work alone. If this is the case, then does the software selected or preferred by girls work better with multiple users or is it designed primarily for the individual user? Were girls choosing a girl partner because they wanted to work collaboratively, or was it because the computer programs they preferred were more successfully enjoyed when more than one person interacted with them?

I had also noticed that girls often choose similar programs, especially when not directed by a teacher to a specific program. This appeared also to be the practice of the boys. And, when directed to use a particular program for a particular lesson, both girls and boys tended to express their displeasure if it was a program they disliked. Also, I had the impression that the programs girls disliked, in general, were the ones that the boys would rather use, and vice versa.

These observations led me to ask if there were certain attributes and styles of computer programs that appealed more to girls, and certain attributes and styles of computer programs that appealed more to boys. And, if this was the case, were the girls being disadvantaged if the style of program they did not like tended to deal with particular disciplines, such as mathematics learning or science learning? Does one of the contributing factors of some girls' bias against science arise partly because the educational computer programs they are using for learning in these subjects are constructed in a way that does not appeal to them? Could this actively turn them away from the discipline?

Influences From My Teaching Experience

These questions were important to me and, I believe, important to other educators who come in contact, either directly or indirectly, with our students. I have found over my 20 years of teaching that the introduction of computers in New South Wales public schools has occurred with very little consultation with classroom teachers and even less curricula support. Teachers, if they wish to use the computers supplied to them, have had to rely on pre-packaged software programs, which tends to make them the agent for someone else's ideas, plans and procedures. Teachers, generally, do not have the expertise to properly evaluate commercial programs and to modify them if necessary in order to enhance their teaching. Too often, it is the teaching activities of the teacher that are modified in order to incorporate the new 'teaching and learning machine' now being used in all schools.

Influences From My Tertiary Studies

The second influence on the formulation of my enquiry was several postgraduate courses I have undertaken. I completed a Master of Education degree at the University of Southern Queensland in 1996. This course was concerned with children's literature, and I was able to use several units as vehicles to explore my interests in literature and girls' learning. After completing that degree I undertook a second Masters degree in 1997 at Deakin University where I carried out studies in Information Technology Education. Part of the assessment for the second degree was designing, but not conducting, a research project that dealt with one facet of educational computing.

As I stated earlier, casual observations at my schools had piqued my curiosity in how girls used, or sometimes did not use, computers at my two schools. I felt that that was an area worth investigating and the Deakin University course provided an opportunity to do so. In conducting literature searches for a suitable topic it struck me how little research dealt with the role of educational software. The majority of literature concentrated on the hardware itself. This surprised me because I thought the relationship between software and gender was an obvious area to investigate. Therefore, I mapped out a project to investigate how software might interrelate with girls, computers, and learning.

This is where my curiosity may have finished as I was intent on updating my librarianship qualifications and did not have the time to follow up my questions of gender and software. However, the courses that I undertook in teacher-librarianship actually rekindled my interest in the relationship between gender and software. In 1998, I completed a Graduate Diploma in Teacher-Librarianship through Edith Cowan

University. Part of this course dealt with criteria to be used in the selection of resources, which included educational computer software. Although gender bias was to be taken into consideration when selecting resources, there was no specific mention in any of the course material or readings of what criteria should be applied to software that would make it accessible and useful to girls. I felt this was an omission of importance and reminded me of my previous studies. The situation was repeated in 1999 when I completed a Master of Applied Science (Teacher Librarianship) degree through Charles Sturt University. Again, no mention was made of gender and computer software. I felt that this was a major failure from both courses because, as a practising teacher-librarian, I knew that budgets for the purchase of software were increasing each year yet there appeared to be no guidelines to assist in its effective spending.

My Present Course of Study

On completion of this course, the opportunity arose to enrol in my current research program which I did as it allowed me to follow up what I believed was a significant aspect of good teacher-librarianship practice. The main attraction of my current course was its practical nature. According to the handbook I received upon enrolling, my study would encompass "a practically-oriented research project in a specific area of science, mathematics or technology education" (*Graduate courses*, n.d., p.5). Looking at research this way, taking it out of the university and situating it in the 'real' world, appealed to me. I believe it embodies the position of Gibbons et al. (1994, p.28), who write about a "new knowledge society" that is "characterised by knowledge production occurring outside universities...to places where people work". It produces knowledge "as a product of professionals [in this case, me] reflecting upon practice where that reflection is generated out of their own interests" (Maxwell, n.d., p.3).

Also, I believe that my research brought to fruition one of Boyer's (1990) four scholarships. Boyer's vision of research in higher education sees four areas of scholarship; discovery of new knowledge, integration of isolated facts and making connections, the application of knowledge so as to improve the lives of all, and assisting others through the teaching of knowledge. My research slotted in with his view of applied research that can assist others in their lives and in the achievement of equity. This was supported by Reason and Torbert (2001), who saw that while the primary purpose of research in the academic culture was to contribute to an abstract body of knowledge, the main purpose of applied research was a practical knowing that could be applied directly to the task of improving the human condition. I envisage that the application of what I discover through my research to my schools will result in better and more equitable outcomes for many of the girls I teach.

The practical orientation of the course was the selling point for me. I was not greatly interested in academic research just for the sake of it. My needs were of a more practical nature and I wanted to do something that would help me, and hopefully others in a similar position, achieve better outcomes for all my students. I had over my years of teaching been relying on what Reid (1994, p.474) called “practice wisdom”, a reliance on knowledge and insights that I had gained from my daily work and interaction with my students. As I had a practical problem to investigate, rather than a theoretical one, the objectives of this course suited me.

Enrollment in the course gave me the opportunity to methodically investigate my casual observations and assess the extent to which girls prefer computer games that have different design attributes to those that boys enjoy. On the basis of these results, in my profession as a teacher-librarian I would be better able to purchase educational software that would not exclude girls from using computers at school. I wanted to be in charge of what was being used by my students in my school, and I wanted to make sure that through both ‘practice wisdom’ and contemporary research, the materials I selected and used were materials that would give all my students the maximum chance of succeeding and enjoying their primary school science experiences.

My Audience

In carrying out my research I always kept in mind my primary audience, those for whom this thesis is being written: myself; my fellow teachers, who will judge my research from what practical knowledge they can gain and use in their own situations; and my examiners, who will judge the worthiness of my research in relation to the academic requirements set out by the university.

As selfish as it sounds, the first, and for me the most important member of my audience, is me. It has been my curiosity that has driven this research. At the end of this long and interesting journey I want to be able to answer and satisfy my queries regarding software attributes that girls prefer, and to use what I discover to better serve my students.

The second members of my audience are my fellow teachers who may also be in the situation of purchasing educational software in a game format but do not know the style or design of software that appeals to the girls as well as to the boys they teach. I hope that my research can result in conclusions and recommendations that assist teachers in purchasing appropriate software, in terms of design attributes, that will contribute positively to their students' learning. I know that in the past, when I have had to select and recommend software for the various faculty committees at my two schools, some guidelines on what should be effective would have been of great assistance to me rather than relying only on my intuition, an intuition that is based largely on anecdotal observations over recent years. When dealing with small budgets every purchase needs to be effective. Schools today do not have money to waste on software that proves to be ineffective for up to half of its student population.

The third members of my audience are the examiners who, from an academic point of view, will be judging my research, interpretations and conclusions. For this audience I am required to present my study in a certain style by using particular language and layouts to demonstrate suitable academic rigour and care and to show that my efforts are worthy of acknowledgement in an academic environment. I am hoping that the way I present my research satisfies both my fellow teachers and academic examiners, with my results and conclusions being accessible to both the practical practitioner and the theoretical observer.

Organisation of the Thesis

This thesis is made up of several major sections that I believe best inform the reader how I arrived at my research question, the elements that influenced me during the course of my study, how I carried out my data generation, the analysis of the generated data, and the conclusions and recommendations that have been derived from the data. It outlines my 'sensemaking' journey (Chenail & Maione, 1997), by providing the reader with an understanding of my 'before research' constructions and understandings, the methods and ideas I used to deconstruct and modify those constructions and understandings, and the new constructions and understandings that resulted from my journey (Dervin, 1992; Duffy, 1995; Shields & Dervin, 1993; Weick, 1995).

Chapter Two deals with a question that has plagued me throughout my research, the question of whether software attributes in educational computer games can be modified in order to enhance girls participation and achievement in primary school science education is indeed a question worth answering. This chapter answers my concerns and does, I believe, help considerably to justify this study.

Chapter Three then continues with a short section which argues that the ultimate objective of my research is to provide a more equitable situation in primary school science education than can be found at present. I also used this chapter to situate my research in Lincoln and Denzin's (2000) "seventh moment" of qualitative research, a view that brings a critically moral approach to what I investigated.

Chapter Four describes how the relationship between women and science in today's Western world has been shaped and changed by the events and social perceptions from our past. This flows on to Chapter Five, where I discuss the current situation of science education and girls in our primary schools, arguing that many girls continue to be excluded from fully participating and achieving in science.

The role of software in computer education has been largely neglected in previous research, particularly in the area of gender and computers. Chapter Six discusses the role that software can play in either helping or hindering the user in an educational setting, and argues that software has a significant part to play in the success or otherwise of educational computing.

Flowing from this is Chapter Seven, a discussion of the relevance of computer games to educational pursuits. Computer games often have been dismissed as a waste of children's time, but I argue that they can be viable educational tools. The main purposes of this chapter are, first, to clarify the important role they can play in education today and, second, to support the justification for their study in an educational environment.

Chapters One-Seven bring me to the question that drove my research, "By using educational computer software that includes design attributes identified as being preferred by girls, could their enjoyment of, and achievement in, primary school science be enhanced?"

Chapter Eight covers the underpinnings of my empirical research, explaining the qualitative research methodology used to generate the data and the theoretical base for interpreting it. This is followed by Chapter Nine, a review of the specific literature dealing with educational and non-educational computer game software that informed me of the theoretical aspects of my enquiry.

Chapter Ten provides the reader with a preamble to the analysis. This preamble outlines a number of quantitative issues regarding my students and aspects such as computer ownership and attitudes towards different aspects of computing. Chapter 11 reports the analysis and interpretation of the generated data. Chapter 12 lists the conclusions drawn from the interpretation of the data and compares and contrasts my interpretations with the theoretical research from the earlier literature review. This chapter also lists the emergent criteria for girl-preferred design attributes of educational software.

Summary

Overall, I hope the reader can see the flow of my thesis and understand how the earlier chapters build an overall picture of (i) the current state of science education and girls, (ii) the inequitable environment that many girls often face, and (iii) how my specific research seeks to assist the girls in my two schools to improve their enjoyment of and achievement in primary school science by ensuring that they are comfortable with the educational software that I select for use in our science teaching program.

Significance of My Research

I believe there are several aspects of my research that makes it significant in the field of girls and educational computer software. First, as I have detailed in the chapter that looks at the relationship between girls and computers, very little research, current or otherwise, has been carried out that deals with the interaction between girls and design attributes of educational computer software. My research intends to add to this field of knowledge.

Second, according to Fromme (2003), research on media use, in my case computers, that concentrates on children is rare. Most studies carried out can be categorised as "youth studies" (p.5), or concentrating on members of the teenage years, rather than the childhood years, the age of my students. Many researchers question if whether or not children have the cognitive capabilities to undertake the tasks set by researchers. In relation to research, this promotes a deficiency model of childhood (Prout & James, 1990; Shantz & Hartup, 1992). Ironically, this is exactly one of the main feminist criticisms of research into girls and computers; that is, there must be something wrong with girls because they do not seem to be able to relate effectively with computers, rather than the researcher trying to understand and accept that some people interact differently with particular artefacts. It is an example of trying to force the subject of research to fit into the research paradigm of the researcher, rather than the researcher adapting their methodology to suit the attributes of the subjects being studied.

This is a model I dispute because, in a general sense, over 20 years of teaching has shown me that children do indeed have the cognitive ability to partake in and actively engage with what is going on around them in their environment. To say otherwise indicates a certain intellectual arrogance and, I believe, a lack of experience with children of that age. What is required is a different approach to the children, using the strengths they do have, honesty and openness, and a willingness to help and cooperate, rather than concentrate on them not being able to fit into 'adult' research designs. In a more specific sense, throughout my research, and particularly in regard to the one-on-one interviews, I was continually surprised at how well my students grasped the questions asked of them and the insightful answers they gave. In my situation, there was certainly no general demonstration of deficiency in terms of the data supplied by my students. Indeed, as the evolution of my interview questions show, they supplied me with insights that allowed me to investigate areas and ideas that I had not initially considered. Hopefully, my research will add evidence that young children are viable and reliable suppliers of data for researchers.

CHAPTER TWO

A QUESTION OF SUPERFICIALITY OR SIGNIFICANCE

Introduction

Murray and Kliman (1999, p.1) ask the question, "Why should educators care about the development of computer games?". The answer they provide is simple. We should care because "these games have the potential to significantly affect girls' experience with and attitudes toward technology". They continue by saying that there are three criteria that need to be satisfied; "the educational content, the features that make it equitable, and *the factors that make it more (or less) fun and engaging to play*" (my emphasis) (p.6). I am interested in the latter and I believe Malone (1981) supports the validity of this enquiry when he states that "there is no reason why educational environments have to be impoverished sensory environments" (p.363). What will provide the incentive for the girls to look at, load, and play a particular educational computer game that may assist them achieving in and enjoying science education in the primary school?

Research carried out concerning the use of computer games for educational or instructional purposes is meagre. A review carried out by Dempsey, Lucassen, and Rasmussen (1996b) of 99 articles related to instructional gaming practices found little convincing research regarding the ways computer games could be utilised for educational purposes. This finding represents the way, I believe, computer games have not been treated seriously for their benefits or otherwise in an educational situation. As Dempsey, Lucassen, and Rasmussen point out, computer games are considered by many as being very useful and relevant tools for enhancing children's learning, but there is little quantitative or qualitative research available to back this claim. I see my research playing a part in remedying this by assisting in designing a vehicle that allows the learner to construct knowledge in the field of primary school science.

Human-Computer Interaction

The term Human-Computer Interaction (HCI) was coined in the 1980s to describe the new field of research that dealt with how people (users) interact with computers on an everyday, practical level. The main thrust of this research was the design of the interface that users manipulate (di Sessa, 1991). Primarily, HCI was concerned with understanding, designing, evaluating, and implementing such findings in order to provide efficient and comfortable interactions *for the user*, not the computer or the software developer (Huff, Fleming, & Cooper, 1992; Jones & Okey, 1995; Preece, 1994).

The underlying theme that emerged from HCI research was that users come first. Users should not have to adapt to the system but rather the system should be designed in such a way as to contribute to and facilitate the successful and enjoyable use of the interface. This is where my research is situated; at the interface, the very thing that my students see and hear every time they select an educational program. My experiences tell me that the appearance of an artefact is important to children when they decide whether or not they like something or are going to enjoy using it. As Lucas (1991) points out, the visual design of the interface affects the learner's impression of the program. If the impression is favourable and friendly the user is more likely to try the program.

It is important at this stage, though, to pause briefly and point out that I am not investigating the content of educational software. What I am interested in is how the content, whatever it may be, is presented to the student. This is an important point to make. McLuhan (1964) made the famous point that the medium is the message, not the content. This is the underlying thought of my investigation. In this particular study I am not interested in what is being overtly taught to my students when they use science education software. What I am interested in is the covert messages being sent to them via the medium of the software design. In particular, I am interested in the extent to which the software has been designed only with males in mind and if it is giving the message that only males are welcome here in this world of science.

The Importance of Appearance

A significant part of my job as a school librarian is to satisfy requests from my students for a "good book to read". Time and time again, when taking a book off the shelf and showing the child, they will reject my choice simply because they do not like the look of the cover. In other words, their first impression more often than not decides whether or not they think they will like the book. Often my detailing positive things about the book, or the author, or what other students have said, will be ignored. It is what the cover looks like that will, in many cases, decide whether or not the book is borrowed.

It is an experience that I have found very frustrating over the years. This is why, I believe, the appearance of a computer game is very important. I am concerned that children will dismiss a game simply because of the way it looks, or seeing or hearing aspects that cause them to decide that a game is not for them without actually engaging with it. Provenzo (1991) cites a 1985 study carried out by Mortlock et al., where it was concluded that stimulus characteristics included in computer games were found to appeal differently to women and men. For example, they found that women were much more interested in the sound effects of the program than were men. This is an early example of what I am investigating.

This opens my research to the criticism that I am only interested in superficial aspects of educational software. This is a criticism that has constantly been in my thoughts. I often asked myself during my study whether my research would make a worthwhile contribution to this area or is it dealing with unimportant elements of what educational software can do for children, and girls in particular, in primary science education. Fortunately, other researchers have entered this debate and affirmed that the supposedly superficial aspects of design are indeed important considerations to be taken into account when evaluating the effectiveness of educational software.

Brown et al., (1997) believe that identifying features that impact on girls and cause them to be less interested than males in computer games, and therefore possibly restrict their achievement and enjoyment in using computers, can yield significant benefits. Of course, such restrictions are, perhaps, of little concern when the focus is on the development of success and proficiency in computer games as entertainment. However, the restrictions do take on significance if the focus moves to the development of interest in educational computer games which are being increasingly used as a learning tool in today's schools. As they point out, "identification of factors that reduce female interest in [computer games] is a necessary first step in modifying these games so that they become entertaining and educational for both genders" (p.795).

In the broader context, McMahon (1996) points out that the form of an object, or artefact, can play a subtle but significant role in how a person interacts with that object and can actively shape a user's, or observer's, perceptions and emotions regarding that object. In other words, what something looks like is important if you want people to interact effectively and profitably with it. This is an important consideration in the context of my study because Sedighian and Sedighian (1997, p.1) make the point that many "educational programs are designed for functionality and do not take into account the aesthetic needs of the learners in terms of colours and graphics" and so can lose the interest of a learner at the very beginning of an interaction that could have delivered an enjoyable and worthwhile learning experience. Klawe et al., (1996) illustrated the importance of the form of the object when they detailed how they constantly needed to fine-tune their interface when designing a girl-friendly game, *Phoenix Quest*, in order for it to succeed with its intended audience. I want to find out what will attract and motivate girls so that they will not miss out on experiencing one facet of science education that can take advantage of the popularity of computer gaming.

Motivation

Another aspect of the design features is motivation. Dweck (1986) tells us that motivation is an important element in education and plays a key role in educational activity. If a student is not motivated then the results of any work they carry out may not indicate their capabilities. In the past, there has been significant research carried out in the field of education and motivation but, as Norman (1993, p.32) puts it, there is “little scientific knowledge...about the factors that underline motivation, enjoyment, and satisfaction” in learning. In the context of computer-assisted learning, Malone (1981) conducted a number of studies to find out what made commercial, non-educational computer games interesting to children; in other words, what was it that captured their attention so much that other toys and activities could not, and could this be transferred to the design of educational software? Many of his findings and conclusions dealt with what would basically be called superficial aspects of game construction and presentation.

However, rather than dismissing these features as superficial and unimportant, he believed that they were relevant and that it was essential they be understood because, as he states, “If students are intrinsically motivated to learn something, they may spend more time and effort learning, feel better about what they learn, and use it more often in the future. Some theorists would also argue that they may learn "better" in the sense that more fundamental cognitive structures are modified, including the development of such skills as ‘learning how to learn’” (p.3). Malone believed it was many of the ‘superficial’ design features that contribute to this better learning.

Other researchers have continued this call. Littleton et al., (1998) in their study of computer-based problem solving software and gender, recommended that further research be conducted in the area of interface design in relation to gender differences, even though they acknowledged that it may seem to be investigating “superficial features of the software” (p.329). They found that slight changes to the outward appearance of the software they were trialing with primary aged children "dramatically transformed the pattern of gender differences in performance" for the girls in their study (p.337). This is supported by Rogers (1995), who states that if software is to be appealing to girls, how it looks has to be taken into account. Sedighian and Sedighian (1996, p.7) found that the "sensory stimuli" provided by the surface design elements of their mathematics-game software added to the fun and enjoyment of playing the game for their students. As one of their students said, "they add flavour to mathematics".

Conclusion

By using what my students tell me they prefer and do not prefer in educational computer games I hope to add to what Cassell (1998) calls the 'participatory design movement'. She describes how in the early days of computing, programs were designed by computer engineers for other computer engineers who would generally have a higher technical knowledge than the average person. As computers became more prevalent in everyday life non-technical users made up the majority of the audience and possibly did not share the same goals that the designers had in mind. Participatory design sees the users as an essential and integral part of the design process, a part that needs to be brought into the early stages of program writing in order for the finished product to be relevant and desirable to the targeted audience. My research can help place my students' preferences into this design process. I hope to find what adds 'flavour' to my students' experiences.

CHAPTER THREE

A QUEST FOR EQUITY

Introduction

Although my research dealt ostensibly with the issue of girl-friendly educational software, the underlying foundation was the search for equity. The reason we seek equity is simply answered by acknowledging that it is a moral given in our society that all are equal and all deserve opportunities that allow the full potential of each individual to be realised. No individual or group should be disadvantaged in our society by the actions, *subconscious or otherwise*, of our educational institutions.

Equity, according to Hansen (1996, p.2), is "a system of rules and principles based on fairness and justice" and goes on to list a number of topics that it encompasses. They include:

- under-representation,
- stereotyping,
- disenfranchisement, and
- bias.

These are descriptions that I believe can be used when discussing the problems girls face in regards to science education in our primary schools and it is an issue that must be addressed.

Henney (1986, p.6) states that equity in "educational opportunity means that each student is given an equal opportunity to pursue his or her own personal interests and to develop his or her own abilities". From an educational perspective, equity is "the concept of equal access to school education, and the fair and just distribution of benefits from [that] system" (*National Strategy for Equity in Schooling*, 1994, p.1), and "is equitable when all children participate and achieve equally" (Kahle, 1996a, p.129). This concept is based on the belief that all children, regardless of their individual circumstances, have a right to an effective education.

In relation to science education, Brickhouse (1994) points out that advocates of equity emphasise that *all* students are capable of learning science and that classrooms must be managed and lessons organised so that all students have an equal opportunity to learn. The Australian Science Teachers' Association discusses equity in terms of the curriculum and defines a 'gender inclusive curriculum' as one in which content, language, and procedures give "as much value and validity to the knowledge and experiences of girls and women to that given to boys and men" (Rennie & Mottier, 1989, p.18).

Sanders (1990, p.182) gives us a plan of action to assist in achieving equity; "[t]he process of equity is quite straightforward: *awareness* of a sex imbalance to the detriment of girls and women, *concern* about it, *action* to correct it, and *results* that eliminate it, thus achieving equality". My research fell into the category of taking 'action to correct it' by seeking to find those attributes that should be incorporated by designers into computer software which result in the encouragement, rather than discouragement, of girls in their science education. This stand was encouraged by Picciano (1994) who believed that teachers cannot stand apart when inequity is apparent but rather they need to become involved in the social as well as the educational issues to ask the unasked questions and to seek the answers.

Computer Games As Texts

Critical examination of the texts that are used in society can illuminate the practices of injustice and inequity, or as Gilbert (1993, p.324) said, practices that "authorize or silence" members of society, that may operate under the cover provided by the status quo. I used the word 'text' quite deliberately there. A text is not always a collection of words. A text is anything that can be interpreted by a person. Bernstein and Diaz (1984, p.12) maintained that a text "is a specific realisation of pedagogic discourse" and "can be referred to in any institutional practice or technique...[any] patterns of general behaviour, or knowledge forms in and through which the production of meaning takes place". Singh (1995, p.82) perhaps said it in a much simpler way; "[a] text can be anything that attracts evaluation; it can be a look". It was from this belief that I felt computer games constituted a genuine text of society and should be examined critically for what it brings to the members of society.

To do this correctly demands a critical literacy approach to the text under examination in order to search for and identify biases and injustices that could be within it. This needs to be done because no text is neutral and an acknowledgment of non-neutrality is the point at which any cultural analysis starts (Beynon, n.d., p.9). This is supported by Street (in Limage, 1992, p.56) who maintained texts "are not neutral artifacts but are always contested and 'ideological'", and as Friedman (1995, p.1) argued, "every encounter between reader and text is a kind of exchange".

By legitimizing and critically viewing computer games as cultural texts I wanted to investigate if they might be contributing to the lack of participation and achievement in science education reported by a significant body of research. By using the critical lens I believed I could open up the cultural pressures they brought to many of the girls in the context of educational opportunity and advancement (Bull & Anstey, 1994) and find ways to change them to ease the pressure, or to eliminate them completely. A critical appraisal could put the girls and boys who play and enjoy computer games on an equal footing, rather than insisting the girls change their preferences in order to fit the mould provided by the boys. What I am doing is acknowledging that girls are not the problem, but rather the problem is "the social and political context in which their difficulties emerge" (Candib, Stange, & Levinson, 1999, p.356).

Preferences of Girls and Boys

In relation to my research, the literature tells me that there are different styles of games preferred by boys and girls, with girls' games involving such elements as low risk, turn taking, and indirect competition, while boys' games supposedly involve high risk, physical contact, and competition. These are the preferred game attributes of the two respective gender groups and the members of these groups are expected to conform to them. Unfortunately, the situation we find ourselves in today in relation to computer games is that the boys' preferences appear to be the norm for the design of the games, with girls' preferences ignored (Chaika,1995; Lovegrove, & Hall, 1996). This is an example of girls being measured by the male's ways of knowing (Koch, 1995) and are found to be wanting. My concern, as I have stated earlier, is that the educational computer games we make available to children display these same design features preferred by boys, thus covertly pushing girls away from programs that are used for science education in primary schools. It could be a small factor in why many girls feel alienated toward science in our schools.

To McDonnell (1994), this results in the very undesirable situation that "the things that males do and like have status by definition, the things that females do and like do not - a double standard that is still largely accepted by men and women alike" (p.51-52). This is a deficit model and it is one that I rejected. I wish to move away from judging educational computer games by the standards laid down by boys' preferences and move to a position that gives girls' voices equal volume and weight when it comes to designing and selecting educational computer games. As Jenkins (1998, p.292) argued, "to be gendered is to be constrained", and I wish to remove such constraints.

I am not claiming that my research will change the face of science teaching in Australian primary schools for the good of all girls. However, I am hoping that it will assist in reaching the situation where girls do have equal opportunity to achieve and enjoy their experiences in primary school science. I see inequity as a mosaic, made up of many tiles. My research hopes to change the face of one of those tiles, bringing the picture of equity a little closer to being complete.

The Seventh Moment

My research dealt with computer game attributes that are preferred and not preferred by my female students. By simply asking what they did or did not like critics could argue that my research was simply an exercise in market research and, as de Castell and Bryson (1998) maintain, there is little merit in labelling that activity as worthwhile educational research. However, it is the utilization of a culturally critical lens that distinguished my research from that of a marketing campaign and resulted in ideas on how best to design educational computer software that will be liked by girls. I believe my research provided sound and informed conclusions and recommendations that put the power back into the hands of girls by providing the tools that could allow them to become more active and willing participants in an area either deemed unsuitable for them or where they were simply not welcome.

As my research was ultimately concerned with equity for girls in science education it found itself situated within the seventh moment of qualitative research as proposed by Lincoln and Denzin (2000). Lincoln and Denzin proposed that qualitative research has developed since 1900 through a number of 'moments', with each 'moment' representing a break with and progression from previous forms of practice. They suggested that the seventh moment was more concerned with the political voice and views inquiry "as a moral act, concerned with the development of critical moral consciousness" (Coleman, 2001, n.p.). In earlier writings, Lincoln (1997) previewed what she saw as the future of research when she wrote, "the purpose of research becomes to move towards social justice, to quit debating about method, to move to an action arena, guided I hope by an ethic of social justice" (p.10).

This was a call to researchers to "engage in concrete steps that will change situations in the future" (Denzin, 2001, p.327). The seventh moment is concerned with a critical and moral discourse and so brings the moral dimension into the research arena, something that I have already stated I wanted to do. Geelan and Taylor (2001, p.9) described it succinctly when they said that the seventh moment in qualitative research "conceptualises educational enquiry as a moral act intent on transforming the social world". To the researcher, in this case me, the seventh moment means a more active and involved role that reflects their own identity and perspective (Salling Olesen, 2002).

Denzin (2001) brought the element of consumerism to many of the everyday activities and practices carried out by people in our society. However, he did not restrict himself to the definition of consumerism that referred to the acquisition and use of goods and services. He viewed consumerism as the "consumption of cultural objects...that can empower, demean, disenfranchise, liberate, essentialize, and stereotype" consumers (p.325). My research concerned itself with the objects that many girls were interacting with, computer games, and I believed these objects were in fact cultural objects that informed girls they were not wanted or suited to use them. They were tools that excluded girls from certain cultural and educational locations, in my specific case science education, that are influential and important in today's society. These computer games are presented and designed in a way that makes them appear to be the natural environment of males, reflecting Barthes'(1972, p.11) view on how "the media dress[es] up reality to give it a sense of naturalness" that nobody questions and simply accepts. Using the lens provided by the 'seventh moment' as advocated by Denzin and Lincoln (2001) strips the perception of naturalness to a social construct built by those who already hold the power and do not wish to share it.

Although I had no ambitions for "transforming the social world", as no individual could hope to do that alone, I did intend through my research to at least help in the push towards such a world. I believe I am answering Collins' (1991) call for a response that shows an ethic of care and an ethic of personal responsibility towards the community within which we all live, work, and play. This is a crucial statement to always keep in mind throughout the reading of my research as it adds the critical and moral perspective that I could be accused of lacking because I had selected the Pragmatist approach for my enquiry.

A Personal Revelation

Situating my research in this moment was done at the strong urging of my supervisor. Upon reading what Lincoln and Denzin (2000) proposed I recognised a situation that I had experienced once before. In my first course of tertiary study I undertook many years ago to prepare myself for a career in teaching I was exposed to many ideas, theories, and beliefs. One theory that was pushed strongly at my college was Piaget's theory of cognitive development, where a child develops cognitively from a concrete approach to the world to the formal operations required for higher thinking. Obviously, I had never heard of Piaget before I attended college but what I was being told about his theory made perfect sense. However, the revelation that I had was that I knew this already; of course children develop cognitively as they grow older, experience more things and come to understand the world around them. What I did not know was the formal language used to describe such development. My exposure to Piaget resulted in my own common sense being brought into my consciousness and made me aware of something that I knew but was not aware I knew it.

The same situation arose after reading about the seventh moment of research. It formally introduced the moral dimension to qualitative research, the real reason why we should be involved in it. Again a light was switched on and once again I had been introduced to a belief or theory that formalised and verbalised something that was already in me, but I *was not aware it was there*. This is what I had intended for my research from the very beginning. I believed girls were missing out on some aspects of their education in primary school because of the way educational computer games were designed.

I wanted first to ascertain the basic attributes of computer games preferred by girls and second, in using that as a guide, to examine the extent to which available educational computer games reflect these attributes. If they do to a large extent, then well and good, my basic tenet would perhaps be disproved. If, however, it was found that the educational computer games largely did not reflect what girls preferred then I would have discovered not only an element of the teaching-learning environment that promoted inequity, but perhaps also information needed to help correct it. With this information, I could establish design criteria that possibly remedies the situation so that when schools and teachers selected educational software they would be able to include girls' preferences. This overall research strategy reflects the seventh moment because my research sought to "seek new standards and new tools for evaluation" (Denzin, 2001, p.327).

Conclusion

If my research results in girl-friendly as well as inclusive evaluative guidelines for educational computer games, then I would have done what Connell (1994, n.p.) called for, that is the "building [of] a culture of equity [where] all forms of injustice are automatically contested and an ethic of mutual care...is central to policy making". Many other researchers from different disciplines (Heron & Reason, 1997; Lather, 1988; Stone & Priestly, 1996) have echoed this call for emancipatory research which is providing methods and strategies for different groups in society to break free from cultural and social stereotypes, to move and succeed in areas in which they have been previously discouraged, and to support "liberating social change" (Greenwood & Levin, 2000, p.94). I am not only doing this for myself, but also for the participants - my students.

CHAPTER FOUR

WOMEN AND SCIENCE (UNWELCOME PARTNERS?)

Introduction

The historical relationship between scientific study and the scientist has been a varied one in modern times. Science has gone from being viewed as a suitable activity for females to participate in to a discipline that was deemed beyond their capabilities and back again to a subject that they should be involved in but are not (Delamont, 1994; Easlea, 1986; Griffiths, 1988). This changing perception of who was capable of carrying out scientific tasks very much reflected the cultural mores of the time.

In today's Western society the terms 'science' and 'women' are not normally found together unless it is a report on why women are not participating and succeeding in the world of science. It is perceived today that science is the realm of the male, an environment in which a female does not belong and would not feel comfortable residing and working. Clearly, this perception, some would say reality, is not one that would be welcomed by at least 50% of our society, that is, women, nor, in fact, welcomed by the majority of males. However, the situation is one that many people rarely think about, nor, I believe, are consciously aware. For many people it is simply the accepted state of affairs and, if not brought out into the open, they will happily accept it and continue on their way.

Historical Perspective

Interestingly, this has not always been the case. From the early 1800s it was accepted that women were more suited to Science than to the Classics (Griffiths, 1988). This was a time when education was dominated by the study of the Classics, an area of study that was seen as a fit and proper activity to be performed by gentlemen. Science, considered then the poorer relation in education circles, was dismissed as unimportant and was, therefore, relegated to the world of women as a subject that was less intellectually demanding or important (Delamont, 1994).

However, after the Western world had been transformed by the Industrial Revolution it was noted by many that money was to be made in the world of science and that the study of the Classics could not compete in terms of financial reward or intellectual standing. With this realisation, women were quickly pushed away from the 'new' technical fields of science which were then subsequently appropriated by men. Suddenly, and for no other reason than money and standing, science became the realm of man, a world that did not welcome, nor wanted women (Perry & Greber, 1990). This development reflects Manthorpe's (in Kelly, 1985, p.147) view that "science is a social construct, its development is inextricably linked with social relations, not least the relations between men and women".

Thus Science, and the study of science, took on the masculine features of its new participants. It was then seen as objective, value-free, individualistic; attributes not culturally ascribed to women. Without these attributes, you could not perform 'good' science. Therefore to perform 'good' science you needed to be male. There was no room for emotionalism in the new world of science. This is an example of what Connell (1987, p.141) describes as an institution's activities and ways of doing things as "practice is of the moment". Science, a female-suited practice had changed to a male-suited practice, not because of the intrinsic activities that were a part of 'doing' science, but due more to economic and intellectual snobbery. Science, or we should say, the practitioners of science, then set about institutionalizing their way of observing and thinking, that is, rationality and objectivity, about the physical world, ensuring that from then on only men would be comfortable in the scientific world. This division of emotional and objectivist thought served well the exclusion of women from science (Brickhouse, 1994; Ives, n.d.).

Contemporary Perspective

This state of mind flowed into the 21st century, where today many people see science as the province of the male and the only females who can participate and succeed in this world are those willing to suppress their supposedly subjective feminine attributes and adopt the objective style of the modern, successful (male) scientist. Kelly (1985) puts forward that there are at least four distinct senses in which it can be argued that science is masculine; the numbers participating, the way in which science is packaged and presented, classroom behaviours and interactions of males, and the type of thinking commonly labelled as scientific which embodies an intrinsically masculine world view. This makes the inference that womens' knowledge is inferior to mens' knowledge (Singh, 1995). Sadly, this is a very impoverished approach to the practice of science. Science is a cultural activity, and therefore depends on multiple views from all the participants in that culture if it is to succeed for all members of that society. By holding and perpetuating the view that only men can do science, 50% of the population is being excluded. Eventually, we find that women become consumers of science rather than practitioners of science (Barr & Birke, 1994) and ultimately, they are excluded from the power that emanates from science in today's society (Frissen, 1992).

The Image of Science and Scientists

The scientist of today is still very much seen as male. This image of the male scientist is not presented in popular culture as being a very attractive person. Scientists are often portrayed as being different, quaint, antisocial or even mad (Barr & Birke, 1994; Mason, Kahle & Gardner, 1991) and it is often this image that is the public face of science. Spender (1995) sees this image as one reason why women feel negative about being involved in science. It is not the fact that they cannot do science, or do not actually like the subject itself, but the public image of a scientist "doesn't fit with their notions of themselves as women" (p.172). However, people forget that it is simply an image, and there is nothing intrinsic to science that points it to being quaint or mad; it is simply an illusion.

Research indicates that the majority of school students see a scientist as a white, middle-aged male working in isolation in a laboratory (Chambers, 1983; Jarvis, 1996; Maoldomhnaigh & Hunt, 1988). Evidence of this was gained by Finson, Beaver and Crammond (1995) when they reported results that indicated 83% of secondary students perceived scientists as male when asked to draw one.

This stereotype is also evident in my own two schools. When I conducted the 'Draw-a-Scientist Test' for an assignment in an earlier coursework subject (SMEC 704 The Inclusive Curriculum - Gender Issues), 83% of the drawings produced by my students in Year 3 to Year 6 depicted a male scientist. Coincidentally, this was the same percentage as Finson, Beaver and Crammond (1995) reported. This widespread perception reinforces the view that science is a masculine activity and not a suitable career for a female to enter (Kahle & Lakes, 1983; Kahle, 1989).

However, it is not only the physical image of the scientist that may turn women away from being active participants in science. Weinreich-Haste (in Kelly, 1985) put forward the view that science is associated with attributes such as difficulty, objects rather than people, and thinking rather than feeling. These attributes that society identifies as masculine suit the perception that science is a cold, logical and unemotional discipline. These are not the attributes that society conveys on women, rather the opposite. Tobin (1996) suggests that individuals feel pressure to conform to and adopt a set of roles consistent with the construction of others in society. Therefore, we can see how it is much easier for women to accept that science is masculine and not a place to locate themselves.

Ramifications of a Masculine Science

So what? This is the question that is often raised when discussing the masculine face of science. There are plenty of other academic avenues and endeavours for women to participate and succeed in. What does it matter if they do not actively participate in the workings of science? It does matter a great deal when such a large part of our society is excluded from any activity purely on the grounds of gender. Sjøberg (1989) found in a survey conducted with women scientists that a strong claim could be made that women in science would have different priorities and that a higher proportion of women in science could imply different decisions. Barr and Birke (1994) see the exclusion of women from science as an exclusion from power; power to participate in the technological and scientific decisions that are constantly made by society that affect all its members.

Members of our society cannot make informed decisions about science if they do not have an understanding of what that science can do. If we continue to exclude women from participating in science they will not, as a group, have the knowledge necessary to participate in the decisions that are constantly being made with regards to what is to be studied and what resources are to be allocated. Many reports indicate that women are not receiving the science skills, knowledge and understanding they need in order to be active advocates and workers in our increasingly technological world (Brickhouse, 1994; Shroyer, Backe, & Powell, 1995). As Davis (1995) puts it, we live in a technological age where everyday decisions are often based on scientific knowledge and if individuals do not have the required knowledge, or the interest, they will not be able to fully participate in the decisions that can both directly, and indirectly, effect their lives.

Gaining entry into tertiary courses that can lead to financially rewarding careers often requires advanced secondary education in mathematics and science. If girls turn away from these subjects early in their educational career they can end up being excluded from potentially satisfying jobs in the future (Keeves & Kotte, 1996). From an educational point of view, less people participating in science means less people available for teaching the discipline in the future. Already this is effecting our society. Thomas (*Crisis in supply of maths, science teachers*, 1998), cites a looming shortage of qualified teachers in science and urges the government to offer some incentive for students to participate. How much easier would it be to find future science teachers if we were not, perhaps, already excluding half of the student population, that is, girls?

From an economic point of view the exclusion of women from science limits the available pool of talented and qualified people from which the industry of science can draw. This is a labour pool that needs to be expanding, not staying static. The American Bureau of Labor Statistics reported in 1997 that the fastest growing occupations in the next decade would be computer scientists and computer engineers (Brzowsky, 1998). The American National Science Foundation estimates that there will be a shortfall of 700,000 scientists and engineers by the year 2010 (Mann, 1996). As the Australian economy closely tracks that of the United States it is plausible to infer that the same shortfalls will be found here, albeit on a smaller scale. In economic terms, can we continue to exclude half of the potential working population by continuing to deny them equitable access to science education?

Rather than exclude women from science, whether or not that exclusion is consciously done, all members of our society should be encouraged to participate from the very beginnings of their education and socialization process. There are many benefits to be found by an inclusive approach to science and science education. By bringing women into the scientific fold many observers believe new and non-traditional approaches to 'doing science' will be introduced allowing problems to be studied from a different, non-masculine perspective (Franklin, 1992; Inkpen et al., 1994). Utilising a greater diversity of people and views improves the chances of success and discovery. As Minnich (in Barr & Birke, 1994, p.480) says, "Knowledge requires many of us", and I am sure he/she did not mean simply more males. To exclude some diminishes the whole.

Linn (1994) points out other benefits, both for the individual and for the community in general, that can be derived from including women in the world of science. She notes that scientific jobs generally pay 50% more than non-scientific jobs that require the same years of education. Individually, this should be seen as a positive step for women. The study of science, when taught through an inquiry method, promotes critical thinking skills that can be used in many non-scientific aspects of their lives. It gives them "skills to critically analyze society and the energy to act upon their convictions" (p.4). This helps promote a vibrant and evolving community where discussion is informed and critical of institutions and accepted norms.

Conclusion

In 1988, Griffiths stated that "the shaping of the future depends on the kind of choices we make right now." This sentiment remains relevant today. If we want our science to be guided by a masculine world-view then we need do nothing. However, if we want to include all of the members of our society then a good start would be to make science more welcoming to women. We must hear what Haggerty (1996) tells us: it is not women and girls who need to be changed, it is the dynamics of how science is done. My research is hoping to take away another small brick in the wall that separates many of the girls in my schools from the world of science.

CHAPTER FIVE

GIRLS AND SCIENCE EDUCATION (UNWELCOME STUDENTS?)

Introduction

School performance, experiences and impressions are very important for the future success and participation of an individual in particular areas of society (Spear, 1984). The perceptions and experiences that a child gains in their education can govern how they participate in society as an adult. Thus, the experiences girls are having in school science today may be a significant determinant of their attitude to science in their adult life. If their attitudes are unfavourable, and science is deemed to be undesirable, then a significant part of society may find itself disenfranchised from making societal decisions on the role science plays in their lives (Barr & Birke, 1994; Brickhouse, 1994). As both Haggerty (1996) and Keeves and Kotte (1996) point out, barriers to participation in school science are likely to influence a girl's decision to opt out of science study as soon as she is allowed the choice.

The Role of Schools

What role, then, does our Western education system play in preventing women from taking an active role in the world of science? Is it partly responsible for the lack of female participants in the science laboratories, the shortage of female high-school science teachers, or the general dislike of science shown by many students, particularly girls? Or as Rosser (1990, p.54) puts it, "what is wrong with science and science teaching that fails to attract females?". Some researchers maintain that the decisions made by girls against a future in science are made as early as primary school (American Association of University Women, 1992 [AAoUW]; Linn & Hyde, 1989; Oakes, 1990), so the answer seems to be yes, something is wrong with our education system that makes it part of the problem. In some ways this does not make sense. With all the research on gender and education that has been carried out in the last thirty or so years, why is it that schools still cannot seem to interest girls in science?

Research would suggest that, indeed, girls do not have the same opportunities as boys when it comes to participating and achieving in science education (Bianchini, Cavazos, & Helms, 2000). The subject of science is seen in our schools as a masculine subject, therefore only boys should apply. It is a perception that, according to Kahle (1996b), teachers and schools sustain, either consciously or sub-consciously. If this is true, then we are letting down half of our school population and depriving them, and our society in general, of the future benefits that can be obtained if they decide to pursue a science-based career. However, it does not have to be this way. Harris, Nixon, and Ruddock (1993) point out that while schools may reinforce cultural stereotypes in relation to female work and male work, they also provide opportunities for girls to reject these stereotypes and allow them the opportunity to gain experience and qualifications that will assist in their choice of non-traditional careers.

In seeking to identify why girls are not achieving in science in our schools three elements need to be considered, curriculum, teachers and their attitudes, and the students themselves and their attitudes.

The Curriculum

Robinson (1992, p.274) states that schools, "being a microcosm of society at large,...perpetuate the male hegemony concomitant with a patriarchal society'. The curriculum of these schools proscribes what is taught there and the curriculum reflects what our society believes. Would it be fair to say that our society, a patriarchal, or male-dominated one, dictates that science is a masculine pursuit? Kelly (1985) believes so, saying that this social construction of science as being masculine discourages girls from participating. Perhaps then, we should not be surprised that a curriculum which reflects society discourages girls because, as Fee (in Haggerty, 1996, p.19) states, it is "unrealistic to expect a sexist society to produce anything but a sexist science."

Kenway and Gough (1998) agree when they state that because males are the main writers and developers of these curricula, the resulting documents will reflect the values, interests, and learning styles of men and so, subsequently, alienate girls. This cannot be seen as a desirable situation because as Parker, Rennie, and Harding (1995, p195) maintain, "exposure to sex-biased materials both communicates and reinforces sex-biased expectations".

Both Kelly (1985) and Greenfield (1997) point out that school science is packaged for learning to suit the ways in which boys are connected to the world. Related to this, Bazler and Simonis (1991) found that even the materials used in school-room science reinforced the masculinity of science. The textbooks in use, for example, provide evidence of this. Smail (1984) documented in her study of science textbook illustrations that when a person was depicted it was generally a picture of a male. Similarly, Taylor (1979) made comment on the small number of representations of people of either gender in science textbooks, reinforcing the notion that science is actually about objects, not people or social phenomena. Rennie and Mottier (1989) explain the significance of this when they state that by using predominantly male pictures, science is presented not as a human activity, but a male activity, and so creates a barrier for girls. Interestingly, this can be a double-edged sword. They also point out that a predominance of male representation "not only limits females to a narrow range of roles, but they also limit the range of activities thought to be appropriate for males" (p.18).

The interim report of the Commonwealth Schools Commission report *A national policy for the education of girls in Australia*, (in Krystyn, 1987) notes a number of factors that appear to be depressing girls' interest in and achievement in science. One of these factors is the separation of theory from everyday application. Harding (1995) agrees, noting that much of the science taught in our schools is presented in a detached, abstracted and depersonalised way. This style of presentation goes against how many feminist researchers believe girls learn best, by relating theory to everyday social settings, and actually privileges a particular masculine mode of enquiry and way of knowing that is not generally suitable or desirable for girls as a group (Belenky et al., 1986; Gilligan, 1982; Fox-Keller, 1985, 1992). Qualter (1993) recognised this and put forward the notion that girls need to see the relevance of science for themselves and the world about them if they are to be interested in being involved in the discipline.

Jewett (1996) believes that girls approach science from the perspective of interdependence and relationship rather than from an isolated skills analysis viewpoint that appears to be favoured by boys. This is supported by Kenway and Gough (1998, p.7) when they describe the "hard" traits perceived to be needed to be successful in science as being "rationality, certainty, control, rigour and emotional neutrality" in contrast to the "soft" traits intrinsic to girls, "sensitive, imaginative, responsive, sympathetic, creative, perceptive, and reflective". In other words, science is presented as a "positivist masculine construct" (Goldman-Segall, 1998, p.1) and perpetuates a world of male privilege (Harding, 1991; Manthorpe, 1982; Weiler, 1995). This is, of course, a naive way to look at science. Many scientists have been successful because of the traits of creativity, imagination, and perception. To say these are things that we do not want in science is intellectually shallow, yet it appears to be exactly the message the curriculum is sending to girls in our schools.

The Teachers

Teachers and their attitudes also have a significant part to play in the success or otherwise of girls in science; "[t]he teacher plays the central role in communicating the essence of science to children" (Estes, 1990, p.687). In other words, they set the tone for the learning environment (Mason, Kahle, & Gardner, 1991). Unfortunately, though, according to Brickhouse (1994, p.402), teachers' interactions with their students frequently work to the disadvantage of girls, not through any intentional malice towards them, but rather as a result of the "deeply embedded cultural views of gender", that is, girls are not good at science. This was clearly exposed by Spear's (1984) study when samples of identical science work, some with male names, some with female names, were assessed by teachers. It was found that the 'male' students received higher scores than the 'female' students. It was implied from this study that teachers did not set out to deliberately mark down the girls, but rather they did not expect the girls to be able to do science as well as boys. The question from this study that arises is what are the day-to-day attitudes and expectations of these teachers in their normal classrooms?

Teachers also send a message to their students about the subjects they teach, or, in some cases, do not teach. An early study by Manning, Esler, and Baird (1981), found that science was being taught for less than two hours a week by the majority of teachers surveyed. Other researchers in America found that over half of the primary school teachers questioned ranked science fourth or fifth out of five subjects (Mechling, Stedman, & Donnellson, 1982; Westerback, 1984). In a more recent Australian study, Brook (2001) found that science was being taught an average of less than one hour per week in primary schools, and not at all in some. When Manning, Esler, and Baird (1981) asked how the teachers saw themselves in relation to the teaching of science, they stated that they saw their role was to transfer selected scientific facts to their students, not a role that is active in encouraging science. It should not, then, come as a surprise that many students see science as merely a collection of facts that their teachers simply want them to remember rather than a dynamic discipline with genuinely exciting possibilities to learn, explore and discover (Mallow, 1985, 1986; Songer & Linn, 1991).

All this would come as no surprise to Jewett (1996), as he points out that the majority of primary school teachers are women; the same women who have been conditioned by society and their own teachers that science is not for them. Koch (1993) makes a similar report from his study that the largely female population of primary teachers generally saw science as being beyond their capabilities and interests. These two observations take on significance when combined with Shrigley's (1974) and Lee and Gropper's

(1978) studies. Shrigley found that teachers who do not like science will likely produce students who do not like science, while Lee and Gropper proposed that students imitate same-sex more than opposite-sex teachers. Therefore, we may have a situation in our schools of female teachers, who do not enjoy science, having their behaviour copied by their female students which is exactly what Baker (1988) and Lee (1984) reported in the research. They both found that girls often received negative messages about science from important females, which obviously includes their primary-school teachers. This introduces a rather frightening self-fulfilling prophecy for girls in our primary schools today.

However, all is not lost in regards to female teachers and their female students. A study conducted by Stake and Granger (in Koballa, 1996) found that girls taught by female science teachers are more likely to be interested in science than girls taught by male teachers. Like much of the research I have reviewed, contradictory results abound.

There are other teacher behaviours that have been documented which tend to favour boys more than girls in the science classroom. Boys are called on more often than girls; acceptance of boys calling out but not girls calling out; waiting longer for boys to provide an answer; boys being asked more interpretative questions while girls are asked yes-or-no type questions; giving girls neutral responses while providing boys with more complex and encouraging responses to questions; giving boys more attention, both positive and negative; circulating around boys more than girls; and giving boys suggestions when they are having difficulty while solving the difficulty for girls (AAoUW, 1992; Greenfield, 1997; Jones & Wheatley, 1990; Klein & Lockheed, 1985; Sadker & Sadker, 1982, 1986; Sanders, 1995). All these behaviours continue to deliver the message that girls do not belong in science. The alarming aspect of this, though, is clearly stated by Kelly (1985, p.141) who argues that "these behaviours [boys getting all the attention] are commonplace - so commonplace that they are virtually invisible".

The Students

It can be hardly surprising to find that girls often do not enjoy science, and self-select themselves out of it when the opportunity arises. It would seem both the curriculum and many of the teachers they have during their formative primary education years are less than encouraging of their participation and achievement in science. Barr and Birke (1994, p.475) found in their research that when they talked to women regarding their impressions of school science, they recalled “powerful memories” of experiences that were “deeply alienating, or at best irrelevant”. However, not all is beyond salvation. It has been found that despite what is against them girls still enjoy and have positive attitudes towards science in the primary years. Kahle and Lakes (1983) found that 9-year-old girls were keen to be involved in scientific experiments, but this keenness fell off when they reached their teenage years. Perhaps the battles they fought finally wore them down.

To bring a more relevant and local picture to me and also to assist set the scene for my study I was interested in what my students thought of Science at my two schools. In order to do this I surveyed all the primary students regarding what they would pick as their favourite subject. I gave them each a sheet of paper which contained a list of 12 subjects[1] that are studied at primary school and asked them to select their three favourites, giving a ‘1' to their favourite, a ‘2' to their second favourite, and a ‘3' to their third favourite. This was done in secret, with all children separated so that their friends could not influence their choices.

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[1] The subjects listed were Art, Computers, Craft, HSIE (Human Society and Its Environment), Handwriting, Language, Mathematics, Music, Reading, Science, Spelling, Story Writing. The subject names were mixed up to give six different variations of the list to prevent a donkey vote from influencing the outcome. When inspecting the completed sheets there was no example of any child simply putting 1, 2, 3 next to the first three subjects listed on their survey sheet.

A total of 139 boys and 136 girls completed the survey. Of the 139 boys eight (6%) selected Science as their number one choice; with the girls, four (3%) selected Science as their number one choice. Both figures were discouraging, to say the least. When looking at all the subjects nominated by the children as being one of their three choices, Science was selected 41 times (10%) out of 417 selections by the boys and selected 18 times (4%) out of 412 by the girls. Computers gained the most number one votes from the boys (47 votes - 34%) and the most total votes (102 - 24%), as well. The girls selected Craft as their favourite subject, selecting it first 47 times (35%), and nominating it 106 times (26%). It would seem that my students, including boys, are not enjoying Science. Whether this is because of the way it is taught, what is included in the curriculum, or because Science is not held in high regard or as important, or because of another reason, I do not know. Hopefully, if I can find the right type of educational software that portrays Science as interesting and worthwhile these very poor figures could be raised.

Strategies to Improve Science Education

Returning to the formal research, there are many things that we, as educators and researchers, can do to try and make primary science education more welcoming and interesting for today's girls, and, interestingly, for boys, too. Speedy et al., (1989, p.15) pointed out in their report that "there is now quite a deal of evidence to suggest that the pedagogies that have been developed to encourage more girls in...science are also effective for many boys". It appears that our work to bring girls into the world of school science can assist in the success and achievement of boys, as well. Everyone can have the opportunity to participate.

A number of researchers have suggested strategies to achieve this. These include:

- putting problems in a social context (Browne & Ross, 1991; Grant & Harding, 1987; Haggerty, 1995; Martinez, 1992; Smail, 1984),

- rotation of duties to avoid the boys monopolising equipment (Greenfield, 1997; Jarvis, 1996),
- where practicable, use single-sex groupings (Morgan, 1989),
- in-servicing of teachers to raise their awareness of gender equity issues in science education (Parker & Rennie, 1986),
- cooperative learning tasks rather than competitive learning tasks (Kahle, 1989; Linn & Hyde, 1989; Mason, Kahle, & Gardner, 1991),
- activity-based curriculum, rather than just reading from a textbook (Kahle, 1996a),
- providing enough time for activities to be completed without having to rush (Tobin, 1996),
- if possible, female science teachers to provide a role model (Koballa, 1996; Steinen, 1992), and
- construct assessment tasks that reflect girls' learning styles (Hilderbrand, 1989; Leder, 1996; Linn & Hyde, 1989; Nichols & Kurtz, 1994).

My research seeks to add to these recommended strategies, that is, can the use of educational software that incorporates what has been discovered as 'girl-friendly' attributes assist in enhancing the enjoyment and achievement of my students in their science education?

CHAPTER SIX

SOFTWARE - HOW IT CAN HELP OR HINDER

Introduction

The role of software is an important facet to investigate within the terms of my research. It is the engine that drives the computer and it is also the artefact that facilitates the interaction between my students and the machine.

Software as a Social Construct

As I stated earlier in regards to equity, the computer can be viewed as a text, and this is legitimate also in the case of software. It is an artefact constructed and designed by a person, and can be subject to interpretation. As Jansen (1989, p.196) put it, "[t]echnological designs are also social designs".

Analysing certain programs can illustrate this point. Friedman (1995), in his discussion of the simulation program *SimCity*, cited how the program had been criticised by both left- and right-wing members of political and economic groups for the messages it sent to the player. For example, the program discourages nuclear power, encourages public transport, and indicates that low taxes would stimulate growth whereas high taxes would produce recession. He continued by stating that "[c]omputer programs, like all texts, will always be ideological constructions" of the programmer/s (p.5). This argument was continued by Gamson et al., (1992, p.374) when they put forward the view that "a wide variety of media messages can act as teachers of values, ideologies, and beliefs and...can provide images for interpreting the world whether or not the designers are conscious of this intent."

We should not be surprised at this suggestion. Researchers have concluded that cultural foundations influence the design of learning systems. No text is neutral, and this is as true of computers as it is of any literary text. The technology we use in our schools has been designed and built under particular circumstances for particular reasons and purposes, and probably embodies a number of compromises. It is important to understand and acknowledge that this non-neutrality exists in our constructed artefacts (which in my case is the educational software we use in our science classrooms) by its reflection, either consciously or subconsciously, of the ideologies, social mores and values held by the designers and managers of the technology (Akrich, 1992; Bardini, 1997; Hannafin & Land, 1997; Lawley, 1993; McDonough, 1999). They are, as Bigum (1990, p.66) said, the “mirrors of minds and the cultures in which they ‘live’”. Matthias (1999, p.6) agreed with this stance when she stated that the design of software “reflects the social construction of the world”. Pournelle (1990, p.247) viewed computer games as “simulations of the designer’s theories, not of reality”.

In a similar situation, both teachers and researchers have, in the past, examined school textbooks for gender stereotypes and, when identified, the texts have been modified to reflect and promote equitable outcomes in education (Clarkson, 1993; Evans & Davies, 2000; Mader, 1994; Titus, 1993). This is because exposure to gender-biassed materials both communicates and reinforces gender-biassed expectations to those students who use the materials (Parker, Rennie, & Harding, 1995). There is no difference in the realm of educational software. It, too, needs to be studied for the stereotypical messages it can promote to students who use it, and when these messages are found they need to be modified. An example of this was a study carried out by Dyrud (1997) who found in her review of Clip Art, possibly today’s textbook in the computer, that only 4.5 percent of the figures that represent people were female and that these figures were situated in stereotypical roles, such as secretaries, nurses, or teachers. Girls using these images in their computer work could be given the message that, once again, females work only in particular vocations, and computer- and science-related fields are not among them. She attributed this imaging to a male bias in the computer-science field and apparent gender-based differences in relationships with machines.

The Sapir-Whorf hypothesis maintains that the relationship between reality and language is reciprocal: "language shapes the perception of reality as much as reality shapes language" (Frank & Treichler, 1989, p.3). If we accept that language, as a symbol system, both reflects and invents our reality, then the same can be said of another symbol system, the system of visual images we find in our social world. If the images that one sees are predominantly of one gender when used in a particular situation then they may reflect the cultural structures that are in place and help maintain and encourage those beliefs by, in turn, shaping what we believe and see as real. It becomes self-fulfilling and circular. If girls are constantly seeing males in technology-developing-and-inventing positions and females in technology-consuming positions the message may soon become their truth and reality.

As stated above, much work has been done in the past to ensure that textbooks used in our schools do not advantage or disadvantage any particular section of our student body through the language or the types of illustrations used. We, as a society, do not wish to send the 'wrong' messages to any of our students. We want them to all feel included and welcome. It is therefore important to acknowledge, as Biraimah (1993) did, that educational software, just like textbooks, "is a form of knowledge control that transmits selected values and role models to students" (p.283). What messages are we sending to our students if the software we supply to them is, possibly, biassed toward males? Is it a message that girls are not welcome to use the technology, or that girls cannot feel comfortable when using a computer, and certainly should not be having fun with it, or, possibly, that the technology is not really meant for their use?

The Role of Software

I strongly believe that software has been the forgotten variable in the 'computers and gender' industry. In my own initial investigations I found little research that could inform me about software preferences and girls. Evidence for this is found when you look at the ERIC database. This is a database that has been indexing Western educational research since 1966. It currently indexes approximately 14,000 documents and 20,000 articles annually. By entering specific search terms into the database search engine the following 'hits' were returned;

- Computers and Education - 21242 citations
- Education and Gender - 19001 citations
- Computers and Gender - 595 citations
- Software and Gender - 188 citations
- Computer software and Sex bias - 23 citations.

Similar results were obtained when I searched the Australian Education Index (AEI)[2], a database that deals with reports by Australian authors on education issues or about Australian education published in overseas sources. This database references journals, conferences, theses, and other research from 1978 to today. The results for the same search as above were,

- Computers and Education - 3519 citations
- Education and Gender - 2234 citations
- Computers and Gender - 80 citations
- Software and Gender - 22 citations
- Computer software and Sex bias - 1 citation.

Similar results regarding the lack of research in this area were reported by Dempsey, Rasmussen, and Lucassen (1996) in their search for research dealing with instructional computer gaming. They located 99 sources, mostly journal articles that dealt with the use of computer games as instructional tools, but of those 99 sources only two dealt with the use of design attributes for the development of effective computer instructional games, a finding which left them "mildly surprised" (p.6). My search of the literature, carried out after their report, does not offer much to counteract their surprise.

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[2] Both the Eric search and the AEI search were conducted on 28th August, 2003

It can be seen from these figures that almost all research concentrated on the machine itself, what it did or did not represent in education or how it related to gender (usually girls), without looking at the most obvious element, the lines of code that drove the machine. What little research that was undertaken seemed to be a backwater of interest to a small number of academics, who postulated that software could play an important part in enhancing girls' success with computers, and by market-researchers, who saw that an untapped market might be just waiting to be discovered and profitably exploited. This view is supported by both Durkin (1995) and Mackereth and Anderson (2000) who both reported the lack of credible research about this facet of computer education.

Girls, Computers, and Schools

Many proponents of computer use in schools, I believe, have overlooked the crucial and influential role software plays in forming attitudes toward computer use because they cannot seem to see through the 'sparkle' of these apparently new, fix-it-all, can-do-anything learning machines. Callister and Dunne (1992) put forward a number of interesting points in this area. They believe that the use of computers in educational settings takes the locus of instructional control away from teachers and passes it on to software programmers, who may or may not have the student's educational interests at heart, and quite possibly have little understanding of pedagogical issues involved in effective teaching and learning. They describe how the teacher becomes a manager of a rigid delivery system of instruction over which they have very little content control, resulting in the "technological dog tail wagging the pedagogical dog" (p.326). As Beynon and Mackay (1993, p.11) put it, "in the triad of designers, promoters and teachers, it is the first two who currently set the agenda of the latter".

I believe that the unthinking advocates of technology in schools may have fallen into the trap that Bowers (1988) identified so early in the rush to get computers on school desks, that is, the people who so forcefully pushed for computers to be placed and used in schools have often "incorporated two seemingly incompatible cultural myths into their thinking - that each innovation in computer technology is a further manifestation of social progress and that technology is inherently neutral" (p.3). In this regard, it has been argued that the non-neutrality of software has pushed boys' ways of knowing forward at the expense of girls' enjoyment and participation (Nicholson et al., 1998; Okebukola, 1993).

It is important to acknowledge the role both teachers and parents play in this. Segel (1986) put forward an argument regarding gender and reading when he identified that it was an adult who often provides the books that children read. It is the adult acting like a filter, making sure that the child is exposed to books deemed 'suitable' for them by the adult community. Perhaps the more modern version of this is the purchase of educational software. Often children of the age that I am concerned with, 8- to 12-year-olds, do not have direct retail access to computer software. Generally, the programs they use are those bought for them by interested adults, or in my students' case, by the school. Also, it is adults who decide what will be produced and provided to them. It is often marketing and advertising that influence the parents who, despite all their good intentions, could easily believe that the programs available only in the 'pink' aisle at the local computer superstore are suitable for their daughters.

Amongst more persistent findings of research regarding girls and computers are reports that girls appear to suffer more stress and anxiety when using computers than do boys (Cooper, Hall, & Huff, 1990; Okebukola, 1993). This situational stress is described by Schwarzer, van der Ploeg, and Spielberger (1982) as a state of unpleasant psychological pressure aroused by interacting with environmental stimuli that are threatening and sensed to be beyond a person's competence and resources. The stress and anxiety levels increase when girls are asked to use computers in public spaces (Cooper, Hall, & Huff, 1990; Cooper & Stone, 1996; Robinson-Staveley & Cooper, 1990). This obviously puts girls at a serious disadvantage when it comes to using and learning with computers in schools, an environment which can legitimately be viewed as a public space.

If girls feel uncomfortable and stressed it is not surprising that they can become unenthusiastic about the artefact that they feel is producing the stress. Stress in any activity can be a significant factor in making a situation feel uncomfortable and may subsequently lead to avoidance of the situation to which the stress has been related. This was demonstrated by Smith and Danielsson (1982) when they found in their studies of children and stressful situations that avoidance was the prevalent response to stress in 11- to 13-year olds. This view, in relation to computer game playing, was supported by Funk (2000) when she put forward her belief that the many negative gender messages girls receive from the majority of computer games push them away and encourage them not to play. Gender-appropriate software may be an important element in allowing girls to feel less situational stress when using a computer. Stockdale (1987) found that if girls are introduced to computing in a more supportive environment, their confidence increased and their anxiety lessened. Gender-friendly software could assist in producing such a supportive environment (Lynn et al., 2003).

Extending from Stockdale's findings is the work of Greenfield (1997). When Greenfield studied a successful school's efforts to promote school science with senior girls it was put forward that a possible reason for the girls' willingness and ability to take part in their science classes related to favourable science experiences in their earlier student years. Several strategies had been used at the school to promote science for all students. They included using a specialist science teacher who conducted science lessons with follow-up discussions in regular classes, the rotation of duties so that boys did not monopolise particular jobs, and the use of hands-on activities was encouraged. It seems likely that because the girls could see themselves achieving and enjoying in science their attitude toward the subject became more positive.

Greenfield's work can, I believe, be successfully transferred and extended in relation to computers and software. Comber et al., (1997) argued that the success or otherwise of early computer experience may be a crucial and significant determinant of confidence in girls, and intervention in the early years may help to offset a reduction in confidence with computers which seems to occur as they grow older. In an interview conducted by Cassell and Jenkins (1998b) with Nancie Martin, a game developer for toy maker Mattel, Martin gave an interesting commercial view of software and girls. Martin stated that research was showing girls were keen users of software during pre-school years, where a lot of material is available, but once they grow out of those programs, around the age of five and six, there is little available for them that they enjoy or want to play. It all becomes 'boy's stuff'. This lack of girl-friendly software could be a small, but significant factor in the apparent uneasy relationship between girls and computers.

I believe that software is one aspect of computer use that can be modified to help girls experience confidence building, rather than confidence sapping, opportunities when using computers at school. Designing an interface that girls find attractive and welcoming, by using attributes they prefer, could affect them in a positive manner, both from the aspects of understanding the material and the desire to use it (Passig & Levin, 1999). Perhaps the use of girl-friendly software, which may help the girls achieve and succeed, could make a small contribution to the positive experiences of girls in their formative, primary years; a crucial time in their development of attitudes and interests in both computers and science, and assist in countering the reports of girls generally having less experience with computers than boys (Goldstein, 1994; Sakamoto, 1994; Schumacher & Morahan-Martin, 2001).

Sex-bias in Software

Studies by Huff and Cooper (1987) and Littleton et al., (1993, 1994, 1998) have fuelled my enquiry into girl-friendly software. Huff and Cooper's (1987) research is often cited in the field of girl-friendly software, while Littleton et al.'s research (1983, 1994, 1998) appeals to me as a way to produce not only girl-friendly software but software that is inclusive of boys. For me, they are highly significant research, and they have continually motivated me to find out if design bias against girls still exists today and, if it does, to discover what I can contribute to diminishing that bias or, hopefully, helping it disappear.

Huff and Cooper's (1987) study of sex-bias in software concludes that educational game designers, both female and male, may be using males as the model for students who use their software. They state, "it is not the computer, or even the software, that is the root of the sex bias in software, but the expectations and stereotypes of the designers of the software" (p.519). As mentioned at the beginning of this chapter, this claim of the social construction of technology has been supported by a number of researchers.

Huff and Cooper asked a number of game designers to produce a software program to assist students learn how to use commas correctly. They were asked to produce a program for boys, a program for girls, and a program for students. When Huff and Cooper examined the finished pieces of software they found that the program designed for boys contained different design features to that of the program designed for girls. This showed that the designers did have inherent understandings about what boys would like and what girls would like and so integrated them into the different programs. This in itself would not be a major finding, possibly most people would simply say that it was obvious that girls and boys like different things and so it would be sensible to incorporate those preferences into software written for them. Earlier research had already identified this phenomenon (Lepper & Malone, 1985).

However, when the game designed for the generic students was examined, it was revealed that that particular program displayed attributes that appealed more to the boys than to girls. What the designers had subconsciously used was the boys' preferences as the default model for students. In other words, they had inadvertently designed a game for boys, not for all students. This finding should cause concern for it seems that when programs designed for students are written they may be written for boys. This may have serious implications for girls' use of, enjoyment, and achievement with computers.

According to Huff and Cooper (1987), an obvious implication of male bias is that software may be designed to appeal to boys without consideration of the effect on girls' motivation to use it or on girls' educational achievement. They state that:

> Children using software designed for the opposite sex are more anxious after they interact with the program, and that anxiety leads to lowered scores in the subject the program was intended to teach. However, this only occurs if the children are using the program in public, that is, in a computer lab with other children present. When the programs are used privately, these differences do not emerge. (p.519)

The mention of students using software in a public space, for example, the computer lab, is particularly significant in my situation as both my schools operate computer labs as separate entities, where most of the computer lessons are held.

Review of other related research carried out after the Huff and Cooper study provides theoretical support suggesting that girls and boys do differ in their stated preferences for design elements of game software, which can spill over to the design and implementation of educational software. For example, Jakobsdottir, Krey, and Sales (1994) examined gender and age preferences for graphics used in educational computer games and identified differences in preferences of the girls and boys as well as attributes favoured by both groups. Their results support the use of design guidelines for producing graphics that appeal to boys and that also appeal to girls, and they conclude that it is important to have these guidelines in place in order to provide direction for programmers and designers. I will review the literature that relates to specific design attributes for girls in a later section.

Another study of significance that has had a major influence on my own research and that is relevant to this discussion was carried out by Littleton et al., (1993, 1994, 1998). A controlled comparison was conducted between two versions of a route-planning task that differed in terms of the scenario; one involved pirates and the other picnics. The subjects were 11- and 12-year-old girls and boys. The researchers found that when the girls used the 'pirates' version of the scenario they performed significantly poorer than when they used the 'picnic' version that featured 'Honeybear' characters. However, the interesting point that came out of the study was that regardless of which scenario was played, pirates or picnics, the boys' performance did not differ.

Several points of significance have come out of the three studies by Littleton et al.,:

- it was demonstrated that children's problem solving performance could be significantly affected by the scenario's setting and, in particular, the girls' performances were strongly influenced by the version of the task employed,
- the performance of the boys remained relatively unaffected by the software version, and
- superficial versioning of the software can dramatically transform the pattern of gender differences in regards to performance and achievement, to the advantage of girls.

However, we must be cautious. It is too simplistic to believe that these results offer a quick solution to bring about equitable use of computers by both girls and boys. The logical extension of this argument is that if we make software exclusively for girls, using the stereotype beliefs of what girls in our modern society want, they will use it and achieve with it and the boys will come along and play as well because they do not care what the software is just so long as they can play on the computer. This is the argument that produces 'pink' software (Berselli, in Gardiner, 2000).

Gardiner put forward the argument that when designers of computer software realised that girls were not interested in the typical game, and so were not spending their money, they designed software that fitted the stereotypes of the material that girls apparently wanted. These 'pink' games are epitomised by the "Barbie" programs that can be found on software shelves today. But are these the type of educational computer programs that I am looking for? I do not believe so. As Linn (1999) strongly argues, "software 'for girls' reinforces the sexist message further by falsely claiming that Barbie, fashion, and cosmetics provide equity balance. Indeed they do. They perpetuate sexism and serve only to enrich the companies that produce them" (p.16). Jenkins (1998) agrees, warning that this may not lead to a desirable situation. He believes that by making and distributing 'pink' software, we run the risk of maintaining, rather than transforming, those traditional aspects of what is perceived as feminine culture which, as he puts it, "keep women restricted to the domestic sphere while denying them the spatial exploration and mastery associated with boy culture" (p.276). Russo (1997) points out that by labelling games as 'girl's only' (which is often what the packaging is promoting to potential purchasers) girls can be encouraged to shut themselves off from the much broader range of products available in the market place.

Interestingly, though, and what has proved to be a continuing and frustrating element of my research, that is, studies that offer contradictory results, is the evidence provided in a follow-up study by Joiner (1998), who was a member of the Littleton et al.1993 study. He found that, when replicating the earlier study, the girls and the boys did not show any preference or better achievement by using one or the other version of the software package and that the boys, rather than being happy to play either version of the software, strongly favoured the 'boy' version. He concluded that for the design of educational software for this age group (11-year-olds), software that is stereotyped for females is actually unlikely to attract girls, and is likely to be unattractive to boys. I am hoping that my data will generate an answer regarding this apparent contradiction, along with many others that have been provided by the research I have reviewed, specifically for my situation in my schools and for my students.

Joiner's observations, I believe, warn us that the labelling of particular educational games as 'girl games' can have a serious, negative effect for both girls and boys. His observations and conclusions do have some credence in my school. This was evident when I observed a particular event at one of my schools.

I had purchased a CD-Rom titled *Games for Girls* (Games for Girls: Gold Edition, 1998) that contained ten individual problem-solving style games. I installed it on our local area network and added the appropriate individual shortcuts to each workstation desktop. There was no indication that these individual games came from a 'girls' games' CD until the program was closed after playing, at which time the title of the CD-Rom was displayed. I was observing a group of boys during a lunchtime session who were playing one of the games from the CD. They appeared to be enjoying themselves, talking about solutions and where to direct the character on the screen.

After playing for a while they decided to finish and play another game. However, when they quit the game and the CD name came up indicating they were playing a 'girl's game' one of the boys noticed the title and quickly pointed out with disdain to his friends that they had been playing a "girl's game". The reaction was as quick as it was final. The game that they had been enjoying seconds before was now an object of derision and statements of 'never playing that game again' flowed freely. I was amused, but disheartened, that a simple label was enough to turn the boys away from something that they had obviously enjoyed. As adults, I believe that we often fail to understand the impact of the labels we give objects. To these boys, that game was not to be touched again no matter how much enjoyment they could derive from it

It is important to state that I have no interest in using my time to produce design attributes that reinforce the already stereotypical view that girls can enjoy using a computer only if they are playing with a virtual reality doll or boys can play a game only if they are 'shooting at' something. Rather, I am looking for attributes that welcome girls and, at the same time, include boys' interests, so that when the software is used there is no feeling that this is a 'boy's game' or a 'girl's game', but rather a game for all. I want to offer guidelines that will alter the way the computer communicates to the girls and boys who are using them.

Conclusion

In conclusion to this section on the role of software, there are three points I wish to make. First, in their book *Gender and schools*, Measor and Sikes (1992) detail that in nursery and primary school classrooms, boys and girls tend to choose different kinds of activities and materials when their choice is free. We, as a society and as an education system, supply these materials so that they feel comfortable and are happy to interact with them. Educational software is one of the items that we need to supply to the pool of children from which our future scientists must come. If the software we provide is designed with all users in mind then enjoyable and successful experiences may result. This is important, because according to Kirova-Petrova, Bhargava, and McNair (1999), it is crucial that we provide successful experiences before biasses set in if we want significant and long-lasting change to happen. I believe that my study will help the girls at my schools have successful experiences in science education because the programs I will be selecting for them will reflect the design attributes that they find attractive and comfortable.

Second, I do not subscribe to the view that all girls will share the same preferences and my research will uncover those preferences, but as Cassell and Jenkins (1998d) explained, to assert that all girls share the same beliefs and preferences while artificial, can be necessary: “Despite the clear dangers of such ‘sweeping generalizations,’ the ability to determine what girls want may seem necessary at a time when we are trying to open up a space for girls to participate within this medium [computer games] at all” (p.25). So even though I acknowledge that my girls are not a homogeneous group, and will show variability in their preferences, I am treating them, for the purposes of this study, as a group with common beliefs, perceptions, and preferences.

Third, I believe that my research answers the call that two earlier researchers have asked of teachers. Evans (1995) asked teachers to continue the work previously undertaken in developing science education courses and materials that are gender-critical and gender-inclusive. If what I can discover allows future science education software to be designed and written in a way that provides girls with enjoyable experiences and enhances their achievement then I will have answered his call. Sanders (1990) told us that to achieve equity in our schools teachers must take action to correct any sex imbalance that has a negative effect on girls. I believe that my research is taking action to do this.

Similar to Gardiner (2000), I see my research as an opportunity, first, to help my students, and my girls in particular, to reject stereotype perceptions they may already have about using computers and educational software and, second, to assist them in achieving positive results and experiences in both their general education and their science education.

CHAPTER SEVEN

THE GAMES WE PLAY

Introduction

From the time computer games became generally available I have been an avid player. Over the past 20 years I have had a variety of electronic game machines which, as I became more prosperous, evolved into quite sophisticated personal computers. These computers were, perhaps embarrassingly, used primarily for game playing. Up to this day it is a pastime that both myself and many of my friends have been involved in and it is one which has brought many hours of enjoyment to us.

I see a similar passion for playing computer games in many of my students. Whenever I take a class to the computer laboratory at either of my schools the persistent question from children is, "Can we play some games, please?". Many a time I have used the prospect of allowing some free time to play games as a bribe to get the 'real' work completed. To me, the obvious motivation factor intrinsic to computer games means that they could, and should, play a role in the teaching-learning environment in our schools. In this chapter I set out the justification for their use in schools.

Seymour Papert (Papert, 1993), begins his book *The children's machine* with a parable about doctors and teachers who have travelled from the past to the present day arriving at modern day hospitals and schools. The doctors see an environment that has radically changed and virtually unrecognisable to them because of scientific and technological advances. Unfortunately, the teachers hardly notice any differences in the modern classroom to that of classrooms of the past. However, he goes on to explain what would surprise the teachers if they could journey to the students' homes.

> The time-travelling teachers of my parable who saw nothing in the modern classroom they did not recognize would have found many surprises had they simply gone home with one or two of the students. For there they would have found that with an industriousness and eagerness that School can seldom generate,

many of the students have become intensely involved in learning the rules and strategies of what appeared at first glance to be a process much more demanding than any homework assignment. The students would define the subject as video games and what they were doing as play.

While the technology itself might first catch the eye of our visitors, they would in time, being teachers, be struck by the level of intellectual effort that the children were putting into this activity and the level of learning that was taking place, a level that seemed far beyond that which had taken place just a few hours earlier in school. The most open and honest of our time-travelling teachers might well observe that never before had they seen so much being learned in such a confined space and in so short a time.

School would have parents - who honestly don't know how to interpret their childrens' obvious love affair with video games - believe that children love them and dislike homework because the first is easy and the second hard. In reality, the reverse is more often true. Any adult who thinks these games are easy need only sit down and try to master one. Most are hard, with complex information - as well as techniques - to be mastered, the information often much more difficult and time consuming to master than the technique.

If that argument did not convince parents that the games are not serious, surely a second argument would. Video games are toys - electronic toys, no doubt, but toys - and of course children like toys better than homework. By definition, play is entertaining, homework is not. What some parents may not realize, however, is that video games, being the first example of computer technology applied to toy making, have nonetheless been the entryway for children into the world of computers. These toys, by empowering children to test out ideas about working within prefixed rules and structures in a way few other toys are capable of doing, have proved capable of teaching students about the possibilities and drawbacks of a newly presented system in ways many adults should envy.

Video games teach children what computers are beginning to teach adults - that some forms of learning are fast-paced, immensely compelling, and rewarding. The fact that they are enormously demanding of one's time and require new ways of

> thinking remains a small price to pay (and is perhaps even an advantage) to be vaulted into the future. Not surprisingly, by comparison School strikes many young people as slow, boring, and frankly, out of touch. (p.3)

Although Papert was writing in 1993, what he has said is still relevant in many of our schools today. Students in traditional classes where the teacher is the central figure find themselves as passive learners and in a position of little control. They generally have to pace themselves with the other students in the class and often receive shallow and imprecise feedback in relation to their efforts and achievement (Squire, 2003). As Weston (1997) observes, it becomes a place where students go to watch teachers work.

The question to be asked from Papert's narrative is, "What is it that makes the interaction with computers so compelling and absorbing?". Friedman (1995) believes the answer is the constant feedback that the user receives from the program with which they are interacting. Every response, or move, that is made by the user is instantly countered by the program, producing an instant and continuous feedback loop that further engages the user. The user and the computer/program become one. My observations of my students, as well as my own experience with game-playing, indicate there is much truth in Friedman's view. Harnessing this attraction, some may say compulsion, to play and directing it to learning situations could be, in teaching and learning terms, a very profitable exercise for teachers to pursue in relation to improved educational outcomes.

Play and Games

"Play is a very serious matter...It is an expression of our creativity; and creativity is at the very root of our ability to learn, to cope, and to become whatever we may be" (Rogers & Sharapan, 1994, p.1). Play, particularly in the early years of childhood, performs many important roles in social and intellectual development of individuals and supports the assimilation of new ideas into a child's existing knowledge structures

(Blanchard & Cheska, 1985; Provost, 1990; Rieber, Luke, & Smith, 1998). It has been defined as voluntary activity that is intrinsically motivating, and may encompass some fantasy qualities (Amory et al., 1998; Rieber, 1996a). Children learn from their interactions with their environment as well as from activities they see as challenging and personally meaningful. Play and games are events that can incorporate these features of interaction, challenge, and personal meaning so that learning can be both enhanced for, and enjoyed by, the players (Brown, Collins, & Druid, 1989; Rieber, Luke, & Smith, 1998).

A number of researchers believe there are long-term benefits to be gained in both intellectual and social growth through play (Glickman, 1984; Singer, 1995). Also, given the current, and future, capabilities of educational technologies, which in my research context is computers, a number of researchers have put forward the idea that games and play can fit in well with the transition from a behavioural to a cognitive mode of learning that is advocated by progressive educators (Burton, More, & Magliaro, 1996; Winn & Snyder, 1996). When discussing play in the context of learning and education, I am referring to what Rieber, Smith, and Noah (1998, p.30) call "serious play" in order to distinguish it from other interpretations and perceptions which may have negative or trivial connotations. Serious play is that activity that contributes to the betterment of the individual rather than the type of play sought for purely recreational and personal gratification.

Despite limited empirical evidence of their educational effectiveness (Hogle, 1996; Pillay, Brownlee, & Wilss, 1999), games have been used by teachers in modern schools for many years to enhance and encourage learning in their students. They have often been used as motivational tools to capture and maintain the interest of students, and have been identified as possibly helpful in facilitating cognitive processes such as making inferences and lateral thinking (Mayer & Sims, 1994; Quinn, 1996). Holland, Jenkins, and Squire (2003) believe that games offer students contexts for thinking through problems and making their own actions part of the solution, resulting in a personal satisfaction when successful or motivation to continue when unsuccessful. Therefore, it is not surprising that the electronic equivalent, computer games, can be increasingly found in our schools today (Gredler, 1996; Heinich et al., 1996).

Computer Games

Many early researchers have given serious thought on how computer games, the electronic equivalent of physical play, can be utilised to enhance educational outcomes in western schools (Negroponte, 1995). Today, the motivation of children to use computers and play computer games seems to be as strong as ever. Although I know most of my students have access to computers in their own homes (evidence from my interviews confirms this), it still amazes me how motivated they are to get to the computer rooms in my two schools, or to use the computers in my two libraries (and they are only simple, non-graphical catalogue-enquiry terminals), or to use the computer that is in their own classroom. For the children the 'novelty' of using them never seems to wear off. Even the software that is available in my schools does not compare technically or aesthetically with the software that the children are using at home. Most of the educational software available is quite unsophisticated in terms of graphics and sounds when compared to latest computer games available to children, yet I constantly observe what Rieber and Matzko (2001, p.15) describe as learners on "auto-pilot", oblivious to external distractions that in a traditional teaching situation would have them continually off-task.

There is obviously something very appealing for children about playing computer games for research informs us that children are using them daily and extensively for personal and communal entertainment. In early research, several studies put forward explanations for this appeal. Nawrocki and Winner (1983) suggested that winning over a challenge is the main motivation. Malone (1981) and Malone and Lepper (1987) found that the elements of challenge, fantasy, curiosity, and control were the motivators for children. More recently, and perhaps more relevant to my research, is Walker de Felix and

Johnson's (1993) study which put forward that it was the structure of the computer game, rather than its content, that appealed and motivated children to play. Laurel (1993) described it well when she noted that the potential of the computer did not reside in its ability to perform calculations, but rather in its ability to represent action in which people could interact and participate. This was echoed by Turkle (1995, p.31) when she put forward the claim that through computer games people have the opportunity to "experience themselves in a new, often exciting setting" that their everyday environment cannot provide.

Research has shown that computer games occupy a significant amount of children's time in their social lives (Buchman & Funk, 1996; Johnson et al., 2002; Rosen & Weil, 2001), but still, my students, both the girls and the boys, cannot get enough of using the computers at school. What confuses me, however, is the literature I read that tells me how girls, as they pass through secondary school, start to turn away from computers, seeing them as a male domain. The girls in my schools, just like the boys, believe they cannot get enough time in the computer room. I continually wonder if the type of software supplied by schools plays a part in their move away from computer achievement and enjoyment during their school career.

I believe it is critical that we keep this enthusiasm in the girls when they go through their secondary education. We must make them feel comfortable and enthusiastic with computers, and computer games is one avenue that can be used to help achieve this. Some studies suggest that experience with computer games promotes positive attitudes towards computers (Culley, 1993; Durkin, 1995; Pulos & Fisher, 1987). Both Greenfield et al., (1994b) and Wilson (2002) found that among adult students cognitive gains arising from using computer games transferred to regular computer use for scientific and technical purposes. Work undertaken by Johnson-Eiola (1997) confirmed transferal of skills honed on computer games to other educational, non-computer-based contexts, particularly the decoding of multimedia texts, texts with which students today are increasingly interacting. Also, Durkin and Aisbett (1999, p.128) point out, "computer games offer a varied and stimulating means of gaining skills in a technology which is increasingly fundamental to educational and occupational opportunities". Obviously, there are other ways of introducing computers to girls but game playing would no doubt be one of the more popular choices for them.

In an early study, Soper and Miller (1983) identified computer game playing among school students as almost an addiction, showing many of the signs of an addict: compulsive behavioural involvement, apathy toward other activities, association with other addicts, and (for school students) failing grades due to disinterest in school. A number of later studies tend to confirm this observation, with reports of small numbers of children meeting clinical criteria for addiction in regards to computer game playing (Fisher, 1995; Griffiths & Dancaster, 1995; Gupta & Derevensky, 1996; Phillips et al., 1995). I sometimes think that many of my students verge on an addiction when it comes to using computers and playing games on them. Phillips and Klawe (1995) cite the attractiveness of computer games to many children as a reason why they should be studied and examined for the potential benefits they may deliver in educational situations.

The appeal of computer games has not diminished over the years since Soper and Miller's (1983) study, probably because of the increasing prevalence of computers in many households and the increasing sophistication of the games themselves. A study carried out by Griffiths and Hunt (1995) found that approximately 30% of 12-16 year-olds they sampled played computer games at least once a day and 7% played at least 30 hours per week. 11% of the sample claimed they simply could not stop playing computer games. More recent figures derived from the 2001 Australian census (Australian Bureau of Statistics, 2003) show that in 2000 over 50% of Australian households had a home computer and that children under the age of 17 years are the most likely group to use a computer at home. It was also found that, in all age groups, males were more likely than females to have used a computer in the week before the census was undertaken.

Some researchers see the link between boys' high interest in computer games and their larger representation, as adults, in high-status computer jobs as not accidental. Computer games are believed by some researchers to provide a smooth and comfortable entry to computer literacy (Agosto, 2004; Greenfield, 1996; Krantz, 1997; Opie, 1998; Subrahmanyam & Greenfield, 1998; Wilson, 2002). Subrahmanyam et al., (2000, p.128) even go as far as to describe them as "training wheels" for skills useful in the fields of science and technology, and so those children not engaging with them at a young age, in other words many girls, may end up disadvantaged in later years. Groundwater-Smith and Crawford (1992) view game playing as a way of demystifying computers which subsequently leads to greater confidence and comfort when using them and thus allows greater risk taking and experimentation. They see the genesis of computer literacy coming from 'games literacy' that computer game playing may provide. Although I tend to agree with this sentiment, it is important to point out other views. Other researchers make a strong point that game playing is, in itself, an end-use application, just like word-processing. Therefore, the linking of game playing as authentic computer experience while word-processing remains associated with pre-computer secretarial skills, in other words womens' work, demonstrates strongly that what counts as experience with computers is a socially generated phenomenon in the computer-gender discourse (AAoUW, 2000; Clegg & Trayhurn, 1999).

Whatever the opinion that one holds, there is still no doubt that there is an imbalance when it comes to boys and girls playing computer games and this touches on the area that I am researching. Provenzo (1992) confirmed through interviews with parents and teachers that girls were less interested than boys in playing computer games, with other studies indicating that this interest declined further as girls matured (Dorman, 1998; Leong & Hawamdeh, 1999; Mumtaz, 2001). The study by Griffiths and Hunt (1995) supported this when they found that although both boys and girls play computer games, boys played them significantly more than did girls. Other researchers have argued that the declining interest in playing computer games shown by girls could be due to most computer games being designed and marketed for boys (Gailey, 1996; Gorriz & Medina, 2000; Oosterholt, Kusano, & de Vries, 1996; Subrahmanyam & Greenfield, 1998). Gorriz and Medina (2000) elaborate that:

> Unfortunately, the majority of today's games are aimed at a male market and in addition are not of particular interest to girls...Thus, in many cases a girl's first experience with a computer is a negative one and can turn her off computing right from the start. (p.42)

Inkpen et al., (1994), found that girls' level of interest in computer games was not as high as their interest in other activities. For example, many girls expressed they would rather read, socialise with friends, or go shopping. This should not be surprising. Literature on social behaviour does suggest that girls, when compared to boys, are more interested in connecting and bonding with others (Grusec & Lytton, 1988), and that in their general play activities girls have been found to be more socially oriented than boys (Coates, Lord, & Jakabovics, 1975; Heyman & Berstein, 1996).

Census data regarding computer game playing confirms the differing level of interest for Australian girls and boys. Data collected by the Australian Bureau of Statistics in 1998 (Australian Bureau of Statistics, 1999) reported that boys were more interested in using their home computer for playing computer games than for study, whereas the reverse was true for girls. In 1998, 63% of males aged over 5 years who frequently used a home computer played computer games on it and 53% used their computer for study purposes, compared to 50% and 56% respectively for girls. However, it is essential to remember that girls are interested in computer games (Agosto, 2002; Yelland & Lloyd, 2001).

One criticism of computer game playing is that it promotes anti-social behaviour. However, it is important to understand that playing computer games is considered by many researchers as not an anti-social activity. Inkpen et al., (1994) found that girls are more likely to play a computer game if there is a possibility of interacting with others during the playing. Lawry et al., (1995) found that boys often play in a collaborative mode and often talk about the games, offering tips, hints and encouragement to each other. Similar assertions are put forward by both Jenkins (1998) and Colwell, Grady, and Rhaiti (1995), with both asserting that computer games provide the basis for social interactions at home, at school, and with friends in the playground.

Other studies also provide evidence that computer games are not a solo activity. Kubey and Larson (1990) found that computer games were played alone 46 percent of the time, 18 percent with family members and 36 percent of the time with friends, while an earlier study by Mitchell (1985) found that video games were a positive factor in enhancing interactions between family members, being "reminiscent of days of Monopoly, checkers, card games, and jigsaw puzzles" (p.134). The video games simply took the place of other social activities. The proposition that playing computer games is not necessarily an anti-social activity is important in the context of educational software and schools. The last thing any responsible school system would want to do is to promote and foster, albeit unintentionally, anti-social activity amongst its students.

If what Oosterholt, Kusano, and de Vries (1996) says is true, then I believe the results of my research can assist in reducing the boys-only elements of games software that may be written into games and put in their place attributes that appeal equally to both girls and boys. This then offers some hope in getting girls playing more games and thus, hopefully, becoming more comfortable with computers in general. I believe this is significant because, if what Perry and Greber (1990) suggest is true - that the social patterns of computer use are not inevitable - then it may be feasible to change girls' patterns of computer use by supplying software that is informed by girls' preferences. The production and supply of this software, therefore, could be crucial. Obviously, though, I am not making a claim that by changing the software, girls suddenly will become more frequent computer users. It would be wonderful if it was that simple. However, it may be that by changing software to being more girl-friendly it may encourage greater use. It is just one brick in the wall.

Educational Computer Games

Edutainment is a term that is used a great deal today. This combination of education and entertainment reflects what some researchers believe is needed in order to attract the attention of today's learners. Affisco (1994), a lecturer at New York's Hofstra University, believes this when he says that "it is already apparent that contemporary students have limited attention spans, have a more visual learning style than their predecessors, and need to be entertained in their classrooms" (p.171). Seay (1997) does not go that far, but he does believe that students of today need to be entertained simply because their culture has trained them to interact in a certain way with the information with which they come into contact. I, personally, do not go as far as these two academics, thinking that the only way I can provide effective learning situations for my students is to entertain them first, but I can see, in this scenario, that educational computer games can be an effective adjunct to the teaching-learning situation.

Distrust of the legitimacy of using computer games in an educational setting may reflect more of a generational issue than an educational one. Researchers, teachers, and parents, the policy formulators and decision makers for today's schools, grew up in a mostly non-computerised environment. Unlike the students of today who are constantly exposed to computers and other technology, our generation's most sophisticated piece of educational technology may well have been a calculator. In other words, we have grown up in a "different media culture and [we have had] different media experiences" than students today (Fromme, 2003, p.2). Rather than viewing this situation with an open mind, we are at risk of viewing and examining the media cultures involving children today from our own adult, and technologically different, perspectives which can result in a certain degree of scepticism and distrust by us. I believe many parents and teachers see that the use of a computer in an educational setting should not include games as they view this as trivialising their children's learning. However, I do not believe using computers in such a way is a waste of time, rather it could be a further opportunity to enhance the teaching-learning environment.

Research has shown, both directly and indirectly, that computer games can assist in successful learning. Paivio (1971) and Bower (1972) reported that improved memory was demonstrated by their subjects when the material to be memorised contained graphic and rich imagery. Although both researchers were dealing with print material, I believe this result can be transferred to the computer game environment because rich and graphic imagery is precisely what modern multimedia-capable computers and software can convey to a user, or in my case, my students. Bielenberg and Carpenter-Smith (1996) conducted research in workplace training and found that when a logically structured story, something that is found in many educational computer games, was presented in a multimedia presentation the adult learners recall and motivation was increased. It is only a small step to proposing that similar results could be found in younger learners, such as my students.

Wartella and Jennings (2000) make the assertion that children today are drawn to technology that encourages active engagement with it. They cite numerous studies that, to them, indicate "children generally prefer more participatory forms of computer-assisted instruction" (p.37). To me, a well designed computer game can give participatory instruction. When a student perceives that they are in control of their learning it has been reported that the their academic results improve (Clements, 1987; Gentner, 1990) and the retention of the learned material is increased and improved (Dempsey, Rasmussen, & Lucassen, 1994). One of the main attractions of many educational computer games is the ability to allow the student to be in control of the pace of the game, which gives them the perception that they are also in control, to a degree, of their learning. Also, if one accepts Rieber's (1996b) and Hooper and Rieber's (1995) assertions that game play is an authentic part of childhood, then it can be seen in the light of the importance of situating learning in authentic situations (Brown, Collins, & Duguid, 1989; Choi & Hannafin, 1995; Van Eck & Dempsey, 2002) that games, and in my case educational computer games, are a legitimate addition to my students' learning.

"Motivated is a description we apply to behaviour which is directed towards satisfaction of some need" (Skemp, 1986, p.123) and motivation plays a crucial role in any learning activity (Dweck, 1986). Researchers have attempted to define the characteristics common to all intrinsically motivating environments: challenge, curiosity, fantasy, and control (Lepper & Malone, 1987; Malone, 1981; Malone & Lepper, 1987). According to Rieber (1996b, p.50), "games represent the instructional artifact most closely matching these characteristics". A motivated learner is a willing, and often successful learner.

In today's computerised society, playing computer games is often a tangible need for children. Placing children in a situation where they need to gain knowledge in order to play or complete a game can be a very motivating experience and computer games have been found to quickly provide this motivation (Malouf, 1988). I have often marvelled at how many of my academically weaker students, who struggle with classroom work, can describe in great detail the rules and relationships they have discovered in their favourite computer games. They appear to be learning without really knowing it (Rieber, Smith, & Noah, 1998; Sedighian & Sedighian, 1996).

If a child is not motivated the results of their learning will probably be mediocre or only satisfactory at best. Finding the motivation for children at school can sometimes be a very difficult task for the classroom teacher (Ames, 1992; Ruenzel, 2000). Often what motivates one section of the class does not effect another section, and groans can be heard softly in the background. However, I have found that simply hinting to my classes that we can go to the computer room if we can get some work out of the way invariably has almost the entire class sitting up and ready to start and finish whatever task I have planned. It is almost Pavlovian.

Further benefits have been claimed from using educational computer games. Butler (1988) and Randel et al., (1992) conducted literature reviews on the effectiveness of educational computer games. The findings by Butler are general and he does not cite their sources, whereas Randel et al., provide the sources and methodology used in gaining their conclusions. Despite the difference in approaches, I have combined their conclusions to summarise the reported effectiveness of educational computer games. They found that when educational computer games are used for instructional purposes:

- information is absorbed faster than that gained from other sources, although not at a significantly greater rate,
- students generally acquire at least equal knowledge as they would in other teaching and learning situations,
- improvements in problem solving is demonstrated,
- they motivate academically slower students, possibly demonstrating the motivation factor or the student working at their own pace, and
- a drop in truancy occurs.

Overall, the results from the literature reviews carried out by these two studies found that in terms of educational outcomes, computer games can be as good as, or in some cases better than, traditional classroom teaching. However, this is not a call to ignore traditional classroom work and to rely solely on educational computer games for delivering instruction. Rather, I am supporting Klawe and Phillips' (1995) idea that educational computer games be used in collaboration with traditional classroom teaching and learning. There is room for both, and if the game is designed appropriately and inclusively, most students will likely benefit in a positive manner.

In 1995, Shears (1995) reported that, after ten years of computers being generally available in Australian school, computers were being used mainly for word processing and educational games. In my experience, this observation has not changed significantly. Although both my schools have dedicated computer laboratories, the predominant use of the computers is still the same as Shears reported with accessing the Internet being the only significant addition. This situation, I feel, gives an added urgency to my research because, if educational computer games are one of the main uses of computers in schools, then it is essential that the games appeal to as wide an audience as possible, and do not privilege one group over another.

There are some educators and researchers who maintain that developing educational games is a “moral imperative” (Squire, 2002, p.1) because children who have grown up as the “video-game generation” simply do not respond as well and as profitably to the traditional classroom (Katz, 2000; Prensky, 2000). Although this sentiment may reflect the same type of ‘hysteria’ that greeted the educational use of radio, or films, or television, or even computers in general - technologies that were going to transform the learning space we call a school (Cuban, 1986) - I personally do not see developing educational computer games as a “moral imperative”. However, they certainly do need to be investigated and harnessed for the potential good they can do in a teaching-learning situation. I believe they can help foster a learning situation that reflects Csikszentmihalyi’s (1990) Flow Theory of Optimal Experience.

Csikszentmihalyi defines flow as “the state in which people are so involved in an activity that nothing else seems to matter” (p.4), and theorises that experiencing flow activity pushes us to the limit of our present capabilities, continues to extend them further, and assists in redefining ourselves into more complex beings. Importantly, in an educational sense, flow demands effort and work, it cannot be obtained by being passive. Squire (2003), in taking up the idea of flow, contrasts the immersed, engaged and motivated computer game player with students in conventional classrooms, where he sees a teacher led class of students who have little or no control over their learning, who are passive recipients of what the teacher decides is worthwhile learning, and who must conform to the pace and ability level of the class as a group, while receiving ineffectual and imprecise feedback from their efforts. I believe I have observed a “flow” phenomenon when observing many of my students concentrating on educational games at school. Their concentration and application with the learning task in front of them, as mediated by the game, indicates complete engagement with the program and, I believe, a “flow” of interactions between user and program.

Conclusion

The thrust, then, of this chapter on computer games - an electronic version of play - is to justify their inclusion within the range of strategies and activities a school can use in order to achieve positive learning outcomes. Rieber, Smith, and Noah (1998, p.34) believe that "play that is serious and focussed within a learning environment can help learners construct a more personalized and reflective understanding", which in turn leads to improved learning outcomes. Computers are part of a child's school-life and social-life, and when the games are free of gender bias and designed to appeal to both sexes, they can engage learners in 'serious play' which can stimulate their interest and assist in their achievement and raising of self-esteem (Brown, 2001).

CHAPTER EIGHT

RESEARCH DESIGN

Introduction

In this section I detail the theoretical underpinnings of my research and how I went about constructing the data for later analysis. I do this to enable the reader to evaluate the credibility of my conclusions and recommendations and to allow my results to be compared and contrasted with other studies. I do not do this so that someone at a later date can replicate my study. As Minichiello et al., (1995) point out, there is little practical value in replicating highly contextualised qualitative research and my study is just that, highly contextualised to my students and my schools. However, what is important is the description of the methodology used, which then can be replicated in other situations and environments and with which informed judgements of credibility could be made.

Research design is defined by McMillan and Schumacher (1989) as the "plan and structure of the investigation used to obtain evidence to answer research questions" (p.30). I used an interpretive design in order to answer my questions regarding what attributes girls prefer in educational computer software. What I investigated was whether or not girls have particular preferences about how computer games are designed and presented, and if so, how those preferences can be used to obtain educational computer software that will enhance their achievement and participation in, and enjoyment of, primary school science. Of course, I have attempted to do more than just describe what I observe. There would be little point in doing a simple descriptive narration of what happened around me. I have attempted to interpret the data I generated to produce useable criteria that will enable me to select appropriate educational software for use in the science education curriculum for my female students.

It is important to note here that I am dealing with a concern I have about my practice with my students in my schools. I want to acknowledge that what I may discover is applicable to my students and my situation and I will not be "mistaking local conventions for universal truths" (Gergen & Gergen, 2000, p.1032), however, my results may be transferable to other situations. That would be up to other readers to decide and judge if what they read here is applicable to their own unique circumstances.

Epistemology of My Research

The theoretical framework that I used to support my research was that of Constructivism. I was first introduced to Constructivism in an earlier coursework unit and it had a fundamental effect on how I viewed the world around me. Before completing the unit I would have put myself into the Modernist category, certain about the reality of the world. I can remember often being derisive of Constructivist-based research that I had read for courses in my previous tertiary studies. How could you have a body of thought that said you could not 'know' the real world? It made no sense to me. Also, the notion that I had upon entering this Doctoral program, that I was going to find the exact attributes that all girls preferred and attributes that all boys preferred in computer software, would indicate, as I see now, my naive tendencies for a Modernist view of the world.

However, the coursework unit forced me to read the writings of the proponents of Constructivism and to try and understand what was being said. I actually experienced something that I had read about in my early teacher education days concerning Piaget's theories of learning. I was faced with new knowledge that did not fit into my personal 'modernist" schema and was 'forced' to somehow assimilate and accommodate it into my schema of the world. Clearly, the changes to my thinking brought about by what I had read and wrote for the unit's assessment meant that I could no longer stand and say with any certainty what was the real world. Rather, I could only convey how I viewed the world that I inhabited, and acknowledge that it might not necessarily be the same as the way another sees it.

Constructivism puts forward the conjecture that there is no absolute truth, rather there are as many truths as there are cognisant beings. von Glasersfeld (1990, p.22) sees this as the fundamental foundation of his belief in Constructivism, stating that "knowledge is actively built up by the cognizing subject", and therefore by implication, it takes away the notion of truth and reality being tangible, describable objects and replaces it with the experiential world of each individual's constructions. It makes the learner the central actor on the stage of learning. In my research situation, it positions both my students and myself into the centre of the investigation and it is the dialogues and negotiations between us that provides the data for interpretation. Including my students onto this stage that is my research is essential, for as Bruner states (in Driver et al., 1994, p.7), "there is no way, none, in which a human being could possibly master that world without the aid and assistance of others for, in fact, that world is others". In this situation I am relying on what Halverson (1998, p.1) describes as the "collective expertise" of my students, the literature, and my experience to provide answers to my questions.

I believe using a Constructivist approach helps my research in a number of ways. It allows me to listen to my students' voices and makes me respect and accept what they have to say. It is not for me to say what they think is right or wrong because it does not fit into what I think is right or wrong, or what the literature says is right or wrong. Rather, the process is a transaction between my students, the literature that I have read, and my experiences, observations and interpretations of what is happening before me. It is up to me to find the best fit for the data that is provided, and to interpret and relate that fit to my own educational situation.

The use of a Constructivist approach also influences how the outcomes should be viewed. I cannot make any grand claims that what I discover is an absolute truth or accurate representation of what is real. What I am researching and reporting is relevant to my situation at this moment in time. This reflects von Glasersfeld's (1990) view that knowledge is something that is governed by the human construction of time and space. He continues by saying that whatever we know can only be known at a particular time and space, with time as something that is constantly changing. This brings in the concept of *viability* in regards to my interpretations, which I discuss later in this chapter.

Mixed Method Inquiry - My Choice of (Mainly) Qualitative Research

There is no doubt that the qualitative data was the foundation of my analysis, but quantitative reporting was used to illustrate empirical realities, certain points and tendencies amongst my students. I do not view the two styles of research, qualitative and quantitative, as incompatible, but rather I have taken the view of Hardy (1999, pp.880, 881) who stated that these methods "are not mutually exclusive but can be viewed as interdependent" and ultimately adds to the "strength and general robustness of the findings". By using these two different approaches, I believe that the quality of my research is enhanced and makes it more trustworthy and useful to others (Tashakkori & Teddlie, 1998).

The use of mixed methods may leave me open to accusations of being indecisive and having a foot in both camps, but I believe it is a pragmatic approach for trying to answer my questions. Also, according to both Robson (2002) and Bryman (1988), the use of mixed methodology can be very useful in the area of applied research, which is the essence of my course of study. And it is here, with the mention of being pragmatic, that I acknowledge that I have been influenced to travel this way by the idea of Pragmatism as put forward by a number of researchers (for example, see Howe, 1988; Patton, 2002; Tashakkori & Teddlie, 1998). I will discuss this issue later in this section on how it affected my research and data generation.

As stated earlier, my study was mainly based on a qualitative approach to fieldwork and research, an approach that, I believe, best supports Constructivism's view on knowledge construction by individuals. The overall intent of qualitative research is to try and understand a particular social situation using a variety of investigative methods (Locke, Spirduso, & Silverman, 1987). It is also suitable for the analysis of natural or real work situations and can thus be inherently representative of what is happening in that situation at that time (Kay, 1992). I also believe it allows the spotlight to be placed upon my students, the users of the computer and software, and away from the computer itself. I want my research to heed Morse and Daiute's (1992, p.8) warning "that researchers are too technical, focussing more on the computer than on the people who use it and the culture that surrounds it".

One of the main reasons I chose primarily the qualitative approach to my research was that I wanted to use the voices of my students to help me find answers to my questions. I did not want it to be just my voice that dictated what was discovered. I wanted to do what Gergen and Gergen (2000) suggested concerning the interpretation of data, that is "remove the single voice of omniscience [me] and...revitalize [the data] by including multiple voices [my students] within the research report" (p.1028). In order to do this I had to involve them more than simple quantitative statistics would allow.

However, this desire to travel the qualitative path proved highly confusing as I searched for a paradigm, or framework, upon which to 'hang' my research. All my reading informed me that I must have this framework to guide me and the correct choice would provide credibility for my findings in the eyes of my readers. It was a long and confusing path. Over a long period of time I considered grounded theory, case study, action-research, and ethnography, with each providing an initial spark indicating it was the one that would best suit my understandings, the way I viewed the world, and how I wanted to carry out my research. Inevitably, though, I discovered aspects in each approach that I could not fit with my personal view or how I wanted to undertake my research, which subsequently resulted in me feeling uncomfortable about using it as a foundation upon which to build my research. Overall, I was in a continual state of angst about this essential aspect of my research. Finally, through a reading provided by my supervisor, *Qualitative methods in research on teaching* (Erickson,1986), I found an approach that seemed not only to fit my requirements with how I wanted to undertake my research, but how I viewed the world around me in general.

Interpretive Enquiry

My research used an Interpretive paradigm as its guide. A paradigm is a "set of beliefs, values and techniques which is shared by members of a scientific community" and acts as a guide for the research being conducted within this interpretive framework (Kuhn, 1970, p.175). When I use the term 'Interpretive' I am using it in the meaning put forward by Erickson (1986, p.119) who sees it as "the whole family of approaches to participant observational research".

Erickson gives three reasons for adopting this meaning,

> (a) It is more inclusive than many of the others (e.g., ethnography, case study); (b) it avoids the connotation of defining these approaches as essentially nonquantitative (a connotation that is carried by the term *qualitative*), since quantification of particular sorts can often be employed in the work; and (c) it points to the key feature of family resemblance among the various approaches - central research interest in human meaning in social life and in its elucidation and exposition by the researcher. (p.119)

The aspect pointed out in (b) above was particularly attractive as I knew that part of my reporting used quantitative data to set certain scenes and describe certain environments, and so a mix of data forms were used to provide evidence for my assertions and conclusions. The use of mixed methods in research is often seen as not being pure, but it is something that appears to happen often, whether it is acknowledged or not (Rocco et al., 2003).

An interpretive paradigm also governs how different aspects of life are perceived. Sarantakos (1993, pp36-38) lists four elements which he regards as fundamental when research is being undertaken and how the use of different paradigms effects them; they are the perception of reality, of human beings, the nature of science, and the purpose of social research. As I used the interpretive paradigm it is important to make explicit how I will be viewing these area:

- I am confirming my beliefs that reality is not out there somewhere in the ether, but in the minds of people, or in my case, the minds of my students. It is socially constructed through the interpretation and interaction of the people involved, and is based on the definition people attach to it.
- I acknowledge that my students occupy the central position in my research, and that their social world has been created and interpreted by themselves. Part of my job is to locate and identify the systems of meaning they use to explain their perceptions of and interactions with educational computer software.
- I will be explaining what I discover not in terms of absolutes but rather in terms of what makes common sense to my students; my approach is inductive, proceeding from the specific to the general and from the concrete to the abstract; the results are not value free, they encompass the students' values, as well as my own.
- My research is attempting to interpret and understand my students' reasons for what they do and what they prefer in order to enhance their enjoyment of using educational computer software.

By allowing the readers the opportunity to understand how I view the world around me, they will be more able to understand the interpretations I make through my analysis. As Erickson (1986) states, the interpretive commentary provided by the writer, in this case me, highlights those points that are important to the writer, and the meanings that the writer attaches to them. The commentary also fills in the gaps that the data does not provide in order for the reader to interpret the data in a similar way to the writer. Importantly, too, the use of an interpretive enquiry demands that the writer reflect seriously and deeply on the data, allowing the writer not only to be the reporter of the data but, more crucially, the informed analyst.

Also, by allowing the reader to see how I view and interpret the world I am agreeing with Denzin (2001, p.325) that I am not “an objective, politically neutral observer who stands outside and above the study”, but rather I am situated within the research environment and my research methods, interpretations, conclusions and recommendations reflect something of myself.

Pragmatism

I mentioned earlier about the use of Pragmatism as one of the theoretical foundations of the methodology of my research. Patton (2002) proposes that a pragmatic position implies the choosing of a paradigm and methods by what will work best in the situation to meet practical issues faced in any inquiry and thereby answer the research question. In other words, instead of pledging undying allegiance to a particular way of conducting research as the only way to find the 'truth' (something I do not think is possible), the researcher uses whatever works to satisfy the questions raised.

By using a Pragmatic approach, I felt I was able to use the best that different approaches offered. For example, Grounded Theory uses analysis from data to inform further data generation and analysis. The modification of my interview questions, that resulted from data generated in earlier interviews, in order to find further confirmation or otherwise for assumptions and interpretations made reflected this aspect of grounded theory. Ethnography makes extensive use of interviews and observation, two data generation devices I used throughout my study. I believe there are also elements of case study, as well as action research in my study, all legitimised, I believe, through the use of a Pragmatic approach. I found the release from dogmatic ideologies on what is the best way to carry out qualitative research provided by a Pragmatic approach was an intensely liberating and uplifting feeling, a feeling that gave renewed vigour and enthusiasm to my data generation, analysis and interpretation.

One of the main historical criticisms of the use of Pragmatism is that it leads to "ineffective and accommodating" research (Crotty, 1998, p.62), with researchers finding conclusions that will fit into whatever the power that holds sway at any particular political moment believes in order for the researcher to gain influence and acceptance. Possibly this could be a valid criticism. It certainly fits well with the modern day belief of being pragmatic in society; not 'rocking the boat', in order for all to get along. However, this is a form of "vulgar pragmatism" (Walzer, 1989, p.58), a form that does not look at society with a critical eye and is not the approach I used. I believe that when melded with the moral perspective encouraged by Denzin and Lincoln's (2000) seventh moment of qualitative research, which I did in my research, my use of Pragmatism situates it in the critical sphere as envisioned by its early advocates (Crotty, 1998).

Padgett (nd, p.5) and Reichardt and Rallis (1994, p.85) put forward several principles regarding Pragmatism which spoke to me personally and, I believe, justified my using the interpretive paradigm that I described earlier as the basis for my research. They are:

- There is no need to establish metaphysical truth; all existing knowledge is fallible.
- All inquiry is value-laden and all "facts" are theory-laden.
- Any given set of data or "facts" can be subject to a variety of interpretations.
- Quantitative and qualitative methods are both concerned with collecting/generating empirical data - the differences lie in how those data are collected/generated, analysed, and interpreted and in standards for rigor.
- The choice of quantitative or qualitative methods should be driven by the topic, not by an allegiance to a paradigm.

I feel this summary also fits in well with my Constructivist views of the world in which my research took place and allowed a critical analysis and interpretation of the data I had generated to be successfully made.

Personal Viewpoint and Understandings

I was not entering my study with any point, opinion, or hypothesis to prove. The small amount of literature that I had reviewed before undertaking this course of study seemed to be definitive and firm. Boys like A, B, and C and girls liked D, E, and F. My research would probably simply confirm what had already been discovered. I freely admit that I often wondered if there was any point in giving my time to study what my girls wanted when the literature was, apparently, already telling me. However, just as Eisenstein (1985, p.20) discovered, "[i]n the course of studying this unfamiliar material, I discovered (as all neophytes do) that what seemed relatively simple at first became increasingly complex on closer examination".

As I read further into the subject I came to the realisation that much of the research already published was in fact unclear, hesitant, and contradictory. Also, much of the literature was dated, as if all the questions had been answered and there was no need to continue investigating the problem. Polkinghorne (1992) reminds us that current data is required in order to make safe decisions. It was these hesitations, contradictions and out-of-date data that prompted and encouraged me to shed my doubts and to undertake the research that I hoped would allow me to arrive at useable and practical criteria for selecting inclusive educational software. I expected these criteria to emerge from freshly gathered data, which I felt reflected Flick's (in Denzin & Lincoln, 2000, p.9) stand when s/he states "research is increasingly forced to make use of inductive strategies instead of starting from theories and testing them".

The contradictions in the literature were also responsible for my decision to take a qualitative approach to data generation and analysis. The great majority of the research

I read was undertaken using a quantitative approach. It was rare to have a study actually ask the students being observed what they thought, what they liked, or what they did not like. I found it very frustrating to think that the answers may have been right there in front of the researchers, but they did not ask the students because they did not want their data 'tainted' by their unquantifiable personal opinions and observations. The more research I read the more I came to agree with Kay (1990, p.3) who found that most of the early quantitative research investigating gender and computers was "surprisingly lifeless, inert, and static" which leaves the reader with an "empty feeling, a nagging suspicion that something is missing". I wanted to help change this lifeless and clinical picture with the voice of my students and identify what might be missing. As Agosto (n.d.) states "the only way to know what aspects of electronic...resources appeal to young women is to ask them" (p.2) which sums up why I chose the qualitative path for my study.

Through my data gathering approaches I was after what Krockover and Shephardson (1995) described as the "fuller, richer images of multiple contexts and identities [that] are clearly afforded by utilising the full array of qualitative methodologies" (p.223). I did not want to supply more statistics, but rather the "richer images" that my students could provide (Kenway & Gough, 1998). I see my research and subsequent results as fitting into Kay's (1992) call for quantitative and qualitative researchers to work together to guide us to new knowledge. I do not wish to privilege qualitative-style research over any other style; I simply feel this approach enhances and extends previous quantitative research carried out in this area of inquiry and suits my belief that there are many shades of grey when trying to understand the motives, understandings and preferences of individuals.

My research is primarily investigative, rather than just the simple gathering of numbers and statistics, and the investigations were carried out by myself. My role as the researcher meant that I was the primary instrument for data generation, not some inanimate survey or test (Lincoln & Guba, 1985). This is important to note as it put me within the area that was being researched. It is this immersion and participation that I believe allowed me to make sense of what was happening and what I was observing within the group being investigated. As Denzin and Lincoln (2000, p.3) maintain, "qualitative research is a situated activity that locates the observer [in this case, me] in the world" being studied.

Also, because I am the main instrument of data generation it is important that my beliefs, personal values, feelings, and biases are identified and acknowledged. Wallsgrove (in Hilderbrand, 1989, p.13) believes that "[i]f you don't come to terms with what you feel, your feelings will interfere anyway, but in a hidden and uncomfortable way". I make no claims of neutrality or objectivity. It is important to acknowledge this because I am interpreting my observations and the generated data through the lens of my personal beliefs and experiences. These personal beliefs and experiences need to be made public in order to assist the reader in understanding the interpretation and discussion of the data and the conclusions and recommendations that arise from those interpretations and discussions.

I have completed a number of tertiary courses that have included subjects that have dealt with issues of gender and technology, gender and science and mathematics education, as well as the general role gender plays within the world of primary education in Australia. I have worked in co-educational primary schools for 20 years as a teacher-librarian. From my studies and my work experiences I have come to the conclusion that girls do not have equitable opportunities in many facets of education, particularly in the areas of science, mathematics, and technology. I acknowledge that this is my personal opinion and was the perspective that I started with for this course of study.

Validity Through Crystallization

Richardson (2000) used the term 'crystallization' when she described an alternative way of providing validity in qualitative research. She believed the traditional qualitative test for validity – triangulation - did not apply in a postmodern view of the world where objects do not have fixed bases from which to triangulate or evaluate data, interpretations, and conclusions. Richardson used the metaphor of the crystal to illustrate her idea that "what we see depends upon our angle of repose" (p.934) because, just as a crystal can give the observer different colours depending on how it is held to the light, so can data yield different interpretations depending on what 'light' of past experiences and influences the reader brings to the reading (see also Janesick, 2003). For example, the earlier chapters of my writing, as well as my original proposal (Appendix 5) provided an insight to the influences that have shaped my views and opinions in order that the reader may gain an insight to how my interpretations and conclusions arose.

The crucial aspect of Richardson's idea of 'crystallization' resides in the belief that although we can gain a deepened and complex understanding of a phenomenon under investigation it can only ever be a partial understanding; simply one truth amongst many truths. Clark (n.d.) argued that a researcher's interpretations or conclusions have no special status or legitimations, rather they are "simply another construction to be taken into account in the move towards consensus" (p.8). By utilizing Richardson's (2000) 'crystallization', I am acknowledge that I am providing the reader with a "thoroughly partial, understanding of the topic" (p.234) but not one that I make any claim of ultimate truth. Any claims I make must be viable within the research community with which I am involved.

Data Gathering

To add "rigor, breadth, complexity, richness, and depth" (Lincoln & Denzin, 2000, p.5) to the inquiry, I used a variety of instruments to generate and verify the data to be interpreted. Using different methods of data generation was not done in the name of validation, but rather as an alternative to validation (Flick, in Lincoln & Denzin, 2000). Also, my use of multiple methods of data generation reflected my attempt to paint an in-depth picture of the circumstances being studied rather than to gain validity in quantitative terms (Denzin & Norman, 2000). This provision of "rich, thick, detailed description" (Creswell, 1994, p.168) provided, what I believe, was a solid framework of transferability for anyone interested in a comparison study (Merriam, 1988).

Physical location of my study

I have been the teacher-librarian at my two schools for the past 17 years, working at one school for three days of each week and working at the other school for the other two days of the week. Prior to this position I taught in a Sydney primary school for three years. In my current position I take each class from Kindergarten to Year Six for periods of 30 minutes to one hour. These classes generally took place in the libraries of the two schools. Both schools have a dedicated room used as a computer laboratory. One school had 23 computers available, which meant that some students had to share with another student each time classes visited the laboratory. The other school had 36 computers available, which meant that a 1:1 ratio of students to computers was always available. All classrooms at both schools also had at least one computer available for the children to use. My observations did not include any classrooms.

Part of my position at the three-day school entailed taking a Year Three class and a Year Five class to the computer laboratory once a week, for a period of up to 45 minutes. In that time I introduced the children to a variety of software packages ranging from applications such as word processing and spreadsheets, reference programs such as encyclopaedias, Internet searching and research, to using educational computer games that supported sections of the curriculum that were being taught by their regular classroom teachers. Occasionally, I would take other classes to the computer laboratory but only for periods of less than 30 minutes. I would do this if there was a particular software package that I wanted to introduce to the children and which they could later use with their own class teacher. The children were familiar with me and the way I conducted my teaching program. The library itself only contained four older computers which are used solely as support for the library catalogue and circulation system. This was the only use of the these library computers.

Also, during the data generation period, I made the computer laboratory available at lunchtime at both schools where students were able to sign up and use a computer as they wished. The children were restricted to only one 'visit' to the lunch time session per week. This was done so as to stop any particular child going to the laboratory every lunch time and taking away opportunities for other children to participate in the lunch time sessions. This allowed the maximum number of children the opportunity to have a turn. Signing-up for the lunchtime sessions was completely voluntary. Some children in the primary did not attend the lunchtime sessions at any time during this period, others were regular weekly attendees, while others signed-up spasmodically.

There were some technical issues that need to be reported in regards to the computer laboratories at both schools. At the three-day school, it was not always possible for the children to save their progress in the computer games they chose to play. This was because there were consistent logging-on problems with the server that occasionally did not allow the students to save to the server or because some games would not allow a game to be saved anywhere but on the computer being used. Often, if a game was saved on an individual machine, it may not have been there the next time the child logged-on because another child may have overwritten the saved game. Also, the child would not necessarily be on the same machine as the previous week so they would not be able to retrieve their saved game. This may have led to frustration for some of the children and may have had an effect on what computer games the children decided to use. This aspect is raised in the analysis section and how I felt it may have influenced childrens' choices.

Respondents

The group from whom I generated the data for my research was the primary-aged students who attended the two schools where I was employed. Their ages ranged from eight years to 12 years. Both schools were public and co-educational. The socio-economic background of the schools would be categorised as middle-class and the majority of the children had an Anglo-Saxon background. All primary aged students were invited to participate in the interview stage of my research. The total number invited was 321. The invitation was extended through a letter sent to the parents, via the child, that outlined my study. It informed the parents that I had permission from my employer, the New South Wales Department of Education and Training, as well as permission from the respective principals of the schools. It also informed the parents that I had ethics approval from Curtin University. Of the 321 students invited to participate, 216 agreed and were subsequently interviewed.

Data Gathering Instruments

Crowson (1993, p.188) recommends “the use of multiple methods of data collection” to assist in validity of any recommendations or conclusions emanating from qualitative research. In order to satisfy this recommendation I used several different data gathering instruments. Over the course of the data generation period I used interviews, surveys, focus, groups, and in-situ observations of my students. The use of these different data generation instruments allowed me to weave a richer picture than if I had relied on one method alone, or as Padgett (n.d., p.10) puts it, to produce “a synthesis, or whole, that is greater than the sum of its parts”.

Time line

The data generation period commenced in March 2002 when I opened the computer laboratories at my two schools at lunchtime for children to use. These observations continued until November 2002. In the second week of August 2002, I asked my students to complete a written open-ended survey when they attended their scheduled weekly library lessons. I commenced my interviews in November, 2002 with a small number of preliminary interviews. These initial interviews were transcribed over the following Christmas break. I used the transcripts from these interviews to modify the questions which were subsequently used in later interviews. I completed the interviews during March and April, 2003. Transcription of the interviews were then completed over the following three months. Focus groups were held in November, 2003. Looking back at this time line I believe I should have undertaken the focus groups earlier for reasons I detail later in this chapter.

Interviews

The main instrument I used to collect the data was the interview. By using interviews, rather than statistical surveys or just observation, I was able to access the perceptions and attitudes of my students, things that are difficult, if not impossible, to obtain using alternate techniques (McCraken, 1988; Partington, 2001). The general sequence of the interview questions was maintained throughout all the interviews, although I did slightly vary the wording of some questions, depending on the age of the student being interviewed. This allowed the interviews to be more like "a conversation with a purpose" (Merriam, 1988, p.71) than an orally administered survey and, I believe, made the formal question and answer process less intimidating and more natural for the children.

The majority of the interviews took place in late March and early April, 2003 at the schools where the children attended. However, I did conduct 50 interviews in November and December, 2002. These were preliminary interviews that I used to gauge the effectiveness of my questions and to uncover areas of inquiry that I may not have considered or had not been brought to my attention by the literature I had read up to that point. These interviews allowed me to fine tune some questions, as well as add new questions. The data generated from these preliminary interviews was included in the overall analysis.

This style of interview was an example of the “semi-structured interview” (Hitchcock & Hughes, 1989, p.83), which enabled depth to be achieved by allowing me to seek clarification on unanticipated issues and opinions raised by the students during the interview. The advantage of this form of interview was that I was in control of the interview but still free to follow any new leads that arose during the course of the interview, an important feature of this form of interviewing technique (Bernard, 1988; Borkan, 1999; Shroyer, Backe, & Powell, 1995). This was evident when you compare the questions that I used in my first interview to the questions used in my final interview [Appendix 4]. A number of questions I used in the later interviews were derived from responses given by children in the earlier interviews. Also, by not using formal, scripted questions that went unchanged I was able to ensure that my interviews did not become a de-facto quantitative survey that did not allow for individual responses.

Interviews ranged from just over two minutes up to 22 minutes. Each child was told that there was no right or wrong answers, they did not have to answer a question if they did not want to or did not know what to say, and that they could ask to stop the interview at any time. No child asked to stop their interview.

I believe that the relatively large number of interviews I carried out helped to optimise trustworthiness of my conclusions and recommendations. With a total of 216 interviews carried out I believe I achieved the sampling adequacy, or saturation of data, as advocated by Morse (1991), meaning that sufficient data has been obtained to account for all aspects of the phenomenon under investigation.

Focus groups

I supplemented the interview data with data generated from focus groups. Beck, Trombetta, and Shane (in Vaughn, Shay Schumm, & Singagub, 1996, p.4) define focus groups as “an informal discussion among selected individuals about specific topics relevant to the situation at hand”. I used these informal discussions because I believed that the extra data generated from them could contribute significantly to my research as it gave me a group perspective of game design rather than the individual perspective supplied by the interviews. This view is supported by O'Donnell (1988), who states focus groups provide qualitatively different information from that obtained in individual interviews. To me this was an attractive feature because data obtained in this way would enhance the credibility of conclusions formed from the interview data. Just as in the interviews the children were told that there were no right or wrong answers, that I was simply attempting to clarify some observations and wanted their opinion as a group. At all times, even though I was the facilitator of the discussions, I tried to maintain a student-centered focus (Chu, 1995) in order to allow the children the greatest chance to put forward their views and perceptions. Again, the children were told that participation was voluntary and they could leave at any time. None of the children declined to participate and none asked to leave during the focus group sessions. During the focus group sessions I summarised points raised by the children so as to promote accuracy for my post-focus group review and also to clarify any emerging themes and ideas, as well as my interpretations, that arose from the students' views (Carey, 1995).

Surveys

A brief survey was conducted of all primary students at both schools. This survey was used to see what type of computer games were liked by the students, as well as the type of computer games that were disliked by the students in order to determine if any particular theme or genre was present in their preferences. It was made clear to all the students that completing the survey was voluntary. No student chose not to participate in the survey. The only students who did not participate in the survey were those students absent from class at that particular time. A total of 288 students (140 girls and 148 boys) filled out a survey sheet. The children were seated around the library in a way that they were not able to see what a friend had written. This was done to reduce any peer influence in the students' replies.

Each student was asked to list the titles of three computer games they liked and the titles of three games they disliked. Under each title was a space to write a free description of why they liked, or disliked, each game. The opportunity to give free description removed any influence I may have had if I suggested sub-headings or elements to think about. I wanted to gain a spontaneous description from the children. This data was used for comparing and contrasting the data that came from the interviews to see if similar themes emerged. The weakness of the survey was that the data gained was not as detailed as that obtained from the interviews and focus groups. Also, I believe that many of the children, particularly the younger ones, found it difficult to express themselves in writing, whereas talking in the interview seemed to be easier for them.

Observation

Further data were obtained through observation of the children as they were using computers at lunch time, when the computer room was available for free use, and during class times with those classes for which I was responsible. A total of 87 sessions was observed over a seven-month period. During this period 254 individual children (127 girls and 127 boys) attended at least one session. A number of children made a regular appearance each week, while other children attended spasmodically. These sessions lasted between 30 to 40 minutes. In both situations, the children had the choice of using any software program available in the school, no programs were specifically directed to be used. As each child used a particular program I noted its title under the child's name. I used this secondary data to compare the attributes identified by the students as being preferred or not-preferred was identifiable with the programs selected by the children.

Data Analysis

Qualitative data analysis can involve coding data into themes, then categories, to assist in forming conclusions (Hewitt-Taylor, 2001; Jasper, 1994). The data coded was gained from interviews with my students. A total of 216 interviews was undertaken resulting in over 270,000 words (including my questions) being recorded and transcribed. With such a large volume of data I decided it was not physically possible for me to cut and past accurately those sections of responses that provided individual data pieces for the various elements and attributes that I was investigating. I felt I would be simply overwhelmed. Therefore, I sought different ways to code and store my data. This resulted in my purchasing and using *N6 Student* (2003), a computer program specifically developed for qualitative analysis.

The interviews were transcribed verbatim with a word processor by myself and several assistants not related to the project. The interviews that were transcribed by my assistants were checked by myself by listening to the interview while reading the transcript. Very few errors of syntax were detected in this checking process, and they were generally restricted to the wrong spelling of particular games mentioned by the children. This was due, I felt, to the unfamiliarity of my assistants with many of the computer games played by the children. Any errors detected were corrected in the final transcript. Also, any inaudible sections listed in the transcript were replayed and often I was able to discern what was missed by the transcriber. I added these words and phrases to the transcript. However, there were still instances where one or two words were still inaudible after multiple listenings and so "[inaudible]" was inserted in these sections.

The resulting transcripts were then entered into the analysis program *N6 Student* from which a number of categories were created to place individual segments of the interviews. Each code represented a theme or idea that appeared relevant to my inquiry, reflecting Seidman's (1998) suggestion on organising qualitative data for easier access to both the researcher and any follow-up studies. The coding process was carried out by reading individual transcripts and allocating an appropriate code to lines of the transcript that exhibited evidence relevant to that code. This resulted in some transcript lines not being coded, being coded once, or being coded under several categories.

Because my study was largely inductive in nature the codes used, apart from the categories that dealt with the child's gender and age, were derived from the data supplied by the interviewees. The coded categories were not predetermined by myself. I did this because, as Strauss and Corbin (1990) caution, using preconceived codes can obstruct the development of new ideas that may have been put forth by the data but end up being ignored or overlooked because they do not fit into what was expected. As new codes were created due to emerging themes previous transcripts were reread to ensure lines relevant to the new category had not been overlooked.

The use of the *N6 Student* program proved very useful as I was able to return to any section of a transcript that indicated support or otherwise of a theme where I was then able to examine the context of the answer. This ability to return to the data piece in its original context also assists in providing dependability of the overall analytic process because it allows the reader, if they wish, to be able to track where the underlying data comes from, how it fits within the context of the interview, and whether my deduction or inference in the analysis is viable and supportable. This is just as Guba and Lincoln (1989, p.23) recommend when they state, "the data can be tracked to their sources, and that the logic used to assemble the interpretations into structurally coherent and corroborating wholes is both explicit and implicit in the narrative".

Strengths and Weaknesses of the Data Gathering Process

It must be acknowledged that my data gathering methods have certain strengths and weaknesses and it is important to be aware of them when considering the data and any interpretations, conclusions, and recommendations arising from it.

The data generated by the interviews was almost overwhelming to me when it came to identifying what the children said and interpreting it in the context of my research. There was a continual struggle between trying not to ask direct questions in order to gain short, direct answers and asking indirect, non-leading questions that allowed the children to say what they wanted to say in their own language. I was specifically 'vague' in my questions because I did not want to put answers into the mouths of the children. I used indirect questions because I did not want to give clues or direction to the children, thus ending up with my ideas, views, and prejudices being reflected back to me in the children's language. I believe I was successful in doing this but with the end result of a lot of forest which made the trees often difficult to see.

One weakness with the data generated by the *N6 Student* program was that the questions asked were not consistent. While there was a core of questions asked of all my students many of the interviews explored tangents as issues raised by the interviewees, but not catered for directly by the questions, were explored more fully with the interview subject. In a qualitative research environment that uses interviews you have to accept there is going to be instances of some students being asked different questions simply because their answers to previous questions can take the interview to areas that were not planned or pre-mapped. This is both a strength and a weakness of the semi-structured interview. Sometimes these new questions were kept for later interviews because I felt they assisted me in finding answers to my research questions. To me, this was an example of what Sing and Richards (2003, p.6) called "the growth of knowledge" in the qualitative research process. Other questions were not kept as they were only relevant to the student being interviewed at the time. The weakness is that it is not practical to go back and reinterview all the previous participants to gain their view on these new questions. Therefore, it is important to acknowledge that when using the data from the *N6 Student* program, not all participants have answered all the same questions for some codes (Saint Germain, Bassford, & Montano, 1993).

According to researchers who have used and promote their use, focus groups have several attributes that can enhance and supplement data generated through individual interviews. The interaction between members of the group often decreases the amount of interaction between the group and the focus group leader, that is, myself, and so assists in excluding the leader's opinions and ideas from influencing the direction of the discussion. Tilting the balance of power to the group and away from the researcher gives more weight and credence to the participants' opinions. Also, because the focus group emphasises the collective, rather than the individual, an atmosphere more conducive to free expression is encountered, and so individual members are more likely to speak out and contribute (Lydecker, 1986; Morgan, 1988; Morgan & Spanish, 1984; O'Donnell, 1988; Welch, 1985).

One of the benefits that arose from using the focus groups was that I was able to put certain questions and ideas that had arisen from my casual analysis of the data already generated directly to the children without the fear that I was putting words into their mouths. The focus groups generally involved fairly vigorous and opinionated views from all the participants and so I felt confident that my asking direct questions would not influence any opinions or outcomes and would give me some clearer insights into the accuracy of my interpretations and inferences. The focus groups allowed me to quickly get to the heart of some of the ambiguities that other data had implied. I did not need to rely on something being brought up by accident so that it could be explored further as I did during the interviews

It is important, however, to note that focus groups do have shortcomings and these need to be kept in mind when interpreting data derived from them. These shortcomings include; they have had little empirical scrutiny in terms of their reliability; participants can believe they are being pressured by the group to agree and supply group-acceptable answers; and it is risky to generalize the data beyond the members of the population from which the data is being drawn, rather it is more sensible to look for trends (Byers & Wilcox, 1991; Crowne & Marlow, 1964; Iorio, 1994; Quible, 1998).

Another weakness I found in the focus group experience was many times the girls indicated that they preferred particular things at particular times. Many of them were conscious that what was liked often depended on how they felt *at a particular time*. This made it difficult to be firm about many of the attributes of games mentioned by the girls during the focus group as being preferred. This needs to be kept in mind when interpreting my conclusions and recommendations.

There was also a specific weakness with my focus group data that my readers should keep in the front of their minds when reading and reflecting on my interpretations. I waited too long after the interviews were completed to conduct the focus groups. By the time I conducted the focus groups many of the children had passed the age at which I had categorised them in the *N6 Student* program. For example, this meant that some students who were ten years of age when they were interviewed individually had turned 11 by the time I invited them to participate in the focus group session. I did attempt to use children who were still the same age as when they participated in their interview but this was not always possible as I needed five to seven participants for each focus group and the majority of the children in each age group I had interviewed had turned a year older.

However, on the positive, the delay between the interviews and focus group discussion gave me time to informally analyse and reflect on the data I had generated from the individual children through the interviews and allowed me to frame questions that enabled me to point my queries directly at areas of ambiguity arising from the interviews. In this situation, I was able to target an attribute specifically rather than hope it would arise naturally through the conversation, as was the case during the interviews.

Evaluation Standards

As I have used the constructivism paradigm as the basis of my enquiry and a qualitative approach to data generation, particular standards of evaluation need to be used in order to achieve trustworthiness in my interpretations and conclusions (Clark, n.d.). Trustworthiness embraces the ideas of confidence and belief in the data generation and interpretation methods being used by the researcher (Hafner, 2001). The criteria generally accepted for this trustworthiness are credibility, transferability, dependability and confirmability (Guba & Lincoln, 1989, p.236-243).

Credibility

Credibility reflects how well the research subjects' realities are reflected and reported by the researcher. Prolonged engagement at my two research sites, that is, my two schools, and persistent observation of my students, two of Guba and Lincoln's requirements for credibility, allowed me to become aware of what software my students were using and how they were communicating with the computer and each other while in the computer laboratories. These observations took place over a period of 11 months, and informally over the past seven-to-eight years when it first came to my notice that many of my female students were interacting differently with the computers when compared to how boys interacted with computers.

The use of negative case analysis is another method suggested by Guba and Lincoln of achieving credibility. I have undertaken this step in my analysis, always seeking examples from my students' actions and words in order to find different ways in which they experienced the software that they where either using or discussing. These examples generally arose from either direct quotes from interviews or from my own recorded observations. By identifying the categories or preferences nominated by the majority of my students, both girls and boys, I believe I arrived at credible conclusions. As Guba and Lincoln point out, the "qualitative analyst ought not to expect that all cases would fit into appropriate categories. But when some reasonable number do, then negative case analysis provides confidence that the evaluator has tried and rejected all rival hypotheses save the appropriate one" (p.238).

Progressive subjectivity is another criterion of credibility put forward by Guba and Lincoln. This involves the researcher recording their a priori construction of what they expect to find in their study before the study is undertaken. Although they recommend that this be recorded with a disinterested peer I did not take that path. Rather I recorded my prior constructions through my thesis proposal where I indicated that I expected to find a significant difference between the software preferences of girls as compared to not just the boys, but also to what is generally available in the education software market. Throughout my analysis I record how this view I had held changed through the agency of the data I generated from my students. This allows the reader to follow how my pre-study constructions were modified and reconstructed. It allows the reader to gain an insight into how I was thinking in the face of the 'thinking' I elicited from my students and to then make a judgement on whether my deductions, inferences and conclusions are credible (Erickson, 1986).

One of the strategies for ensuring credibility recommended by Guba and Lincoln (1989) that I did not use was member checks. In the introduction to this thesis I mentioned how there has been little qualitative research carried out involving children because many researchers believe children do not have the cognitive capacity to carry out the tasks and verbalisations required by many researchers (Fromme, 2003). I also mentioned how this leads to a deficit model of childhood and how I rejected that notion. I believe that my non use of member checks is an example of how I changed the recommended verification strategies to adapt to the subjects being investigated.

I was concerned that there could be, from the viewpoint of my students, a perception of a power relationship between them and me during the data generation stage of my research. During the interview process I could assure my students that there were no right or wrong answers and I was simply interested in their opinions. I believe the questions I asked were framed in a way that did not lead the students to give a particular response and that throughout the interviews the children did in fact answer in an open and honest manner. However, I felt that if I returned at a later date and asked them to verify the extent to which I had interpreted their opinions correctly they may have had some reluctance to contradict me if they felt that I had in fact misinterpreted what they meant.

To my mind, any interpretations of data I had made that was confirmed through the agency of member checking could be tainted with the thought that the student may have agreed with me simply to keep me happy. In trying to justify this stand I found that both Hewitt-Taylor (2001) and Silverman (1993) addressed this issue and confirmed my belief that if a research situation incorporates a perceived power relationship the member checking process can be tainted and should not be used. Therefore, the absence of member checking data should not be viewed as an oversight or slackness on my part, rather its absence was due to its inappropriateness caused by the possibility of a perceived imbalanced power relationship between myself and my students.

Transferability

Transferability refers to the extent to which the findings of qualitative research can apply to other situations and environments. In this instance the acceptance of transferability rests upon the reader, where it is up to the reader to decide the extent to which the circumstances presented in the research under examination can be applied to circumstances with which they are familiar and interested in. In addressing this particular criterion of evaluation, I have supplied the reader with enough details of my research environment in order for he or she to make a considered and informed judgement on their own behalf.

Guba and Lincoln (1989) recommend certain elements to be supplied and presented to the reader. They suggest that the "major technique for establishing the degree of transferability is thick description" (p.241). I believe I have given a comprehensive and detailed description of the research environment that I was involved in that produced the results of this study. This description encompasses the location, the time line of investigation, description of the students and their background circumstances relevant to the study, as well as my background and prior knowledge, understandings, and constructions that I took with me into the study.

Dependability and **Confirmability**

Guba and Lincoln see dependability and confirmability as being "concerned with assuring the data, interpretations, and outcomes of inquiries are rooted in contexts and persons apart from the [researcher] and are not simply figments of the [researcher's] imagination...[and] that data...can be tracked to their sources" (p.243). To provide for this an audit trail must be available to the readers so that their judgments of the dependability and confirmability of the researcher's actions and interpretations can be made from an informed stance.

Audit trail

One of the benefits of using a qualitative data analysis program such as *N6 Student* is its ability to tag specific units of text, thus allowing both the researcher and examiner to return to the source of an interpretation or inference and examine the context in which the original comment was made. This allows an informed judgement to be made on the extent to which an interpretation or inference is valid. In other words, the reader is able to confirm the researcher's conclusion, thus adding trustworthiness to the research as a whole. Also, by supplying the original interviews on a DVD as mp3 files, the reader can, if they wish, go to the original source to ascertain the accuracy of any transcripts made from the interviews, as well as to ensure that the students were not unduly led or directed in their responses. These original sound files also allow the examiner to make judgements on how the interview process was carried out and to ascertain if the questions posed were indeed the ones that I have reported. I have purposely chosen not to include a printout of the interviews within this thesis as, in total, they span over 273,000 words and 748 pages, a total simply too large to be of any practical use. However, I have included on the DVD the original *N6 Student* data, and the transcripts in Word format. Overall, the interview process is completely open and transparent for any reader to judge.

Other data sources are supplied in the appendices of this thesis. These are the listings of software used in the school computer laboratories, both as a printed frequency file broken down by sex and as *Claris works* files listing which students used which programs over the observation period. This data can be searched by sex, age, grade of child, and/or school. Notes I made from the focus groups are supplied, as well as the mp3 files of the recorded focus group sessions. However, scanned copies of surveys used in the data analysis chapter have not been attached. As over 300 copies of this survey where collected I felt it was impractical to scan and include all the images in an appendix.

All these artefacts are supplied to the readers so as to allow them to make their own informed judgement regarding the confirmability and dependability of my research findings.

Fourth Generation Evaluation

Guba and Lincoln (1989; 2001), however, believe that the criteria for trustworthiness are not enough for a constructivist-based, qualitative study. They argue that these criteria simply mirror that of quantitative research and only "speak to the methods that can ensure one has carried out the process correctly" upon which the worthiness of the study can be judged (p.245). For them, they needed something extra that reflected the constructivist paradigm inherent in qualitative research.

In their 1989 book, *Fourth Generation Evaluation*, Guba and Lincoln described how evaluation of educational programs had been carried out historically via a positivist, or scientific method approach that did not, nor could not, take into account the constructivist paradigm of teaching and learning. They saw the previous practice of evaluation as having a tendency towards managerialism (Clark, n.d.; Hall, 1995) or evaluation for the holders of the power, authority, and money. This approach did not take into account the values, beliefs, and constructions of those being evaluated and so, excluding the research subjects in this way, was incompatible with constructivist theory.

Due to the incompatibility of constructivist research and positivist evaluation, Guba and Lincoln propose a new generation of evaluation practice - Fourth Generation Evaluation - to enable researchers using constructivism as their epistemological foundation to arrive at "truths" through negotiation with the community being studied. The concept of a negotiated "truth" is essential, for as Hall (1995, p.4) argues, "'Truth' is a social construct, an explicit or implicit convention of a social interchange which is subject to a constant dynamic multisite multigroup set of negotiations". "Truth" can only come from negotiation with all stakeholders, and the early practices of evaluation could not and would not allow such negotiation to take place. The power was in the researcher's pen. Guba and Lincoln believe that further criteria are needed in order to convey the "authenticity" of the research outcomes.

Criteria for Authenticity

I lingered and reflected on their call for 'proof' of authenticity, and can see that it is a viable and important outcome to pursue. However, I became increasingly frustrated in trying to wed their criteria for authenticity with my students and their constructions and I felt that this should be addressed here rather than glossed over in the hope that it is not noticed (Singh & Richards, 2003). While I felt that some of their criteria could be accommodated, no matter how I tried to manipulate the scenarios I felt I was being artificial in my attempts to satisfy all their requirements for authenticity. I believe this comes from the age of my subjects, and again reinforces my view that conducting research with children means the researcher must adapt and change certain accepted practices that are used with adult participants in order to make the research process viable and productive. I will leave it to the reader to decide if I have taken an acceptable path for the seeking of authenticity in my reported findings.

Fairness

In their description of authenticity criteria, Guba and Lincoln describe several 'tests' to indicate that the subjects' views and ideas had been faithfully represented. The first they list is fairness, which refers to ensuring that the different constructions of the participants are taken into account and given respect in an even-handed and balanced fashion. They suggest two ways to do this. First, identify all the stakeholders of the research and seek their input, and show this input through the audit trail mentioned in earlier criteria. I believe I have done this in the earlier sections that identify and describe my students. In my research, they are the group of stakeholders.

The second suggested way is "the open negotiation of recommendations and of the agenda for subsequent action" (p.246). Part of the criteria they list for this is that the negotiation should be "carried out by equally skilled bargainers, from approximately equal positions of power" (p.246). I believe the age of my students precludes this from happening, and even bringing in an outside voice defeats the purpose because the outside voice still has to interpret the childrens' voices, meaning that the children are not speaking in the first person.

I also stumble on this point because my research, in relation to this thesis, concludes at the reporting stage. Of course, I will be continuing with feedback from my students, post-research, when I expect to introduce educational software packages into my schools that reflect the findings of my research, and subsequently refer to my students about the success or otherwise of those packages. To me, my research will be an ongoing process of purchase, evaluation and discussion, and modifications of purchases, if required. These steps will be continually monitored and repeated while ever I am involved in my teaching environment. I have always kept in mind the practical orientation of my research and the course of study I have undertaken.

Therefore, it can be seen from this that negotiation of the results with the participants and subsequent action before the completion of the research is not relevant in my situation, and so I cannot in good conscience claim to have satisfied fully Guba and Lincoln's fairness criterion for authenticity.

Ontological Authenticity, Educative Authenticity, Catalytic Authenticity, and *Tactical Authenticity*

According to Guba and Lincoln (1989), these criteria refer to the extent to which the research subjects' constructions have become more sophisticated because of their participation in the research, how they have come to understand and accept the constructions of others, how action has been stimulated by the research, and how the participants are empowered to act upon recommendations. Again, I believe that these criteria will not be satisfied until after the thesis stage of my research is complete.

After I have finalised my conclusions and recommendations from my investigations I will be in a position to discuss what we, as a group, have discovered and how, by changing and modifying the educational software games that we use in my schools, better and more profitable teaching and learning outcomes have resulted. I envisage opportunities for students to demonstrate software that they believe is suitable for use in my schools in light of my findings and if, after discussion, the software is deemed suitable listing in priority order according to budgetary requirements to purchase the software and to introduce it into the classroom. I envisage a democratic approach to the purchase of most educational game packages to be one practical result from my research, which in the long run, I hope, satisfies Guba and Lincoln's criteria for overall authenticity of my research.

Criteria of the Moral and the Ethical

Earlier I quoted Guba and Lincoln's (1989) criteria for trustworthiness and outlined how I believed I achieved that. When writing at a later time about the seventh moment in qualitative research Denzin (2001) stated that additional criteria for evaluation needed to be added to those already published. He stated that the criteria for evaluating critical qualitative work were "moral and ethical". I cannot direct the reader to particular pieces of writing, analysis, or interpretation that demonstrated I satisfied those criteria. What I ask of my readers is that they reflect on my writings as one piece and in doing this I believe it will be apparent that I have taken the ethical and honest approach to my research and used my time and energy to contribute to the advancement of girls in the areas of not only science education, but also computer use in general. The moral perspective of bringing equity to a group that may not historically have had equity underlies all my efforts.

Conclusion - A Question of Viability

Ultimately, it is up to the reader to make their own judgements of the worth of the interpretations and conclusions of my research, to make a judgement towards the viability of my work. Is what I have done and presented viable within the knowledge and understandings of my audience? In my mind, it is. However, as Bakhtin (in Shotter, 1995, p.43) believes "truth is not to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of the dialogic interaction". Therefore, the information I have supplied in this chapter is the dialogic interaction between the reader and myself.

By detailing extensively the knowledge claims I have made, the relevant influences in my life, my research participants, and how I conducted my research, I believe I have provided "shared access" (Ernest,1995, p.480) to the pieces of knowledge needed to establish a common understanding between myself and my reader in order for the reader to make a judgement on the viability of my interpretations and conclusions. The reader may not totally agree with the specifics, but could concede they are viable within the context of the research environment, which reflects Hardy and Taylor's (1997) point that shared meanings do not have to be the same, just compatible amongst the participants, in this case the reader and myself.

CHAPTER NINE

LITERATURE REVIEW (OR DOES ANYONE REALLY KNOW WHAT GIRLS PREFER?)

Introduction

The results of the 2003 Computer Aptitude Test [CAT] which showed that girls in New South Wales primary schools were outperforming boys in computer achievement reinforced my concerns about the research that had been carried out in the preceding three decades regarding girls and computers. Much of the research was old and may not be as relevant today as when it was first carried out. As Parker, Rennie, and Harding (1995, p.191) point out, "contemporary data are required for decision making, and reliance on old, even established, findings is unsafe". This concern regarding old data is particularly relevant to the research that was specifically behind the reasons why I wanted to conduct my own study. Was the small amount of research that had tried to ascertain the attributes of educational software that appealed to girls also dated? Even though the ERIC and AEI citation figures quoted previously showed that only a very small percentage of the overall educational research carried out in relation the gender and computers dealt with issues of software, what was investigated and the conclusions arrived at may be irrelevant to the girls who are in my schools today.

I believe this has added an interesting dimension to my research. Initially, I was discouraged with the CAT results, not for the sake of the girls, but for the impact it had on my feelings towards the relevance and necessity of my own research. Am I a decade too late? However, upon reflection, I think what I can do now with my data is see whether the earlier research is in fact outdated. Will the data supplied to me by my students show different preferred attributes of girls and boys than the literature or will it confirm it, or will it modify it by different degrees? I believe a review of the literature that I have read before conducting my study will enable a decision to be made in this regard. Also, my reviewing the literature can assist the reader to understand how my ideas and conclusions have been partially shaped. Obviously the literature that I have reviewed for my study will have had an influence upon me, in relation to the questions I chose to ask, in the way I analyse the data, and in the conclusions to which the data leads me. As I acknowledged earlier, my experiences cannot be excluded from the analysis. My history sheds light on my conclusions.

The literature carried out in the past three decades regarding gender, software, and learning agrees on several major themes, or attributes, in regards to what girls prefer. These major attributes appeared to be confirmed by a large number of studies. There are also a number of minor attributes that appeal to girls that have been identified by a smaller number of studies. I have used these identified attributes as the headings for the various sections of my review but it is important to remember that they are not meant to be exhaustive. They are attributes that have generally been derived by the preconceptions of the researchers themselves. In other words, they went into their research trying to confirm what they already thought they knew. Only a few, qualitative studies allowed the children to speak for themselves.

I shall review the major findings first, and then proceed to smaller, less documented attributes. Not surprisingly, contradictory findings appear throughout the literature, which may reflect Connell's (1987) stated belief that there are more differences within the gender group than between the genders.

Two things, however, need to be noted before reading this review. First, it should be pointed out that much of the research reviewed is based on general computer games, not educational computer games specifically. It is the findings of these studies that many early designers have transferred to educational computer game design. Designers have tended to take what is popular in the mainstream of computer entertainment and simply transferred it across to the education market. It is important to note that the successful computer games in the entertainment marketplace are generally boy-oriented because they are the major consumers and spenders; it is the boys who are paying the dollars to feed the computer games industry. In the educational field we, as teachers, are hopefully not assisting the market to make money but rather to locate and purchase those software packages that can assist all our students perform and achieve in their education.

Second, it must be acknowledged that the majority of the research I am reviewing has been conducted overseas and may not be directly relevant to Australian conditions and circumstances. Welch (1987) cautions us about taking research findings in other countries too literally because of different cultural values and practices so the reader should take into account not only when the research was carried out but also where it was carried out.

Violence

I would like first to deal with the issue of violence and computer games in relation to my research. I firmly believe there is no place for violence or violent themes in educational software made available to school-aged children. However, having stated my position, it must be pointed out that there are some software packages available on the educational market that do contain violence, albeit of the cartoon or fantasy variety, and so this is a feature that must be investigated.[3]

The general thrust of the literature that investigates violence in computer games states that girls do not like violence and aggression (Butler, 2000; Glaubke et al., 2001). Cooper, Hall, and Huff (1990) reported from their review of earlier research that girls preferred a format without aggression or shooting action. This is supported by Dempsey et al., (1996a, p.2) who, in a two-year study of "adults playing relatively unsophisticated

[3] For example, in my two schools, several educational computer programs include comic violence. *Sim City 3000* has various monsters available to destroy a city that the player may have built; in *Aussie Maths Invaders* the player shoots down algorithms by typing the correct answer to the question and pressing <enter>; in *Phonics Alive! 2* the player blows up a sound blend when he/she identifies correctly the images that match the blend.

computer games", found that "active" games were perceived to be male games. Brunner, Bennett, and Honey (1998) found that girls preferred to persuade rather than conquer, indicating that violence and aggression were not desired parts of their game play. On the surface this seems quite straightforward and clear cut, however, the sample used by the researchers was small, only consisting of 24 adults "balanced by gender and profession". This is not an overly large sample, and so the conclusions drawn may be in need of other support.

In another study, Funk and Buchman (1996b) found that it was more the human violence that turned girls away from a game, whereas fantasy violence did not have the same effect. The researchers surveyed 357 American 7th- and 8th-grade students using a survey that allowed one of four numerical responses. These responses were statistically analysed to discover any areas of significance. In their study, it was found that girls and boys did not differ significantly on the total proportion of violent games identified as favourites, just in the style of violence. Girls indicated that violence of a fantasy- or cartoon-style, rather than human violence, was an acceptable part of their favourite games and did not turn them away from them.[4] Their research confirms the findings of Morlock, Yando, and Nigolean (1985), who found an identifiable difference between genders. In their survey of American college students, they reported that males preferred more violent and aggressive themes games, as well as fast action, and females preferred

[4] Funk and Buchman (1996a, p.222) described fantasy violence as "a story where a cartoon character must fight or destroy things and avoid being killed or destroyed while trying to reach a goal, rescue someone, or escape from something", and human violence as "a story where a human character must fight or destroy things and avoid being killed or destroyed while trying to reach a goal, rescue someone, or escape from something". Glaubke et al., (2001, p.8) describe this facet as comic and serious violence. They see "comic depictions of violence [as] those depictions portrayed in a humorous or playful context, often in a slapstick manner, usually with little or no harm to the victims(s). [It] is often accompanied by silly sound effects. Serious depictions of violence are more dramatic, often realistic in context and frequently results in harm to the victim(s)". I would like to restate there is obviously no place for human or animal violence in educational computer games.

more imaginative and fanciful style games that did not contain direct human-centred violence.

However, Morse (1995, p.16), citing unnamed research, is more explicit and direct in the language used in describing the relationship between girls and computer game violence. Girls do not like the idea of having to "kill" or "maim" on-screen opponents, rather, in the words of Schuster (in Glaubke et al., 2001, p.21) they wanted "high-skill, not high-kill". While the findings by Funk and Buchman (1996b) appear strong they were still derived using quantitative methods and, unlike my approach, did not actually ask the students what they thought but rather limited them to choosing a number to represent how they perceived certain aspects of computer games. Again, I see a chance to actually ask children what they think and to respond freely without constraints, being missed.

Boys, on the other hand, according to the research, appear to like violence and aggression in their computer games. Caftori and Paprzycki (1997), in a combination of Caftori's doctoral findings and an analysis of published literature, found that American boys like shooting, fighting, or killing games involving battle or space ships. De Jean et al., (1999) found in their extended observation of children interacting with computer games at a science exhibition in an American museum that boys gravitated toward the games that had violence as one of the main elements in the design, games which the majority of girls avoided.

However, when reviewing the literature for this section I found the premise of boys enjoying violence not convincing. A number of researchers quote other research in their introductions regarding boys liking of violence and aggression in computer games, research that had often been conducted in the mid-to-late 1980s, or cite popular computer games as evidence that boys like violence. Few have actually conducted first hand research on the matter of boys liking violence and aggression. It appears to have become 'a given' by being constantly repeated and quoted in introductions. For example, as evidence that boys prefer violence in their games, Canada and Brusca (1992) cite Wilder (1985) who, in turn, had cited Lepper and Malone (1981) regarding this aspect of boys' preferences. Cooper et al., (1990) cite Beyers' (1984) conclusion that boys liked 'blasting' things out of the sky. They also cite Fisher (1984) and Gilliland (1984) for support on this issue who, as can be seen, carried out their research in the early 1980s.

I am not saying that boys may not like violence and aggression in their computer games. Personally, I believe many do find that aspect of computer game playing attractive. However, in regards to the research I have reviewed, it appears that it is a case of if something is cited often enough it eventually becomes true. This could be of some significance, as well, in terms of what elements are needed in an educational computer game for boys. If it can be shown that violence, either fantasy or human, is not an essential element of enjoyment for boys it allows a greater array of software to be made available that could support both boys' and girls' preferences; more inclusive programs rather than exclusive of one gender or another. I think it will be interesting to see if there is a difference in my students, first, if violence is in fact mentioned, and second, if it is mentioned what style of violence they identify as being a preferred attribute of the games they play, or if in fact violence and aggression is a prominent feature with the majority of one group or another.

From this literature I would put forward the inference that the presence of fantasy violence will not turn girls away from a computer game, however human violence is likely to.

Setting or Scenario

Researchers have put forward the idea that video and computer games can be an extension of the play area of children. Jenkins (1998), in his essay on play spaces and gender, reviewed literature that researched the area of play in which boys and girls moved about, and found that historically boys, in general, used more physical space to play in their house and around their neighbourhood than did similar aged girls, and that this play space has become slowly restricted in recent years due to the proliferation of medium- and high-density living. The use of computer games to take the place of the supposed play space is a central theme in his essay. He postulates that many city children mediate their adventures through computer games and gives this as one reason why boys may prefer games that have adventurous and exciting locations as their game setting. The type of settings preferred by girls and by boys is well described in the literature.

Girls have shown a preference for certain scenarios, or settings, for computer game play. A fantasy setting appears to be a strong attraction to girls. Funk and Buchman (in Cesarone, 1998) indicated that American girls strongly preferred a fantasy setting and in another study found that girls were more likely than boys to list fantasy games as their favourites (Funk & Buchman, 1996b). The fantasy scenario is indirectly supported by Martinez (1992) who modified science experiments to include a fantasy scenario and found that, in general, American middle-school girls' interests were engaged.

Brunner, Bennett, and Honey (1998), reported that girls enjoyed adventure and mystery settings in the computer games they preferred. They put this down to the fact that most mysteries have a complex plot and what they described as 'intelligent' action, in contrast to the normal mindless action that is often found in computer games. They reported that the action the girls preferred was directly related to solving the mystery and did not involve harming other living things. Neumark (1991) also supports these as attributes favoured by girls from her interviews with Australian Year 7 girls. Related to this style of scenario is the detective-based mystery where the player can take the part of a detective trying to solve puzzles. The success of the *Where in the World is Carmen Sandiego* (1996) series of educational computer games, where the player takes on the role of a detective to track down the fictional criminal Carmen Sandiego, attests to this.

Gailey (1992) reported that the girls in her study were more likely than boys to play the fantasy-adventure scenario game than any other genre that she offered. In her study, Gailey looked at Nintendo games sold in America and how they were played by children. Her study only consisted of interviews with 21 adults and children, observations in game arcades, playing some games with some children, and surveying software shelves. She has explained clearly her findings, but I am not totally convinced with her conclusions in terms of the depth or rigour of her research. However, in her defence, other researchers have used her as supporting evidence for their own findings. Kafai (1995), in discussing Gailey's conclusions, interpreted this as the girls escaping to a world where they could succeed in their own right without having to face the sexism and violence that they are confronted with in most computer games. However, the use of a fantasy scenario does not exclude boys. Scott, Cole, and Engel (1992) put forward that boys also enjoy fantasy scenarios.

It is not just the fantasy scenario, though, that appeals to girls. Glaubke et al., (2001), in their analysis of published research, found that girls also preferred realistic settings in the computer games they enjoyed playing. They put this down to the girls wanting to be able to relate what they were doing on the screen to their real life. This finding is supported by Kafai (1996). In her study, where she asked American children to design their own computer game, she found that six out eight girls based their design around real-life settings in contrast to the boys who, seven out of eight times, set their design in a fantasy world. Laurel (in Subrahmanyam & Greenfield, 1998) found that in their imaginative play, American girls enjoyed playing out the lives of real people within familiar social settings, using available props to enhance the play. To Subrahmanyam and Greenfield, this suggested that girls would probably prefer computer games they interacted with to be likewise set in realistic social scenarios. They went further and stated that computer games "set in imaginary worlds would not make contact with the fantasy life of the typical girl" (p.57).

Research looking at boys' preferences in relation to the game scenarios indicated more robust and action oriented elements, albeit still in the realm of fantasy. Caftori and Paprzycki (1997) reported that boys enjoyed a space background in their game choices. When Kafai (1995) asked boys to design a game she reported they liked adventures set in a background of hunting other creatures or people and subsequently rescuing hostages or returning artefacts.

The literature on scenario preferences of girls provides a good illustration of the contradictory conclusions the research provides. One group suggests that girls will respond positively to fantasy/imaginative scenarios, while a second group states that it is the realistic setting that appeals to a girl's imagination and, in fact, the use of a fantasy scenario would detach the girls from the game. In my view, the research does not allow me to state with any confidence what the girls' preference would be in relation to the setting of a game that would appeal to them and encourage their play and enjoyment. All the studies derive their conclusions from what appears to be sound methodology and data generation. I am hoping the data I have generated will be able to answer this question for me in relation to my students in my schools.

Feedback

The literature indicates that girls prefer a different type, or style, of feedback than do boys to indicate their success or otherwise during computer game playing. In 1991, Hall and Cooper conducted a study where they analysed the writings of 63 first-year American college students that described two interactions with computers, one successful interaction and one unsuccessful interaction. They inferred from the analysis of the pieces of writing that girls liked to know the computer personally, rather than treat it like an impersonal object or artefact. Hall and Cooper felt that this feeling of knowing the computer enhanced their experience and confidence with the computer and the software being used. They believed the style of feedback that the girl player received assisted in putting a 'human face' to the computer, making it more human-like. They did not mean that an actual face need appear in the feedback sections, just that human-like attributes could be designed into the feedback interface.

Earlier, Cooper, Hall, and Huff (1990) cited research that reported girls preferred verbal feedback to indicate how they were going when playing a computer game. This would relate to Hall and Cooper's (1991) suggestion of interacting on a human level with the program. Interestingly, Cooper, Hall, and Huff (1990) found that boys preferred non-verbal feedback or graphical feedback. They wanted the computer to show them graphically, and probably finally, that they had either succeeded or they had failed in the task that was set for them.

Kafai (1995) also identified a difference in the style or form of feedback preferred by girls and by boys. In her study, she asked students to design their perfect computer game and noted what elements were selected by boys and by girls. After analysing the different design elements in the games Kafai identified that girls designed their feedback in a non-violent form. If a player provided a wrong answer or performed an incorrect act they were deprived of something that could help them in the future playing of the game or they were required to start over again. There was no death or violence involved in the feedback.

This finding was supported by Miller, Chaika, and Groppe (1996). In their study, a series of focus groups, involving 30 American girls between 11-years and 17-years-old, were used to find what they wanted and liked in computer games. The researchers inform the reader that the group of girls used in the study were self-selected when they answered an advertisement regarding the research and so acknowledge that they may not be a true sample of the population as a whole. However, the responses they received in the discussions and written responses did prove uniform across the group of girls and they felt confident in their findings, one of which indicated that the girls did, indeed, prefer feedback to be of a gentler nature than the 'get it wrong and you die' style seemingly associated with boys' playing preferences.

This style of feedback preferred by the boys was identified by Kafai (1995). She found that when boys included feedback into their game design it was generally of a violent nature involving the player either dying or transforming into something else. In many ways this style of feedback reflected a boy's propensity for the trial-and-error approach identified by Subrahmanyam and Greenfield (1998). They reported that boys preferred this instant feedback; they knew straight away whether something was right or wrong. If they passed they continued playing, if they failed the game ended. Their conclusions were the result of what they claim was ten years of research on the effects of video games on cognitive processes and so, I believe, can be accepted with confidence.

Glaubke et al., (2001) found that girls preferred positive feedback, particularly when it was unsolicited and appeared randomly during the game. In their focus group-based research on games and game features that girls preferred, Miller, Chaika, and Groppe (1996) found that positive feedback during a game provided a fun feel for them and helped them enjoy the overall gaming experience. Morse (1995) supports both Kafai (1995) and Miller, Chaika, and Groppe (1996) when she states that girls are more impatient with games in which players 'die' if they fail to find the one single solution or make the perfect move at the critical time. They want to be able to continue the experience, not to be cut short and expelled from the game. The negative feedback of dying appears to appeal only to the boys.

The literature is telling me that my girls should identify a preference for non-violent, verbal and supportive feedback that allows and encourages them to continue playing the game.

Texture of the Game (Aural and Visual Aspects)

In an interview with Heather Kelly, the director of on-line design with the computer software company *Girl Games*, Cassell and Jenkins (1998a) are told that girls enjoy a rich texture of game elements. The elements that make this texture are high quality graphics and sound. Miller, Chaika, and Groppe (1996) also found this in their focus group interviews. They found their subjects placed a high value on the visual and audio design of the game environment, describing how they wanted a multi-sensory environment within the game that would enhance their enjoyment. In reading, illustrations play a major role in motivating readers to pick up, browse through, and read books (Duchastel, 1978), therefore it should not be surprising that the graphics of a computer game would play an important part in motivating players.

In a study carried out by Jakobsdottir, Krey, and Sales (1994), in which they examined the preferences of 316 American Year 2, Year4, and Year 6 students in relation to a set of computer graphics that were designed to exhibit either high female interest, high male interest, or equal interest, it was found that large and detailed graphics that incorporated people, animal, and plants were favoured by girls. Passig and Levin (1999) back this up with data from their study of American Kindergarten students and interactive multimedia stories. They observed that girls found the visual aspect of interactive multimedia stories much more interesting and stimulating than did the boys. The use of colourful scenes was found to interest and motivate the girls more than the boys.

A variety of scenes was also identified by Dempsey et al., (1996a) as being important to women. In their study on the use of simulation games as an instructional tool, the female adult participants believed that there was not enough variety in the screens used in the simulation games, and stated they found the experience boring and did not capture their interest or attention. Although this study was carried out with adult subjects, it may be transferable to primary-aged girls. However, it is important not to dismiss out of hand the importance of the texture of a game in relation to boys. Kafai (1995) reported that, in their game design, boys showed a desire for sophisticated graphics and animation, important and essential ingredients in any texture-rich game environment.

Colour plays an important part in making a computer game enjoyable for girls. Jakobsdottir, Krey, and Sales (1994) reported that Year 2, Year 4, and Year 6 girls placed an emphasis on colour, and not just primary colours. They preferred shades of colour, as well, to add to the playing environment and the girls seemed to prefer brighter colours over darker colours. How the colours are used with each other appears to be important, also. Freedman (1989) found that girls were not only more concerned and interested in colours than were the boys, but also on whether the colours used actually went together and produced a pleasing picture.

Interestingly, Cassell and Jenkins (1998a) reported in their interview with Heather Kelly that it was found that older girls, 12-to13-year olds, did not care for pink. Even though they did not mind the colour in itself, they saw it as a 'young' colour and so would rather not have it dominate the game environment. This was in contrast to six-to-seven-year old girls who did like pink. Therefore, even though colour is important to girls, it is the right colours that have to be used. It will be interesting to see if pink gains any special mentions in my interviews and if it does, whether there is an age element involved.

Graphics and colour have been identified in the research as important aspects of girls' preferences in regards to the texture of games. However, the other element of game design, audio, does not appear to have been looked at in the same depth. Malone and Lepper (in Wilder, Mackie, & Cooper, 1985) found that girls liked music in computer games whereas boys did not regard music as important to their enjoyment. Henney (1986) put forward that boys liked the 'noise' a game made, however this noise was in the context of the action of the game so probably referred to sound effects rather than music. Cooper, Hall, and Huff (1990) found in their review of the literature that girls, unlike boys, generally wanted music to be part of the game that they were playing. Kafai (1995) reported that girls were interested in the sounds made by a program, but did not specify if they were musical sounds or sound effects.

However, having music in a game did not necessarily enhance girls' enjoyment of the game. Fiore (1999), in data derived from her earlier doctoral research, found that American girls often found the music used in games boring or irritating. She found that girls disliked the droning and repetitive sounds that were commonly found on computer games that they had encountered, describing the lack of aural variety as off-putting, unexciting, and adding nothing to the enjoyment of playing. This finding was also backed up by Miller, Chaika, and Groppe (1996) in their focus-group discussions with primary aged girls. It would appear the type or style of music may be important to girls, possibly more than it is to boys.

As much of the research related to texture in game design is several years old it could be open to more discussion today because of the sophistication of today's computer games. The early days of computers and computer games saw mainly mono-sounds broadcast through a small, internal computer speaker. Many games now come with digital and multi-channel soundtracks, often featuring current popular music that can be played through relatively sophisticated speaker systems. This would allow a much greater immersion into the game environment than would have been available when much of the research reviewed was carried out. I would expect my data to reflect the availability of modern music in computer games and the desirability of having it as part of a game environment.

However, as with most of the literature that I have found, there is an alternate voice to be heard. In a study that investigated 11- and 12-year-old children's views of educational software designed by other children, Rieber et al., (2001) reported that the children did not mind if a game presented basic graphics and sound if the game's premise was one that interested them. They put forward that the children "recognized the importance of a game's "deep structure" over that of surface features such as graphics and sound" (p.11) in relation to making the game enjoyable. This study appears to be a lone voice reporting this but in reading many of Rieber's American-based research papers I have come to respect his opinion and views and so, although I feel the weight of the literature is against him, it is a voice that should at least be acknowledged.

Narrative

Stories and children are two things that go together seamlessly. Studies by Gee (1996) and Labov (1979) tell us that by the time children enter school the vast majority of them have a deep understanding of stories and how they are structured. Stories allow children to make connections between events, objects and actions that need to be carried out (Amaro & Moreira, 2001) and assist them in making sense of the multiple events that are constantly happening around them. This requirement for sense making should continue into the realm of the computer game, with the game using the story as a device to bind the activities that the player has been asked to perform and to enhance the enjoyment derived from the playing.

A strong narrative behind the game is indicated by the research as being an element that appeals to many girls. De Marle, the chief narrative writer of *Myst* (1993), (in Polak, 2001) puts the success and popularity among female gamers of that game down mainly to a strong narrative that allowed the players to become immersed in the game. Even though set in a fantasy world, the storyline was consistent and believable for the player, enabling belief to be suspended. A number of other researchers have made this same observation for the need of a strong, complex, and in-depth narrative. Miller, Chaika, and Groppe (1996) reported that the girls in their focus group sessions indicated a strong desire for a storyline. Miller was quoted in a later interview (Krantz, 1997, p.76) saying, “girls don’t think boys’ games are too hard: they think they’re too stupid”. When most ‘boy’ games seem to rely on fast-response and a quick finger on a joystick, it can be seen that girls who desire a story to lead them along and draw them in are going to be dissatisfied and turned-off.

Laurel (Cassell & Jenkins, 1998c) found in her market research that girls were attracted to complex narratives that were the driving force behind game play, making that style of game popular with them. De Jean et al., (1999) reported in their observations of how children interacted with video and computer games in a hands-on science museum exhibit that girls were much more interested in the games that had a story behind it. Murray and Kliman (1999) report in their review of the literature that girls want in-depth narratives to be the foundation of the games they choose to play.

In terms of boys and their preferences, the same research usually states that boys do not have an interest in the storyline of the game they play and, in fact, sometimes find that the storyline is an optional extra and may, in some cases, interfere with getting on with the game.

Further evidence regarding the importance to girls of the narrative and characters that could be found in a game is presented by Inkpen et al., (1994). They reported that in their interviews with girls who played computer games at home, many could not name the games they played, or how many games they actually owned. However, they could give detailed recounts of the storyline, the personalities of different characters, and describe the relationships between those characters. Obviously, they became engrossed in the story provided by the designer.

In relation to the narrative element I would expect my data to show two things. First, girls indicating a preference for programs that demonstrate a narrative as being an integral part of the game, and second, the presence of a story underpinning the game they have been asked to construct in their minds for other girls. I would expect the presence or otherwise of a background story to a game as not being an important element put forward by the boys in the same questions.

Characters and Avatars

The ability to identify with a character or characters is an important consideration I keep in mind when selecting stories to read and share with my students. I believe that the potential for empathising with a central character can enhance the pleasure and experiences in reading with my students. In software, a similar situation is found.

Friedman (1995), in an essay on interacting with games software, puts forward the view that rather than simply watching the ‘hero’ the player can actually be the hero. Demaria and Mascio (2001) point out how the interactive nature of computer games, with the player being continually prompted to make choices, permits greater identification and stronger relationships with the game characters. Therefore, if a computer game does utilise a character, then designing a character that can be readily identified by a player could be an essential part of successful engagement with a computer game.

In research carried out during the 1990s, it was found that female characters still featured less than male characters in educational software aimed at American primary schools (Biraihmah, 1993; Hodes, 1996). How this may effect girls using educational software is not clear when the literature is analysed because the results dealing with the gender of characters found in computer games and girls’ preferences is ambiguous. In their research results, Jakobsdottir, Krey, and Sales (1994) recommended designers of computer games include female characters if they wanted the graphical aspect of any game to appeal to girls. Littleton et al., (1998) reported that it was apparent that many of the girls in their study identified with the female characters being used in the ‘girl’ version of a computer game, unlike the boys where no personification of the characters was evident. This probably reflects what Agosto (2003, p.28) proposed when she said that “girls tend to engage more when they see some aspect of themselves, such as a protagonist of similar age...reflected in a computer program”. She went on to say that girl characters can “bolster girls’ feelings of assurance and self worth” (p.31).

This is supported by both Glaubke et al., (2001), who found in their study that girls liked to have player-controlled characters that were female, and De Jean et al., (1999), who found that their female research subjects enjoyed playing a game where they could identify with a similar-aged, computer-generated female protagonist. Also, this reflects work carried out by Neumark (1991), who interviewed Year 7 girls in two Sydney high schools about what they would like in a comic that introduced girls to computers in a friendly and positive fashion. She found that having a group of girl characters, like themselves, was a popular and oft-mentioned element. Although not directly related to software, it does point out that girls identify positively to girl characters in material that is designed to encourage their participation in an activity.

However, it would appear, though, that girls did not want the characters to be stereotyped. Fiore (1998), in her EdD research, reported that girls did not want their characters to be all skirts and pastel shades, with their activities restricted to 'girls' stuff'. They wanted their avatars to be adventurous and sporty, not docile and domestic. She reported some girls also wanted the choice of selecting either a girl or a boy as the main character.

The results of this research probably reflect Libby and Aries (1989) findings from an analysis of the fictional stories of 42 girls and boys where they found that the girls introduced female characters more often than boys did. McDonnell (1994) agrees with this, asserting that "girls have traditionally been absorbed in female-centred stories" (p.67). This may indicate that girls like to see a protagonist that they could perhaps identify with in their narratives. I do not believe it is a big step to transfer that finding to a computer-based narrative or game and this view can be supported by Littleton et al., (1998). In their report of the development of an educational computer game dealing with mapping they found that the girls performed far better in a version that had female characters than in the version that had male characters. They concluded that many of the girls identified with the female characters, more so than the male characters.

However, the lack of female characters within a computer game may not actually turn girls away from it. In a study by Chappell (1997), the hypothesis was put forward that girls' attitudes toward a computer software game are negatively affected by the under-representation of female characters. From the results of the study, Chappell concluded that the hypothesis could not be supported. The absence of female characters did not affect the girls' attitudes toward the program. Further support for this conclusion is provided by Joiner et al., (1996). In their study, involving 65 English children (31 boys and 34 girls aged between 10- and 11-years) they reported similar results when they changed the gender of characters in a computer game to see if they could detect a difference in performance between girls and boys. They found that in relation to performance on the game boys did better than the girls regardless of what gender was represented by the characters and that the girls' performance, regardless of the gender of the computer characters, did not significantly differ. Once again, however, this conclusion was derived from statistical analysis of responses that the children supplied using a scale of 1-5 on a questionnaire. No provision was made for the children to explain why they chose a particular response, a weakness some researchers see in this type of data gathering instrument; they were bound by the responses provided for them by the researchers (Morse & Daiute, 1992). As I have discussed before, it is a shame they simply did not ask them what they thought about the characters, allowing them to express themselves in their own words instead of words selected by the researchers.

From this, it is difficult to state one way or the other regarding the desirability of having female characters in a game in order to enhance girls' enjoyment and success. However, regardless of the gender of the characters used, there are other aspects on which the literature may be clearer. In research conducted by the software company *Purple Moon* (Purple Moon, n.d.), which was based on "thousands of hours interviewing girls and boys nationwide" (p.1), it was found that the type of characters preferred by girls and boys differed significantly. Girls preferred their leading characters to be everyday people that they could easily relate to and are as real to them as their best friends. Boys, on the other hand, wanted their leading characters to be fantasy-based action heroes with super powers.

In their interview with Brenda Laurel, the co-founder of *Purple Moon*, a computer games company that design games for girls, Cassell and Jenkins (1998c) describe how she found in her research that girls wanted multiple characters in the game, characters with which the player could develop a relationship. Just having one character, and no others to interact with, did not appeal to girl players. Also, she reported that the girls wanted complex characters. They did not care for the one-dimensional, stereotypical 'sexy' female presented in many computer games. They wanted characters that had some emotional depth to them; depth that could be discovered during the playing of the game. Laurel did not specify that these characters must be female, just to have aspects about them that the girl player could discover. She found that girls were very positive with the diversity of characters that her company was supplying in their games. Laurel's findings are reflected in research carried out by Klawe et al., (1996) who found that girls wanted to get to know the characters in the game *Phoenix Quest*, a program that was being developed as an educational game that both girls and boys could enjoy equally.

From the literature I am not entirely sure what to expect from my data. Personally, I would think that the girls will indicate a preference for female characters in the games that I ask them to design in their imagination. I would hope this is so because the message that is being sent by many computer games is that only males can be adventurous and the only role a female can have is one of helpless victim in need of rescuing. This type of presentation can lead to stereotyping of women as being weak and victims whom are always in need of male support, a situation that should be neither encouraged nor tolerated.

Collaboration/Cooperation and Competition

The theme of collaboration/cooperation versus competition appears regularly in any discussion of girls interacting with computers and is one area where there appears to be a clear divide between girls' preferences and boys' preferences. Generally, it is believed that girls are socialised to cooperate more than compete (Unger & Crawford, 1992) and a preference of girls for working together is one of the few gender differences identified in the research on gender and learning styles (Severiens & Ten Dam, 1994). This situation appears to extend to software preferences for I have found the literature on girls' preference for software that promotes cooperative and collaborative play is consistent. Girls prefer software that allows them to play with their friends in a cooperative manner rather than in direct competition against them.

A number of studies I have reviewed provide support for this statement. Elliot (1990) found in a study involving Year 7 and Year 8 girls that they preferred to collaborate on their projects with their friends, rather than work individually. Even though the subjects of the study were slightly older than my students, the conclusions can, I believe, be transferred to the younger age group. Hawkins (1985), in earlier work that incorporated activities using word processors, found that the teachers in the study reported girls liked the collaborative facet of constructing a story together, via a word processor, with their friends. Other work carried out by Henney (1986) in an Australian primary school support the preference of girls for collaborative and cooperative attributes in educational software.

In a paper detailing the development of the game *The Logical Journey of the Zoombinis* (1996), Rubin et al., (1997) found the attribute of cooperation a popular element of the game. Students reported that being able to discuss with a friend how to get past a particular problem in the game was one of the best parts of playing the game. Interestingly, boys, too, liked this aspect of the game design. De Marle (Polak, 2001) also places cooperative play as one of the reasons for the success of the adventure-style game *Myst* (1993) has had with female gamers. When Hawkins (1987) examined the role of nature, nurture, and society at large in influencing girls use of computers it was found that the characteristics of the task that had been set strongly influenced the amount of time the girls used the computer. She reported that the mathematics and science software the girls preferred were those programs that allowed them to work cooperatively with others. Also, they were observed to spend more time on the computer when using them. I view Hawkins' findings as strong. Like myself, she conducted in-depth interviews with students in classrooms (8- and 9-year-olds in one class, and 11- and 12-year-olds in another class), as well as following their progress over a two-year period. She also used quantitative instruments to measure the students' progress with the software.

It would appear that the desire to play in a cooperative mode is strong in girls. In her interview with Cassell and Jenkins (1998c), Brenda Laurel, from the software company *Purple Moon*, describes how she was surprised to observe girls playing collaboratively with programs that were actually designed for single play. She felt this indicated the strong desire of girls for programs they could play with their friends and hence influenced how she programmed the games for her own company. This observation may reflect the strong social orientation of girls that Miller, Chaika, and Groppe (1996) found in their focus-group based research into girls' preferences. They found girls identified scenarios such as career explorations in real life simulations, interactions with virtual reality males, and soap opera/talk-shows with girls being able to decide the fate of the characters as popular choices. Miller and her team put forward that all these represent a social or people oriented scenario that could be discussed with friends during the play of the game.

Similar results were reported by De Jean et al., (1999), when they related their experiences in developing and play testing the computer game *Phoenix Quest*. They found that the majority of girls stated that the social interaction allowed by the program was a very desirable and welcome feature. Murray and Kliman (1999) also report that girls find social interaction an important feature of computer game play. If a software package can encourage this kind of interaction through the way it is designed and presented it may help in encouraging girls to use and enjoy it. This is an aspect of computer and software design Chen (1986) called for so early in the academic discussion of girls and computers. If girls perceive that computer work is necessarily isolating and interaction with others is not encouraged by the software, it may be possible to persuade them otherwise by using software that overtly encourages peer collaboration and cooperation.

The flip-side to this aspect of cooperation, collaboration, and social interaction is competition. Would the presence of competition help or hinder a girl's enjoyment of a computer program? General evidence regarding this may be found in the work carried out by Lenney (1977). She argued that men and women react to achievement situations differently and her analysis of adult performances indicates that women's self-confidence seems to be affected by specific task characteristics. She presents evidence that women are more likely to express confidence in tasks that feature social, collaborative tasks rather than competitive tasks.

In a meta-review of literature documenting the existence of a technological gender gap, Canada and Brusca (1992) put forward the idea that it is not computers and technology per sé that females avoid, but rather the competitive male environment that surrounds the field. Unfortunately, their report is basically a narrative, and they do not give any indication of the research design in the studies they analyse making it difficult to judge the reliability of their interpretations and conclusions. However, other studies may provide evidence to support this view.

Arch and Cummins (1989), in what I see as a methodologically sound study that involved a small group of first-year college students, found a distinct difference between males and females regarding the preference for an element of competition in a computer game. They showed that the males were more likely than females to indicate that competition was an essential aspect of any computer game. In another study, Swadener and Hannafin (1987) interviewed a group of 32 randomly selected Year 6 girls and boys who were asked to complete a questionnaire. A statistical analysis was carried out on their responses and one finding indicated that boys demonstrated a more competitive attitude in a computer situation than girls. However, they concluded that the difference was not statistically significant.

The majority of the literature I reviewed would indicate that the element of competition would, generally, discourage girls from using a particular program. Kelly (Cassell &

Jenkins 1998a) maintains that girls do not like competitive elements in computer games, and they identify such attributes as being male and therefore not suitable or desirable for them to be associated. In studies of early, relatively unsophisticated computer games, it was found that the common way computer games were designed encouraged players to repeat cycles of competitive, aggressive behaviour, which is behaviour that girls often do not care for (Lockheed, 1985; Serbin, Powlishta, & Gulko, 1993). Perhaps the fact girls do not play as many games as boys was put in place from the very beginning of the mass marketing of computer games.

As mentioned earlier in this discussion of cooperation versus competition, it is an area where there appears to be a clear cut division between girl and boys. A number of reports indicate that boys find competition an essential part of a computer game. Klawe et al., (1996) found in their development of *Phoenix Quest* that the majority of the boys were only interested in the more competitive mathematics puzzles - puzzles from which they could gain points. The girls, on the other hand, were more interested in writing notes to 'Julie', a female character in the game. They concluded the boys were learning the mathematical concepts being presented by the game while the girls were, in many ways, wasting their time communicating with a game character and missing the educational point. Yelland and Lloyd (2001) put down the desire for competition in a computer game as being a reflection of boys' participation in physical sports and other games.

Nicholson et al., (1998) conducted a study that observed over a six-month period a class of Year One students composing stories on computers. They found that girls preferred collaborative work in their story composition, and when they composed together, they tended to support and encourage each other and find ways to incorporate everyone's ideas and suggestions. In contrast, the boys were observed to make the writing process a competitive one by comparing stories and identifying differences in a competitive manner. Morse (1995) cites unnamed research as saying when boys and girls play the same game they play it differently, with boys preferring to compete against one another while girls will work cooperatively to solve the problem or complete the game. Further evidence is provided by Shade (1994). In this study, 72 children aged 4 to 8 were videotaped playing a variety of educational software. The observations were later coded and analysed statistically for any significant responses. The results of the analysis found that boys were more excited than girls when they were interacting with drill-and-practice software that had a competitive element such as score keeping or time limits. Shade felt this may explain why boys seemed to be more interested in what he described as 'low-level' drill-and-practice software, for competition is often a central feature of that style of software design (Clements & Nastasi, 1992; Clements, Nastasi, & Swaminathan, 1993).

A subset of the competition element of a game is trying for a high score. What I have written above may indicate that girls do not care for gaining points while playing a game. Points would not seem to lend itself to cooperative play. However, the literature does shine some interesting and contradictory light on this point. Beyers (1984), Fisher (1984), and Gilliland (1984) all report that boys like having point accumulation as a feature of preferred computer games. On the other hand, Caftori (1994), in her doctoral study of K-Year 3 children and mathematics software, found that the number of girls who strived to achieve the highest score equalled the number of boys attempting the same. The inclusion of point accumulation did not turn the girls away from playing the games. Malone (1981) maintains that a score-keeping feature in a computer game can be a motivating feature for all players, regardless of gender.

Winning the game does not appear, though, to be the 'be all and end all' for girls. Brunner, Bennett, and Honey (1998) believe it matters more to the girls what they win or lose rather than whether they win or lose. To them, it would appear that the girls were not interested in mastery over the game or the computer, but rather interested in the enjoyment gained from actually playing the game. I think this observation of girls not placing high importance on winning, rather the journey that arrives at winning, reflects

Turkle's (1984) book, *The second self*, that differentiated between 'soft' and 'hard' mastery styles among children using computers.

Turkle described 'soft mastery', the approach she believed girls generally took, as being an interactive, close, and personal relationship between the user and the computer, while 'hard mastery', the approach she believed boys generally took, involved a greater distance between the user and the computer. To the boys, it was a tool, an object, to be used to gain something. Basically, she put forward that males want to master the computer while girls want to explore with it. Evidence for this may be gained from Passig and Levin's (1999) study on the use of multimedia interfaces, where they reported that boys wanted control over the computer and to 'dominate' the program. Dalton (1990) reported that the boys were most happy when they controlled the pace of the lesson being taught by an interactive learning program, again an illustration of the boys' desire to control the activity.

However, there is evidence that competition does not turn girls away from playing and enjoying a game. In the study by Chappell (1997), the hypothesis was put forward that girls' attitudes toward a computer software game are negatively affected by the inclusion of competition into the game design. From the results of the study, Chappell concluded that the hypothesis could not be supported. The inclusion of a competitive element did not affect the girls' attitudes toward the program. Signer (1992) reported in her study of cooperative learning strategies using computer-based materials that competition between student groups kept interest high for all students involved in the study. However, notwithstanding these findings, the preponderance of the literature indicates that girls do not prefer competition in their games and would rather have attributes that encourage collaborative and cooperative play. I would expect this conclusion to emerge from my data.

Speed of the Game

The preference of boys for competition and the preference for cooperation for girls that the literature appears to indicate flows on to the attribute of the speed, or pace, of a computer game. Speed of game play is another aspect of game design where the literature indicates there is a difference between the preferences of girls and boys. Generally, it has been shown that girls prefer a slower, more even-paced game play in comparison to boys. Polak (2001), in talking with the chief narrative writer of one of the biggest selling graphical adventure-style computer games, *Myst* (1993), found that games that did not rely on timed responses but rather allowed a leisurely pace to the play, appealed to women. He believed this was shown to be true by the number of women who were reported to have purchased and completed the game. Murray and Kliman (1999) also reported a similar finding in their review of the research carried out for their study. They concluded that girls prefer not to have a time limit for completing a game, rather an unlimited time to explore all the facets of the game at their leisure and pace. Brenda Laurel, founder of the girls software company *Purple Moon,* found, and she admits it was to her surprise, that girls did not care for "beating the clock" in their game choices (Cassell & Jenkins, 1998c, p.122).

In their work on the problem-solving game *Logical Journey of the Zoombinis* (1996), Rubin et al., (1997) found that girls did not like the idea of a time pressure facet in the game. They needed time to think, discuss, and reflect on the problems presented by the program. Forcing them to rush made the game unenjoyable, and reduced it to a trial-and-error approach. Inkpen et al., (1994) believed that the presence of a speed factor prevented social interaction between the players, as they had to concentrate on the game, not the friends they were playing with, therefore, they concluded this did not suit the more social oriented girls, but rather the boys.

This echoes the work of Scott, Cole, and Engel (1992), who reported that girls did not like fast-paced games, rather preferring a slower pace. The research carried out by

Caftori and Paprzycki (1997) and Kafai (1996) support this view. They, too, observed that girls preferred a slower game in terms of what is happening on the screen. Glaubke et al., (2001) agrees on this point also, however they do point out that not all girls wanted just a slow pace to the game, but a variable pace that they could control themselves as players, rather than the pace being dictated by the game.

Of course, as is becoming common in this review, other research has arrived at a different conclusion to that of Glaubke's group. Dalton (1990) found that girls wanted the pace factor taken out of their hands and given to the program to control the speed of play, whereas boys wanted to control the program in terms of pace. Dalton did not report whether this program-dictated pace was slow or fast.

The slower pace of the game that has been reported as being preferred by girls can perhaps be explained by the research of Scott, Cole, and Engel (1992) when they reported that girls preferred to have time to reflect on problems and solutions, and to discuss their actions with others if they were playing with a friend. They wanted what Passig and Levin (1999, p.181) described as a "calm game", a game that did not rush them and made them make hasty or ill-considered decisions.

The literature certainly describes a different picture in regards to boys and their preferences in relation to game speed. In Klawe et al., (1996) where they report on the development of the adventure game *Phoenix Quest*, it was stated that boys wanted fast-paced action as being an essential part of the game design. This conclusion is supported by the review carried out by Nicholson et al., (1998) in their work with Year One children and collaborative computer games. Both Caftori and Paprzycki (1997) and De Jean et al., (1999) report, too, that boys like a high-speed, fast-action game. Passig and Levin (1999) found that boys were more interested than girls in the pace of a game. I was unable to find any research that indicated boys preferred slow-paced games over fast-paced games. This may indicate a definite schism between girls and boys in relation to speed although Caftori (1994, p.249) did report, in contradiction to her own literature review, that the girls in her study enjoyed a "fast-going" game as much as the boys did.

In relation to the attribute of the speed, or pace, I see the literature as overwhelmingly indicating that girls prefer a slower, or user-controlled, pace to the game. However, I believe there could be room for faster action without completely alienating the girls. Perhaps to make a particular game popular with both boys and girls, the ability to change the pace of the game may be a desirable feature of the game design. Overall, I would expect my data to indicate that the girls will prefer slower paced games compared to the games identified by boys.

Activities

The type and number of activities appears to have an affect on girls' attitudes towards a program. Kafai (1995) found in the games designed by girls, multiple activities was a key feature. It seemed that the girls did not want a game to centre around one type of activity but rather a number of different activities that the girls could move between as and when they wished. Other research agrees on this point; Murray and Kliman (1999), who cite unspecified research pointing to girls preferring multiple activities, Westrom and Super (1995), who found in their first-hand research that girls wanted multiple activities that they could quickly go back-and-forward between during the time available to play, and Klawe et al., (1996), who also found girls' preference for multiple activities in their game development program. To the girls, the activity was the point, not winning the game. They wanted, as Hall and Cooper (1991) point out, to achieve something apart from winning.

The type of activities also appears to be important to girls. Cooper, Hall, and Huff (1990) cite various research that indicates girls want activities that have a purpose and that can be completed. Again, it is not a case of playing the game for the sake of playing. Something needs to be achieved. Morse (1995) describes how girls also prefer multiple solutions to the activities and problems that may be posed by the computer game. They do not wish to be backed into a corner or hemmed in by a single solution as dictated solely by the person who programmed the game (Cassell & Jenkins, 1998a; 1998c). This may reflect the observation of De Jean et al., (1999) that girls liked problems that could be solved with creative and unusual solutions. Interestingly, Dempsey et al., (2002), in their investigation of how a selection of 40 games were played by males and females, found that more females than males felt it was not important to complete the games successfully. This seems to be at odds with Cooper, Hall, and Huff's (1990) findings. This reflects the contradictory results that much of the literature has presented to me.

Unusually, the literature that I reviewed for my study does not illuminate what boys may feel in terms of multiple activities within a particular game. The only mention is by Hall and Cooper (1991), who put forward the observation that boys will play a computer game for its own sake - they simply want to be entertained. Achieving something other than the derivation of pleasure does not appear to be a priority to them. In a general pointer towards the desirability of incorporating a variety of activities within a game design is the research carried out by Lincoln (1995), who believes that because "children are the primary stakeholders in their own learning processes" (p.89) it is possible to enhance their intrinsic motivation by empowering them in the sense that they are able choose what they learn and in the ways in which they learn. Giving the student a range of activities within a game design, which on the surface conveys to the student a sense of control over their learning, may possibly increase their motivation in that particular learning situation.

Overall, the literature does indicate to me that my girls should show a preference for games that have many different activities within the one program and I am interested to see if my data reflects this.

Instructions and Help

The ability to access instructions on how to play a game can have an effect on a girl's enjoyment when playing. In research carried out by Lancy, Forsyth Jr., and Meeks (1987) and Lancy and Hayes (1988), it was found that girls seemed less tolerant of the frustrations inherent in figuring out how to use a program. Not having easily-accessible and clear instructions proved to be a negative in their enjoyment. In follow-up work by Forsyth Jr. and Lancy (1989), where a software program that taught primary-aged children mapping skills was used, it was observed girls enjoyed the game. One reason the researchers put forward for this enjoyment experienced by the girls was the accessibility of the game. As they described it, the game was easy to 'get into', and there was an absence of frustration brought on by not knowing what to do.

Recommendations regarding instructions in relation to girls' use of a computer game were put forward by Glaubke et al., (2001). They suggested that instructions needed to be clear, precise, and available, and help to be readily accessible if further information was needed to explain the game play. These recommendations reflect the work carried out by Whooley (in Scott, Cole, & Engle, 1992), who found that girls preferred clear instructions for the programs they were using.

This is in contrast to what is seen as necessary for boys. Whooley (in Scott, Cole, & Engle, 1992) found that boys did not require the same depth of instruction as the girls wanted. If instructions were needed, the boys preferred short instructions that did not delay them unduly from returning to the game. Most times they were ready to use a trial-and-error approach in order to find out how to play the game. This was concluded by Greenfield (1996) when she stated that the average male computer game player may be more willing to "learn by acting before he understands all the rules...of the game" (p.88). Revelle (1984) reported similar findings, saying that boys tended to immediately engage in trial-and-error when trying to figure out a new game.

Research on the use of instructions, however, does not fully support the notion that girls will refer to instructions more often than boys. Carroll (1997) and Gery (1991) found that when a user has a question they often follow a predictable path to finding an answer. They will try and see what happens, ask another person, call the vendor, search in-game help, and lastly, read the instructions. Obviously, calling the vendor is not really a solution for students playing a game at school, but the other strategies would offer a solution to a problem. Miller, Chaika, and Groppe (1996) did describe how girls were often not motivated or interested in looking through an instruction manual that may be available.

In light of these findings, I would expect my data to show girls seeing in-game access to instructions and help as a desirable feature of a game. I would also think that one of the reasons they may give for not liking particular games would be because it was hard to understand, or too complicated. This may indicate that finding out how to play the game was not part of the game design and so frustrated the girls when trying to use it.

Challenge

According to Professor James Gee (Bedigian, 2003, n.p.), a proponent of computer gaming in education, challenge comes down to staying at the edge of what a player finds "doable" and thus creates "a sense of pleasurable frustration" within the emotional field of the player. The literature points to girls preferring a puzzle and problem-solving based genre in their computer games to provide this pleasurable frustration. Some observers relate this preference to the fact that problem-solving lends itself to cooperative and collaborative styles of play (Morse, 1995) and, as I have written above, this is a play style that girls appear to favour. Both Brunner et al., (1998) and Walter (1998) point out that girls much prefer to outwit a computer opponent rather than 'blowing it up' as boys may do, and they like the puzzles to be integrated in the narrative in a way that makes logical sense. They do not appear to like puzzles just for the sake of solving them.

Having a number of possible solutions is also important to girls. Bunderson and Christensen (1995) cite unnamed research that indicates girls like to have more than one possible answer to puzzles and problems faced in a game, which again lends itself to discussion and social interaction with other players. Rubin, et al., (1997) reported how they incorporated the idea of multiple solutions in their development of the *Logical Journey of the Zoombinis* (1996), a game that I know is mentioned frequently in the interviews I conducted. Both Caftori and Paprzycki (1997) and Cooper, Hall, and Huff (1990) report that girls enjoy word-oriented puzzles and word games. This may reflect the findings of Cassell and Jenkins (1998a) and Passig and Levin (1999) who reported that girls like to write or type input into a game. Interestingly, though, this is in contrast to the graphical-based, click-and-point problems presented in the *Zoombinis* series, which appears very popular with girls

Related to this is the process of how the solutions are discovered. Subrahmanyam and Greenfield (1998), in their discussion on what makes girls want to play computer games, believe that girls do not like the trial-and-error approach when it comes to solving puzzles. They prefer solutions that can be gained from observing what is happening in the game and to be able to use that information to solve the problem or puzzle logically. Trying different and haphazard solutions, often resulting in the game ending or the player 'dying' does not, as has been mentioned above in the 'feedback' section, appear to appeal to girls.

Other evidence, though, indicates that boys, too, enjoy problem-solving and puzzle-based computer games. In research under controlled conditions that involved 36 four-year-old children, Sherman, Divine, and Johnson (1985) reported that the both boys and girls overwhelmingly preferred problem-solving software over drill-and-practice software. They reported that problem-solving programs engaged all the children significantly longer than the other type. Similar findings were reported by Klawe et al., (1996) in their observations of boys and girls playing computer games at a museum exhibition. They noticed both the boys and the girls preferred programs that had a puzzle element that needed solving. This is an important conclusion to keep in mind, for it indicates that educational computer games based on a problem-solving genre can attract both girls and boy users, unlike other genres that may exclude one gender or the other.

The aspect of challenge is a difficult element to quantify and is probably best described by Malone (1981) whose results were gleaned from his PhD research. Malone believed that challenge was one element that provided intrinsic motivation for playing electronic games.[5] According to him, challenging games must provide objectives that the player is uncertain of attaining and they should be personally meaningful. Nawrocki and Winner (1983) support this with their assertion that the key to motivation is winning while remaining challenged. The challenge element is crucial. Neither of these research pieces, though, deals directly with the variable of gender. It is not said that girls were more desiring of the element of challenge than the boys, or vice versa.

The issue of gender and challenge was commented on by De Jean et al., (1999) in their observations and interviews of girls and boys who interacted with a hands-on science exhibition. They found that the both girls and boys indicated that an element of challenge, even though they found it difficult to describe just what constituted a challenge, was an important element in gaining satisfaction from playing a computer game. In their report, challenge was the only element common to those identified by the girls and the boys interviewed.

From the literature, I would expect that problem-solving and puzzles should feature in the elements mentioned by both girls and boys in the data I have generated. It will be interesting to see if the more abstract element of challenge is mentioned.

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[5] The other elements identified were fantasy, curiosity (Malone, 1981), and control (Malone & Lepper, 1987).

Miscellaneous Elements

Throughout the relevant literature, a number of other elements have been identified as appealing to girls but have only been identified in either one or two studies. Unlike the attributes mentioned above, which have multiple sources of evidence, I believe it is difficult to give them strong credence, at the moment, because of the lack of studies identifying and confirming their status as preferential elements of computer games for girls. However, they have been identified and so I have grouped them under this heading so that they will be acknowledged as part of the study. It will be interesting to see if they emerge from my data as attributes identified by my students.

Game saving

Being able to save a game position at any time was identified from the literature by Caftori and Paprzycki (1997) as being a feature wanted by girls. However, the research that they gained this from is not clearly cited. Fiore (1999) reported the same element using evidence she gained from her doctoral work. This feature may relate to the girls not liking the 'dying-and-starting-again' facet mentioned in the *Feedback*, *Genre*, and *Challenge* sections.

Collecting objects

The collecting of objects arises in one piece of research. When Kafai (1995) asked students to design their own ideal computer game, she observed that many girls had collecting objects as a main theme and purpose to the game. She gave no consistent reason why the girls wanted to collect objects, just that they included the activity in their design.

Humour

The presence of humour in a computer game as desirable for both boys and girls was identified in two separate studies. Brunner et al., (1998) reported that the girls they studied were very interested in having humorous elements in computer games. The type of humour was described as being based on the character, either appearance or actions, and the situations found in the game. It was humour not designed to put someone down or to hurt another player. In their research on the computer game *Counting on Frank*, Westrom and Super (1995) tracked and counted which click-ons[6] were used by the boys and by the girls. They found that both boys and girls enjoyed the click-ons that provided humour and multimedia effects more than those that provided verbal information only.

[6] A click-on was described by Westrom & Super as an image or object on the screen that animated when clicked-on by the user.

Summary of the Literature

As stated at the beginning of my literature review, there were contradictions found in the literature, and relying on what different researchers reported to use as a buying guide would probably result in hopeless confusion. In order to demonstrate this, and to again show cause for my research for my situation, I have summarised in table form the findings of the literature that I have reviewed. I have placed contradictory research beside each other.

Table 1: Attributes preferred by girls as reported by the literature

Girls would be turned away by violence and aggression	Brunner et al, 1998; Butler, 2000; Copper et al., 1990; Dempsey et al., 1998; Glaubke et al., 2001; Morse, 1995	Girls would not be turned away by violence and aggression (referring to fantasy violence)	Funk & Buchman, 1996b
Girls prefer fantasy/mystery/adventure setting	Brunner et al., 1998; Cesarone, 1998; Funk & Buchman, 1996b; Gailey, 1992; Martinez, 1992; Neumark, 1991	Girls prefer realistic settings	Glaubke et al., 2001; Kafai, 1996; Laurel, in Subrahmanyam & Greenfield, 1998
Girls prefer verbal feedback	Cooper, Hall, & Huff, 1990		
Girls prefer non-violent feedback	Kafai 1995; Miller, Chaika, & Groppe, 1996		

Girls prefer positive feedback	Glaubke et al., 2001; Miller, Chaika, & Groppe, 1996; Morse 1995		
Girls prefer large and detailed graphics with shades of colour	Freedman, 1989; Jakobsdottir, Krey, & Sales, 1994; Passig & Levin, 1994		
Girls prefer a variety of scenes	Dempsey et al., 1996a		
Girls view music as important in a computer game	Cooper, Hall, & Huff, 1990; Malone & Lepper in Wilder, Mackie & Cooper, 1985	Girls find music annoying and irritating in computer games	Fiore (1999); Miller, Chaika, & Groppe, 1996
Girls prefer a strong narrative	De Jean et al., 1999; Inkpen et al., 1994; Krantz, 1997; Laurel, in Cassell & Jenkins, 1998c; Miller, Chaika, & Groppe, 1996; Murray & Kliman, 1999; Polak, 2001		
Girls prefer female protagonists	De Jean et al., 1999; Glaubke et al., 2001; Jakobsdottir, Krey, & Sales, 1994; Klawe et al, 1996; Littleton et al., 1998	Girls do not prefer female protagonists	Chappell, 1997; Fiore, 1999; Joiner et al., 1996
Girls prefer realistic protagonists with emotional depth	Purple Moon, n.d.		

Girls prefer multiple protagonists	Laurel, in Cassell & Jenkins, 1998c		
Girls prefer to collaborate	De Jean et al., 1999; Elliot, 1990; Hawkins, 1987; Henney, 1986; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Murray & Kliman, 1999; Nicholson et al., 1998; Rubin et al., 1997; Shade, 1994		
Girls do not like competition	Arch & Cummins, 1989; Kelly, in Cassell & Jenkins, 1998a; Lockheed, 1985, Serbin, Powlishta, & Gulko, 1993	Girls like competition	Caftori, 1994; Chappell, 1997; Malone, 1981; Signer, 1992
Girls prefer a slow paced game	Caftori & Paprzycki, 1997; Inkpen et al., 1994; Kafai, 1996; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Rubin et al., 1997; Scott, Cole, & Engel, 1992	Girls preferred a variable or fast paced game	Caftori, 1994; Glaubke et al, 2001
Girls prefer multiple activities that also have a purpose	Cooper, Hall, & Huff, 1990; Kafai, 1995; Klawe et al., 1996; Westrom & Super, 1995		

Girls prefer clear and accessible instructions	Forsyth Jr. & Lancy, 1989; Glaubke et al., 2001; Lancy, Forsyth Jr., & Meeks, 1987, Lancy & Hayes, 1988; Whooley in Scott, Cole, & Engel, 1992	Girls do not view clear and accessible instructions as important	Carroll, 1997; Gery, 1991; Miller, Chaika, & Groppe, 1996
Girls prefer problem-solving computer games with multiple solutions	Brunner, Bennett, & Honey, 1998; Bunderson & Christensen, 1995; Caftori & Paprzycki, 1997; Cooper, Hall, & Huff, 1990; Subrahmanyam & Greenfield, 1998; Walter, 1998		
Girls prefer to be able to save their progress at any time	Caftori & Paprzycki, 1997; Fiore, 1997		
Girls enjoyed having humour in a game	Brunner, Bennett, & Honey, 1998; Westrom & Super, 1995		

Table 2: Attributes preferred by boys as reported by the literature

Boys like violence and aggression in computer games	Caftori & Paprzycki, 1997; Canada & Brusca, 1992; De Jean et al., 1999		
Boys enjoy fantasy/space/adventure settings	Caftori & Paprzycki, 1997; Kafai, 1995; Scott, Cole, & Engel, 1992		
Boys prefer violent / trial and error feedback	Kafai,1995; Subrahmanyam & Greenfield, 1998		
Boys prefer sophisticated graphics	Kafai, 1995		
Boys prefer 'noise' made by game, not necessarily music	Henney, 1986		
Boys prefer 'super-hero' protagonists	Purple Moon, n.d.		
Boys prefer to collaborate	Rubin et al., 1997	Boys prefer competition	Klawe et al., 1996, Yelland & Lloyd, 2001
Boys prefer a fast paced game	Caftori & Paprzycki, 1997; De Jean et al, 1999; Klawe et al., 1996; Nicholson et al, 1998; Passig & Levin, 1999		

Boys do not care about instructions	Greenfield, 1996; Revelle, 1984
Boys prefer problem solving computer games	Klawe et al., 1996; Sherman, Divine, & Johnson, 1985

It can be seen that when the research findings are compared the boys appear to be a far more homogenous group then the girls. The research concerning the girls indicated several attributes that produced contradictory findings, whereas in relation to boys only one attribute was reported by the research as being contradictory.

CHAPTER TEN

PREAMBLE TO THE ANALYSIS (A PORTRAIT OF MY STUDENTS)

Introduction

In order to set the scene for my inquiry I asked several general questions relating to each student's contact with and attitude about computers in general. I believed this was important as the attitudes and understandings regarding computers and their use by my students was very relevant to my study. It is the computer that delivers the software to my students and so how they related with it could have an effect on my data and my subsequent interpretations. In other words, I needed to know how my students felt about computers and how they viewed its place in their schema.

Background Information

The total number of students that was asked each question differed because questions were added and removed throughout the interview period as new information was gleaned from earlier interviews. As stated in the Research Design chapter, the interview questions evolved through being informed by answers provided by the children.

From the 212 students (F=105 / M=107) who were asked if they had a computer at home the following numbers were derived.

Table 3: Computer ownership

Girls who own computers	103	98%
Girls who do not own computers	2	2%
Boys who own computers	102	95%
Boys who do not own computers	5	5%
Percentage of computer ownership - both sexes	97%	

Table 3 shows that the students at my two schools had a high rate of access to computers in their homes. This pattern reflects the economic background of this local school population. In comparison to the broader population's household computer ownership, my students' access was considerably higher. Data collected by the Australian Bureau of Statistics (*Australian Social Trends*, 2003) show that only a little over half of all Australian households have personal computers.

From the 110 (F=105 / M=105) students who were asked if they thought computers are made for girls, boys, or both, the following figures were derived.

Table 4: Opinion of who computers are made for - girls, boys, or both?

Girls who think computers are made for girls	1	1%
Girls who think computers are made for boys	11	10%
Girls who think computers are made for both	93	89%
Boys who think computers are made for girls	1	1%
Boys who think computers are made for boys	10	10%
Boys who think computers are made for both	94	89%

Table 4 shows that almost all boys and girls indicated that computers are made for both sexes. It could be inferred that both groups felt comfortable with using computers. Computers were perceived as a sex-neutral technology, suitable for use by both girls and boys.

Of the few students who responded that computers are made for a particular gender some interesting and concerning reasons were given. To Ron (9, lines 142-7)[7],

[7] All names used are pseudonyms. The first number in the brackets that appear after the child's name refers to their age. The line numbers refer to lines as printed by the *N6 Student* program. Text inside a square bracket has been added by myself to provide, where needed, clarity and context. Italicised text inside square brackets indicates a further question I asked during the child's reply to gain more information.

computers are made for boys "because, I've seen this show on scientists on Discovery Channel and they're typing in all these different words that I can't even pronounce [*And they are usually men that are doing that?*] Yeah, there's only one girl in the room and that was to serve beverages". Thus it seems that even today powerful messages are being delivered by images broadcast in the mass media. Jeremy (11, lines 78-81), believed that "[computers] are made for boys. Because many girls these days don't know much about computers whereas boys do and if girls do learn they learnt it off a boy". This, too, indicates that some boys believe that the world of the computer is the realm of the male. However, the majority of my students saw the computer as something for everyone to use.

Nevertheless, a difference was found when I asked the students who enjoys more using computers. From the 200 (F=100 / M=100) who were asked this question the following figures were derived.

Table 5: Who enjoys using computers more - girls, boys, or both the same?

Girls who think girls enjoy using computers more than boys	12	12%
Girls who think boys enjoy using computers more than girls	58	58%
Girls who think boys and girls enjoy using the computer the same	30	30%
Boys who think girls enjoy using computers more than boys	14	14%
Boys who think boys enjoy using computers more than girls	57	57%
Boys who think boys and girls enjoy using the computer the same	29	29%

Table 5 indicates an interesting contrast to the figures regarding for whom the computer was made. Although a large majority of my students seemed to believe that computers are made equally for both girls and boys, it is the boys who are perceived to derive more enjoyment from interacting with the machine. I found it difficult to come up with a convincing reason for this discrepancy. Perhaps this indicates a stereotype in action in that although the children generally perceive computers as being made for both sexes it is a domain that belongs to males, an activity that mostly males enjoy. This result may indicate reluctance by many girls to fully partake in the 'fun' side of computing.

Clarke (1986, p.47) stated that "[c]urrently, the clearest message being conveyed by the visible role models is that computing is...a male activity". Some may regard her conclusions as out of date due to the gender equity policies and initiatives that have been put in place since then. However, more recent research tends to confirm that girls continue to view computer activity as being a male domain. When Clegg and Trayhurn (1999) conducted in-depth interviews with British women they found that gender was a common factor reported in their opinions of computers and that being heavily involved with computers and computer games was very much a male activity. Of course, this may have reflected the adults' memories of their own computer use as children. Clegg and Trayhurn did not address that interpretation in their research.

Part of my research involved finding out how computers and computer use was perceived by my students, particularly in relation to sex. Did my students attitudes and perceptions reflect Clarke (1986) and Clegg and Trayhurn's (1999) research? To investigate this I conducted a test similar to de Castell and Bryson's (1998) 'Draw-a-computer whiz-test' which in turn was based on to the 'Draw-a-Scientist Test' described by Finson, Beaver and Cramond (1995). de Castell and Bryson (1998) asked secondary students to draw a computer-whiz. Their results show that 71 percent of the students perceived a computer whiz as male, 18 percent as female, and 11 percent as sex indeterminate. When I conducted this test with my primary-aged students I added another category; what did a computer whizn't look like? I asked my students to draw a computer whiz on one side of a piece of paper and a computer whizn't on the other side. Their drawings resulted in the following figures (see Appendix 5 for full details).

From the 260 (F=126 / M=134) students who produced a drawing the following figures were derived.

Table 6: Is a computer Whiz / Whizn't male or female?

	Male	Female	Indeterminate
Girls drew a computer Whiz as;	60%	39%	1%
Boys drew a computer Whiz as;	86%	5%	9%
Girls drew a computer Whizn't as;	41%	57%	2%
Boys drew a computer Whizn't as;	89%	7%	4%
All students drew a computer Whiz as;	73%	22%	5%
All students drew a computer Whizn't as;	66%	31%	3%

From Table 6, it appears that the majority of the girls viewed a person who is comfortable and successful with computers is most probably male. Sadly, over half the girls indicated that a computer whizn't is female, but interestingly the boys' drawings of a female whizn't accounted for only 7 percent of the total whizn't's. Whatever way you look at the apparent perceptions of my students, as far as the boys are concerned, whether you are good at computers or not, you are probably a male because it is a male domain. This result reflects the opinions put forward by both Deaux and Kite (1993) and Katz and Ksansnak (1994) who believe that boys are very rigid in their stereotyping of activities and gender roles. The girls' perceptions were not far behind - computers tend to reside in a male world.

Related to the use of computers is the question of computer games. From the 97 (F=35 / M=62) students who were asked whether or not they liked computer games the following numbers were derived.

Table 7: Children who like computer games

Girls who like computer games	34	97%
Girls who do not like computer games	1	1%
Boys who like computer games	56	90%
Boys who do not like computer games	6	10%
Percentage of students who like computer games	93%	

As my research was aiming to increase the effectiveness of educational computer games for girls the results of Table 7 are particularly encouraging because the medium that I wish to utilise to encourage girls to become more involved in primary science education - computer games - is a medium that almost all seem happy to use. It appears that I have a receptive audience.

As a further part of gathering background information in relation to my students' attitudes and opinions of computers and computer games, I asked whether they thought computer games were generally made for boys, made for girls, or made for both boys and girls. I was interested to see whether the girls, generally, viewed computer games as an artefact that was made for boys' consumption only, or whether they perceived them as made for them as well.

From the 204 (F=97 / M=107) students asked this question the following numbers were derived.

Table 8: For whom are computer games made?

Girls who think computer games are made for boys	18	19%
Girls who think computer games are made for girls	3	3%
Girls who think computer games are made for both	76	78%
Boys who think computer games are made for boys	29	27%
Boys who think computer games are made for girls	1	1%
Boys who think computer games are made for both	77	72%

In Table 8 the figures indicate that the majority of girls and boys perceived computer games as something made for all children. However, a significant minority indicated that the playing of computer games is a domain of boys. Jonathan (12, line 96), perceived the situation largely as a numbers game when he observed that "there's a lot more games for boys and only a couple for girls". To him, it is the marketplace that has decided that computer games belong to boys. Marty (10, lines 156-8), seemed to hold the same opinion when he said, "[when I go] into a shop and look at computer games, they're all shooting and, or bike games or skateboarding, something like that", and these are types of games that he believed only boys would enjoy.

Unfortunately, this seems to be the same message received by the girls in this significant minority. Raelene (12, lines 82-4) also noted that "when you go to the computer shop it's mostly army stuff and there's not much girl's stuff". The content of the games could also influence how a girl viewed their appropriateness. Alison (12, lines 127-9) claimed that "most computer games are actually made for boys because most of them have action in them". It might be important for me to change the perception that computer games are only for boys if I want all my students to feel comfortable and welcome when using educational computer games. Possibly, the introduction of educational computer games that exhibit 'girl-friendly' attributes might help to eliminate this unwanted perception.

Another question that I was keen to find an answer to was whether or not girls thought boys and girls liked different sorts of computer games and vice versa. From the 207 (F=102 / M= 105) students who were asked this question the following numbers were derived.

Table 9: Do girls and boys like different types of computer games?

Girls who think boys and girls like different types of computer games	90	88%
Girls who think boys and girls like the same types of computer games	12	12%
Boys who think boys and girls like different types of computer games	96	91%
Boys who think boys and girls like the same types of computer games	9	9%

It is clear from Table 9 that a very large majority of both girls and boys seemed to believe that their opposite sex likes different types of computer games. This suggests that girls and boys were aware that they are constructed and viewed socially and culturally by each other. It will be interesting to see if the qualitative data provided by my students when they were asked to design a computer game for the other gender supported these figures (see Chapter 11).

From the 209 (F=103 / M=106) students who were asked what they thought about using computers at school the following numbers were derived.

Table 10: Perception of computer use at school

Girls who see computer use at school as positive	98	95%
Girls who see computer use at school as negative	5	5%
Boys who see computer use at school as positive	104	98%
Boys who see computer use at school as negative	2	2%
Percentage of students who see school computer use as positive	97%	

It can be seen in Table 10 that an overwhelming number of my students viewed using a computer at school as a positive experience. By far the most common response from both the girls and the boys about using computers at school was that it was fun. Interestingly, what made computer use fun was different between the girls and the boys. The trend in girls' responses concentrated on how they could learn with the computer and use it to complete work or prepare for future employment. Alison (12, line 28-30) said that it's good "because it helps you later on in life when you're applying for jobs because most [jobs] nowadays you have to know how to use a computer", with Jane (11, lines 16-18) agreeing, stating that "It's good because and cause you know [inaudible] how to use a computer when you are older just in case we want a job to do with it".

The boys, on the other hand, generally saw the computer as a play thing, being able to use it to play computer games seemed to be the most positive aspect about it. Jeremy (11, lines 19-21) saw computer use as giving "the student a break from school work and then lets them unwind and enjoy what they are doing", while Steven (9, line 48) claimed that "It's really fun, playing all the games". These opinions reflect what the literature reports regarding the differing perceptions and attitudes to computers demonstrated by girls and by boys. Girls tend to see the computer as a tool, an object that allows them to achieve other things, while boys see it as something they need to control and master, with games being the perfect medium to allow this (AAoUW, 2000; Cassell & Jenkins, 1998d; Schofield, 1995).

This is not to say that only a few girls mentioned games or a few boys mentioned applications. In follow-up questions on what they like best about using computers at school, both girls and boys frequently mentioned playing games, using the Internet for research, and using applications to complete work or to make work more attractive in the presentation stage.

From 192 (F=91 / M= 101) students who responded to the question of what they liked best about using computers at school the following figures were derived.

Table 11: What do you like best about using computers at school?

	Playing games	Assist in school work	Other
Girls	48%	40%	12%
Boys	64%	21%	15%

Table 11 indicates the boys tended more towards the game aspect of school computer use whereas the girls concentrated more on how the computer could help them with their school work.

When asked what they did not like about using computers at school the largest response from both groups was having to perform work-related tasks.

From the 192 (F=91 / M= 101) students who responded to this question the following figures were derived.

Table 12: What do you dislike the most about using computers at school?

	School work		Technical issues		Nothing		Other	
Girls	25	27%	14	15%	27	31%	25	27%
Boys	26	26%	17	17%	40	39%	18	18%

As can be seen from Table 12, boys nominated using the computers for school-related work as their biggest dislike, which is consistent with the literature, however, I was surprised a similar response was gleaned from the girls as the same literature indicates that girls see the computer as a tool to help them achieve in the tasks they undertake (AAoUW, 2000; Cassell & Jenkins, 1998d; Schofield, 1995). I would have expected a smaller response from them. It was encouraging to see a large percentage of students disliking nothing about school computer use indicating they were keen and willing to interact with the computers in either a work or play situation at school.

The only other negative that was mentioned by both the girls and the boys was the technical issue of computers not working and being unreliable. Many students mentioned how they had lost work they thought they had saved or the frustration with the computers not working or not being able to run a particular program. It would appear that it is the equipment side of the computer use that frustrated many of my students. Although this issue is outside the realm of my investigation, it is something that I need to be aware of as I am involved in the maintenance of the computer laboratory at one of my schools. If this was a source of negative sentiment for my students than it needs to be addressed just as much as the issue of making available suitable software needs to be addressed.

The last question that I asked in order to gather background information was whether my students perceived the computer that they used at home to be a 'he', a 'she', or an 'it'. This may seem a strange question to ask but I was interested the extent to which my students attached a gender to the computer and their reasons for doing so. I felt this might cast some light on the comfort levels of my students when they used the computer. For example, would the girls feel uncomfortable using a computer if they thought it was 'male', or vice versa with the boys.

From the 215 replies[8] (F=109 / M=106) of students who were asked the gender of their home computer the following figures were derived.

Table 13: The home computer is a 'he', 'she', or an 'it'.

Girls who think their computer is a he	43	39%
Girls who think their computer is a she	42	39%
Girls who think their computer is an it	18	17%
Girls who do not know the gender of their computer	6	5%
Boys who think their computer is a he	59	56%
Boys who think their computer is a she	26	25%
Boys who think their computer is an it	8	8%
Boys who do not know the gender of their computer	13	11%
Percentage of students who see their computer as a he	102	47%
Percentage of students who see their computer as a she	68	32%

It can be seen from Table 13 that the majority of my students seemed to attach a gender to their computer at home, with a slightly larger perception of it being male. Three interrelated themes emerged from the interviews: (i) the person they mainly associated with the home computer, (ii) the programs installed on the computer and, (iii) the gender of the main user can influence students' perception of computer gender. I felt the first and second conditions could be relevant to my students' perceptions of the computers they used at school.

To many of the children, and this appeared not to be age related, the significant person who used the computer most at home could be the deciding factor of the computer's

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8 A number of students gave conditional replies to the question with the computer being a 'he' under some circumstances and being a 'she' in different circumstances, therefore this number reflect replies rather than students asked as in the other questions.

gender. If the mother appeared to use the computer the most then it was often called a 'she'. Conversely, if the father was seen to be the main user then the computer was viewed as a 'he'. For example, Rick (10, line 209) said that it was a 'he' because "dad uses it a lot and me and [my brother] and mum only use it to check emails or something", while Jed (10, line 152) described the home computer as a 'she' because "my mum plays it a lot, like it's my mum's best friend". This finding could be relevant to how students perceive computers at school. At both my schools it is mainly the male teachers who are involved in computer education, with only one female teacher involved in direct instruction of computer use. The literature (Clarke, 1986; Clegg & Trayhurn, 1999) suggests that computing could be perceived as a male domain and that to counter this stereotyping female role models should be encouraged and used. Encouraging the female teachers to use the computer laboratory with their classes may be something that should be pursued at my schools.

The type of programs installed on the family computer also appeared to influence how the computer was viewed. The type of programs mentioned most were games, and these were mainly identified as boys' games. For Karen (10, lines 203-5) her computer was a 'he' because "we've got mainly all boy programs, and boy CD's" and it was also a 'he' for Craig (11, lines 72-4) because "there's lots of war games on my computer but there's no girl's games on it". I felt this was directly relevant to what I was researching because as the main purchaser of educational software in my schools, the type and style of game that was installed onto the school computers could send a message to the girls or the boys that these computers are either male or female, thereby affecting students' comfort levels and attitudes towards using the computers.

It would have been interesting to pursue this line of inquiry in order to ascertain if the perceived gender of a computer interacts with or affects the comfort level of opposite gender users. Also, I would have liked to have found out if my students perceived the gender of their home computer to be different to the gender they might have attached to the computers they use at school.

Conclusion

The purpose of this chapter is to illuminate the backgrounds of my students' perceptions and feelings regarding computers in their lives. When summarising how the girls and the boys in my study responded I was surprised more by the similarities than differences between the two sexes. Most of the related gender/computer literature is situated in the understanding that there is an identifiable difference between girls and boys and their attitudes towards and perceptions of computers, with researchers trying to find out why this is so. What I found in this background 'check' was more attuned to Connell's (1987) statement mentioned earlier; "if it was not for the cultural bias of both writers and readers, we might long ago have been talking about this as 'sex similarity' research" (p.170). In looking at Table 14 below, the degree of similarity is overwhelming.

Table 14: Comparison of 'typical' girls and boy at my schools.

The typical girl at my school;	The typical boy at my school;
- owns a computer,	- owns a computer,
- has a positive attitude towards using computers at school,	- has a positive attitude towards using computers at school,
- likes computer games,	- likes computer games,
- believes computer games are made for everybody, but	- believes computer games are made for everybody, but
- believes boys enjoy using computers more than girls,	- believes boys enjoy using computers more than girls,
- feels that girls and boys like different types of computer games, and	- feels that girls and boys like different types of computer games, and
- does not attach a particular gender to her home computer.	- sees his home computer as a 'he'.

I did not believe that these results undermined my research position. In fact this summary reinforced the need to study the make-up of the educational software I used in my schools. My students seemed to believe that boys and girls like different types of computer games. This was the major thrust of my research, to identify what my girls preferred in their computer games in order to transfer those identified elements into the educational computer programs used for science education.

CHAPTER ELEVEN

ANALYSIS, DISCUSSION, AND RECOMMENDATIONS (OR WHAT DO MY GIRLS REALLY PREFER?)

Introduction

This chapter provides a descriptive analysis of data from multiple sources interspersed with interpretive commentary supplemented by other research findings in the literature. I view this chapter as a conversation between the data, the literature and me resulting in recommendations for design attributes of educational computer games that may advantage my female students. Various researchers see qualitative data as being jointly generated between the subject and the researcher and I feel the metaphor of a conversation reflects this (Bianchini, Cavazos, & Helms, 2000; Briggs, 1986; Mishler, 1986). Many of my questions result directly from the responses of my students, allowing a further and deeper probe into their beliefs and perceptions related to their interactions with computers and computer games.

I have used a synoptic style, as described by Erickson (1986), by reporting the data under thematic headings so that all relevant information can be seen together, thereby enabling the reader to make an informed judgement about the viability of my interpretations, inferences, and conclusions. I have also included frequency tables where appropriate, as suggested by Erickson, to illustrate general patterns within the data.

Gender Specific Recommendations and Criteria

The analysis, interpretations, conclusions, and recommendations that arise from my data are formed to assist educators to evaluate and select potential educational computer software that encourages girls to participate, enjoy, and achieve in primary science education. The criteria that evolve from my analysis relate to educational computer software that are likely to appeal to *most* girls, rather than to *all* girls. As Agosto (n.d.)

points out, gender theory maintains that whereas sex is biologically determined, gender is constructed through the social process and can be in a continual state of flux along a feminie-masculine continuum. That is, "genetic makeup determines whether a person is a woman or a man, but societal conditions result in a person's viewing the world in gender-schematic or gender-aschematic terms." (p.4)

From this we can see that if a girl views herself as fitting a restrictive societal mould she could possibly miss out on many different avenues of experiences in her life, whereas a girl who sees herself in gender-aschematic terms may be able to break from boundaries set by society and participate in activities not normally associated with her biological sex. What emerges from my research are criteria that could be used to select educational software that encourages gender-schematic girls into unconventional subject areas.

Although Agosto warns that the "concepts of 'sex' and 'gender' should not be conflated" (p.4) and I acknowledge that preferences vary among my female students, the main objective of my research is to uncover those preferences and attributes that are *most likely* to attract the greatest number of girls. Earlier, I cited Cassell and Jenkins (1998d, p.25) who stated that "[d]espite the clear dangers of such 'sweeping generalizations,' the ability to determine what girls want may seem necessary at a time when we are trying to open up a space for girls to participate within this medium [science education] at all." It is for this reason that I use the term 'girl' and 'boy' in place of the more exact terms of gender-schematic girl or boy as used by Agosto (n.d.).

Emergent Themes

Interpretive analysis of the data resulted in a number of emergent themes: Violence, Settings, Feedback, Game Texture (visual and aural aspects), Narrative, Characters and Avatars, Collaboration/Cooperation and Competition, Activities, Challenge, Genre, and Miscellaneous. A brief explanation of these themes follows.

Violence: This theme identifies the views and perceptions of the children regarding the use and presence in computer games of violence, both human-oriented and cartoonish, and how its presence may or may not discourage girls from interacting with educational computer games.

Settings: Setting deals with in-game scenarios that encourage or discourage girls' participation with computer games.

Feedback: This theme identifies styles of feedback preferred by girls which, when incorporated into educational software, may encourage them to continue playing.

Game Texture: Game texture refers to the look and feel of the game, and covers the aspects of colours, style of graphics, and sounds - both sound effects and music - that may appeal to girls.

Narrative: Identifying the types of background narratives that drive preferred computer games is dealt with in this theme, indicating the importance to the girls of the storyline as well as the subject matter with which they feel comfortable.

Characters and Avatars: The look and gender of the avatar that represents the player is investigated in this theme, resulting in the identification of attributes that seem to appeal to girls more than to boys.

Collaboration/Cooperation and Competition: This theme addresses the extent to which the presence of competitive game elements hinders or encourages girls' enjoyment of computer games. Also, the attribute of cooperation is investigated to ascertain whether it is a preferred attribute of girls that could be incorporated into educational software.

Activities: This refers to brief in-game activities that often are situated within the main game. The analysis seeks to ascertain the extent to which the presence of these activities is preferred by girls.

Challenge: Computer games can be sources of great challenge to many players. This theme concerns the extent to which girls prefer computer games to challenge them and, if so, the style or type of challenge they want.

Genre: The genres of computer games that appeal to girls seem to be different to those that appeal to boys. This theme identifies the game genres favoured by most of the girls and the genres that they appear not to favour.

Miscellaneous: A number of minor themes were derived from the data which did not support strong recommendations because of the small number of children subscribing to them. However, those included in this section were adjudged to be of importance because of their peripheral influence on girls' choice and enjoyment of educational computer software.

Interspersed throughout the thematic sub-sections are recommendations which constitute the final criteria for 'girl-friendly' attributes that I discuss in Chapter 12.

Violence

As mentioned in the literature review, I believe violence in its human form has no place in educational computer games. However, cartoon, or fantasy violence is actually present in some educational computer games and so I felt it was a valid element to be investigated in the context of my research.

From what was reported by the girls in the interviews, the presence of violence was not perceived as a positive attribute for most girls. This was consistent across the age range of the girls interviewed. A convincing trend emerged when the girls were asked what they like in their favourite games: the absence of any violence, either fantasy or human. When Kimberley (8, line 22) was asked how she could make a favourite game at home more enjoyable to play she replied, "[by making it so you do] not have to kill anything". Mary (9, lines 23-4) offered a similar reply on how to make a game she likes better: "Make sure there's no such thing as bombs and no wars and stuff like that, like a happy village". Other girls indicated violence could constitute part of some games that they enjoyed playing, but they made up a small minority in relation to the overall preference for the absence of violence. This view was reinforced when the girls were asked what they believed other girls liked in computer games. It is strongly evident from the replies that they seemed to believe that girls as a group do not want violence in their computer games.

A constant theme throughout the interviews in relation to negative aspects of computer games is violence towards other people. No other grouping of negative game attributes mentioned is as large as the one dealing with violence. Overall, in considering the interview data, the preference for no human violence is strongly apparent. This should not be surprising as the literature dealing with this aspect is firm: girls do not like human violence in computer games (Butler, 2000; Cooper et al., 1990; Glaubke et al., 2001).

However, supporting evidence for this preference for limited or no human violence could not be found when data generated from the 'liked/disliked' survey sheets was analysed.

Table 15: Games listed as liked which contain elements of violence

	Number of games mentioned	Number of games with elements of violence	
Girls	131	39	30%
Boys	165	83	50%

Table 16: Games listed as disliked which contain elements of violence

	Number of games mentioned	Number of games with elements of violence	
Girls	79	19	24%
Boys	87	20	23%

Tables 15 and 16 indicate a significant percentage of games which contain elements of violence as being liked by the girls. However, a similar percentage is listed as being disliked by girls, so at best these figures are ambiguous when trying to interpret the significance of the violence factor for girls in deciding whether or not they like a particular computer game. What is evident from these figures, though, is that both the girls and the boys can identify many more computer games they like than dislike, indicating a wide exposure to the medium as well as reflecting and supporting the earlier figures (Table 7) that indicate both sexes enjoyed playing computer games.

It is also difficult to draw any firm conclusions from the observation data. Obviously, both my schools do not allow overtly violent computer games to be brought from home to be played on the school's computers, nor are any games that involve the depiction of realistic human violence purchased by the school. However, there are several games available at school for the children to use that do have violent aspects, albeit violence presented in a cartoon or humorous fashion. (This was surprising to me, in a way, as I had not really considered the violence aspect until my research made me look more critically at individual games to see what elements were in them). Is there any evidence that boys or girls play these games more or less than the other sex group?

A total of 60 individual games were observed being played by girls at one time or another over the observation period. Games that included some form of cartoon violence numbered nine[9], not a large proportion of the total, and of those nine games two were the most often played. The most popular game with the girls, the *Zoombinis* series, has features of violence in several scenes where the player-controlled characters are knocked back by guardian characters. However, this is done in a comical manner. The second-most popular game is *Kung Fu Kim*, a game in which a cartoon character tries to defend himself from flying objects with his hands. As he is hit by these objects his life slowly drains away until he 'dies' and the game is over.

From the popularity of these two games it appears that many of the girls do not mind elements of cartoon violence and this representation may in fact reflect the style of action many of the girls indicated during the interviews that they liked to be present in a game. Support from the literature is available for this interpretation. Funk and Buchman (1996a; 1996b) reported that it is human violence rather than cartoon, or as they labelled it "fantasy violence", that girls reject. However, it is important to note that apart from these two popular games, the *Zoombinis* series and *Kung Fu Kim*, the other games with cartoon violence were not played often, with five of them played by girls less than ten times over the observation period. Whether this use is due to the violence or poor game play cannot be determined, however, the fact that many of the boys played these games more times than the girls tends to add strength to the inference that the game play is

[9] The nine games were, *Aussie Maths Invaders*, *Bow & Arrow*, *Dynomite*, *Hoyles Kids' Games*, *Kung Fu Kim*, *Lego Island 2*, *Missile Command*, *Sim City 3000*, and the *Zoombinis* series.

satisfactory and it is the violence attribute that may have turned the girls away from playing.

This is not to say that girls did not necessarily want action in their computer games. Instead they appeared to prefer action that does not incorporate violence. Amber (11, line 46) identified action, but "not like fighting action", as something that made computer game playing enjoyable for her. Amber (lines 85-7) continued this line of thought when asked what she perceived other girls liked when she claimed, "I'd probably say, probably action but not like not... [*Violent action?*] Yeah, not violent action" as an alternative to the violence found in many computer games. A small number of girls mentioned games that incorporated car racing, snowboarding, and skateboarding, which lent weight to the interpretation that they enjoyed the action inherent in these physical activities being transferred to computer games. Interestingly, though, when the girls were asked what they believed other girls would like little mention was made of sports. The only indication that sport-oriented action was perceived as something that other girls would like was five girls claiming girls would enjoy games that include horse-riding scenarios.

In analysing the boys' data resulting from the observation sessions, 11 games from the 67 that were played at one time or another could be identified as involving cartoon or humorous violence.[10] The most popular, *Dynomite*, involved shooting eggs with a slingshot at other eggs in order to make a descending wall of eggs explode before it touched the player's slingshot. The equal second most popular game was, as with the girls, *Kung Fu Kim*. It would appear, too, that many of the boys enjoy playing a game that incorporates elements of cartoon violence as a central theme. However, the other equal second popular game, the *Thinkin' Things* series, which has no cartoon violence in it, contradicts this view. Of the ten games the boys most frequently played, seven do

[10] The 11 games were the same as the girls plus *Battleship*, and *Minesweeper*.

have elements of cartoon violence, whereas only four games from the girls' top ten frequency of play had elements of cartoon violence.

In the games that included cartoon violence that were observed being played, considerable differences were found in terms of frequency of play by girls and boys.

Table 17: Frequency of games featuring cartoon violence selected by girls and boys

Game	Selected by individual girls	Selected by individual boys	Total number of times selected
Aussie Maths Invaders	4	3	7
Battleship	0	2	2
Bow & Arrow	11	36	47
Dynomite	18	48	66
Hoyles Kids' Games	13	13	26
Kung Fu Kim	43	46	89
Lego Island 2	2	39	41
Minesweeper	0	1	1
Missile Command	3	28	31
Sim City 3000	3	15	18
Zoombinis	61	35	96

Table 17 indicates *Bow & Arrow*, a game where the central theme revolves around shooting living things such as butterflies, appears to have been significantly more popular with boys than girls. Similarly, *Missile Command*, a game where the player defends their cities from destruction by falling missiles is considerably more likely to be played by a boy than by a girl. A similar situation is observed with the game *Dynomite*. However, in the case involving *Lego Island 2*, I am not certain if the presence of cartoon violence is the major reason why girls did not play it. Possibly, the title had something to do with it, with the girls perceiving Lego as a male pastime. (The small number of players who selected *Minesweeper* and *Battleship* make it unsafe to make significant inferences.)

The significant game in terms of gender balance in playing is the *Zoombinis* series. The figures in Table 17 for this game reflect the 'cute' factor that, according to the interview data, appeared to appeal more to the girls than it did to the boys. Also, the occasions of cartoon violence are few and it is certainly not the main feature of game play. Overall, though, what can be inferred from the figures derived from the observation sessions is that the boys where more likely than the girls to play a game that has cartoon violence as one of its central features. (The one game to contradict this, *Aussie Maths Invaders*, does have significant educational content.) The question then, is whether cartoon violence, just like human violence, turned the girls away from playing a computer game.

The issue of cartoon violence is one that features strongly in the focus group responses. The girls, across all the age groups, generally agreed that human violence is neither appropriate or wanted in computer games. However, it was generally agreed that violence depicted in a cartoonish manner is funny and often made playing the games more enjoyable. It is the element of realism that appeared to turn the girls away from violence. Being able to inflict violence upon another human being is not something they wish to see in a computer game. Strategies to avoid violence in games are mentioned, with one girl saying, " I avoid the violence and swearing in GTA [Grand Theft Auto] by driving around it". It appears she played and enjoyed the game by incorporating strategies that allowed her to avoid those parts of the game she finds undesirable. I suspect other girls may have used similar strategies.

However, the girls did not see any advantage in taking violence out of games. A number of girls mentioned that if the game has a violent premise, for example a fighting game, and it fits the storyline then it is obvious violence will be part of it and this appears to be acceptable. It is the addition of violence that does not appear relevant or necessary to the game play to which the girls generally object. The girls also distinguished between gratuitous violence and violence that occurs through the inherent action of a sports game. The example of blood showing from a character's body if they fail to perform a trick in a skateboard game is acceptable. Again, the girls seem to be making the distinction between violence and action, something that needs to be kept in mind when establishing girl-friendly selection criteria. Interestingly too, the girls generally conveyed the view that they were perfectly aware that real people are not getting hurt and killed in a computer game, however they still prefer it not to be present in the games they play.

The data from the interviews also provide evidence that many girls perceived violence as an integral part of games more suited to boys. This reflects and supports the earlier data indicating that girls believed boys liked different computer games to girls (Table 9). When the girls are asked what they believe are the features that boys like in computer games, by far the largest category identified was violence. The constant theme throughout the girls' responses was that the boys wanted violence in their computer games. One only had to do a search for the term 'killing' or 'shooting' through the girls' interview responses to see that, in most cases, they were referring to something that interests boys in computer games. Even games that girls liked themselves would, in some opinions, need to be modified in a violent manner in order to appeal to boys. For example, Joan (10, lines 94-6) stated she would design a game for boys based on the *Zoombinis* series but the characters would "have little guns and they shoot this person" in order to make it enjoyable for the boys.

This is a rather worrisome finding, that the girls appear to perceive boys' preferences in such a black and white manner and appear to believe that violence is an underpinning of the enjoyment boys derive from computer games. It also indicates that if violence, particularly human violence, is present within a game, it may be an indicator to the girls that the game is aimed specifically at boys and therefore would be unsuitable for them to play.

Unfortunately, the boys did not show much deviation from what the girls perceived of their enjoyment and preferences with violence being by far the most prevalent positive attribute arising from their interviews. This was common across the age range of the boys and confirms the findings of Caftori and Paprzycki (1997) and De Jean et al. (1999) that boys like shooting, fighting, or killing games. It is the violent elements of games that appear most prominently when the boys described what they liked about their favourite games. And, unlike the non-violent action that was claimed to be preferred by the girls, the action indicated by the boys includes explosions, blood, weapons, and conquering armies. Of the 109 boys who were interviewed, only two specifically mentioned that they liked a game because it did not have violence in it with the others generally describing games that invariably incorporate some form of violence.

However, as with the girls, a significant number of boys did mention during the interviews that action is an element they enjoy in computer games. A number of boys stated how they liked to operate, through the computer games, machinery such as helicopters and cars, as well as play computer games that are sport-oriented. This is an interesting discovery. Could it be possible to supplant the depiction of human violence with excitement generated by non-violent action emanating from sport-based game play resulting in a combination that does not alienate the boys from playing educational computer games? This is an element that needs to be emphasised if inclusive educational software is one of the reasons for purchasing a particular program.

In analysing the games listed by the boys in the ‘liked’ and ‘disliked’ survey, a similar conclusion regarding violence being a central theme to ‘liked’ games is found. Of the 165 games listed by the boys as being liked, 83 have game play that revolves around either human or cartoon violence. From this, it could be inferred that violence is, at least, not a turnoff for boys and, at worst, a necessary component for their enjoyment. However, I did determine that 28 games listed as 'liked' by the boys had sport or racing as their foundation, indicating again that non-violent action is also able to deliver the enjoyment they want. This may be an element that could be linked with the girls' apparent liking of non-violent action to produce educational computer games that satisfy the preferences of both sexes.

The focus group data tend to confirm the observation that boys enjoy the violence in the computer games they play. It is the one question that appeared to pique the interest of the boys the most and made them quite animated. A recurring theme across all ages in the boys' focus groups is the perceived enjoyment of realistic human violence, with only a few dissenting voices stating that violence is not necessary. However, as with the girls, the boys generally agreed that if there is violence it must be in the context of the game. They do not seem to think that the presence of violence simply for its own sake is acceptable. The issue of cartoon violence was only mentioned in the context that violence should be depicted in a cartoon fashion for younger children. Considering the age range of my students I assume they mean pre-school and infant aged children.

Conclusion

Although it would appear from the generated data that there may be no common ground between the girls' desire for non-violent action and the boys need for some degree of violence, this may not be necessarily true.

Many of the girls enjoyed action in their games, just as long as it was not violence-based action. The number of games with a sport theme that were mentioned by them gives credence to this observation. The boys, too, in their list of 'liked' games indicate a number of games, 28 in all, that have sport or some type of racing as a central theme. It is here I find some common ground between the girls and the boys that could provide a selection guideline for educational software that is inclusive of both the girls' interests and the boys' interests.

Possibly, the boys' seemingly insatiable appetite for violence could be tempered with the non-violent action that a number of the girls mention in the interviews as being acceptable to them. Like the girls, many of the boys indicate they like games that have imaginative action of the sort found through sport simulations such as skateboarding, golf, and snowboarding, and through racing simulations with cars, boats, and helicopters. Adding elements from these and other 'action' sports to educational games may increase the interest of both the girls and the boys without the distorting or harmful presence of graphic violence.

From the data generated and the interpretations made I believe it could be safely concluded that educational computer games which have incidental elements of cartoon violence will not turn girls away and, at the same time, will not be alienating to boys. Also, elements of action that are derived from sports will be a desirable attribute to the girls, while again not alienating boys.

Recommendation: That any action present in the game should be derived from non-violent, virtual activities.

Recommendation: That no realistic human violence be present in the game.

Settings

A variety of locales, or particular settings, did not emerge from the interview data as being a game attribute important to the girls. Only a small number of girls actually mentioned the setting of a game as being a reason why they liked it. Rose (10, line 11) likes a *Saddle Club* game because "there's a lot of places where you can go and you talk to people", indicating that she enjoys exploring the game's virtual world and interacting with the characters that populate it. Similarly, Teresa (10, lines 83-5) enjoys the locales found in role-playing games, finding them interesting and liking "where you have a lot of different scenarios and you have to do different things, and you might not know what those things are but you eventually learn them". Overall, though, evidence for a variety of settings is not strong. While many girls mentioned individual settings that they liked, no girl specifically mentioned multiple settings as a preferred attribute.

The interviews indicated that both realistic and fantasy settings are acceptable, with neither being favoured by any significant number of girls. This is interesting when compared to the literature. The majority of the literature that researched this attribute indicates girls prefer fantasy settings (Funk & Buchman, 1996b; Gailey, 1992; Martinez, 1992). It is put forward that the fantasy world of a computer game allows girls to escape the real world of violence and discrimination that they may face in their everyday lives (Kafai, 1995). Interestingly though, in later research again carried out by Kafai (1996), it was found that the majority of girls, when asked to design a computer game, selected a realistic setting for their game. She gave no explanation for the apparent contradiction between that finding and her earlier research.

There are other dissenting voices to the view of girls preferring fantasy settings. Glaubke et al., (2001) found in their research that girls were happy with realistic settings in computer games, allowing them to relate the activities they were doing through the computer to their own lives. Support for this interpretation can be found in the analysis of focus group data generated by Miller, Chaika, and Groppe's (1996) research. They found that realistic settings, particularly those which involve people, facilitate discussion among the girl players about what is happening in the game. This takes on a stronger relevance when analysing the girls' perceptions on where games designed for other girls should be set, as discussed later in this section.

Throughout the interviews, very few girls mentioned specific settings that they did not like and which would turn them away from playing a computer game. Computer games with a car racing setting were mentioned by three girls, but this is the only setting that was acknowledged more than once. The only other inference that can be made from the interviews is that many of the girls do not care for settings based around war or fighting. This is consistent with what many of the girls said about their dislike for human violence in general in computer games.

In general, the boys indicated throughout the interviews they preferred different types of settings than those indicated by the few girls who specifically mentioned the attribute. However, as with the girls, only a few boys indicated the type of setting they preferred. Overall, though, the few mentioned by the boys can be described as more adventurous and physical than settings indicated by the girls. Sporting settings were identified by a few boys while 'outer space' also gained mention, albeit by a smaller number. Overall, the few settings specifically identified by the boys appear to be more robust in nature when compared to the settings apparently preferred by girls.

Support for this finding also comes from data dealing with girls and boys designing a computer game for use by other girls or other boys. When the girls were asked where they would set a game they might design for girls, a very strong theme emerged that girls want shopping centres and homes as settings for their games, although these did not feature in any strength when the girls described what they personally preferred in the games they like. This observation is supported by Laurel (in Subrahmanyam &

Greenfield, 1998), who found in her research that girls liked playing out the lives of real people in real social settings such as homes, shopping malls and schools. As they were designing for other girls, and not themselves, I interpret this as them perceiving other girls being restricted by domestic borders - or perhaps stereotypes - but do not see themselves suffering the same restriction.

When asked to describe where they would set a game they would design for boys, the girls indicated very clearly and firmly settings dealing with physical sports, outdoor activities and racing. This finding reflects research conducted by Caftori and Paprzycki (1997) and Kafai (1995) who both report their boys preferred outdoor settings in their favoured computer games.

This observation provides support for Jenkins' (1998) commentary on the play spaces of boys and girls. He cites earlier research that concluded American boys demonstrated a far greater physical range of play spaces, basically the entire neighbourhood, when compared to American girls, who tended to restrict their play spaces to the house and surrounding garden, or developed spaces such as shops and malls. The girls in my study appear to have been reinforcing the belief that girls are restricted in their play areas and they transfer this to their design of girls' computer games. I believe this could be a critical insight for designing educational computer games for girls. If we accept that girls are restricted in their play spaces, both physically and in their imagination, we run the risk of reinforcing and preserving those aspects of traditional perceptions of girls' play which contribute to restricting them to a domestic environment. This observation could possibly be reflected in the 'pink' software that is marketed to girls. However, by using well-designed and thought-out educational computer software that allows girls to explore greater virtual areas of play, we may assist them in developing a more exploratory and inquisitive mindset.

Recommendation: That the setting of the game encompass a wide virtual area of play that does not restrict the actions or explorations of the player.

The focus groups involving the girls gave an indication that there is general agreement for games to be set in familiar and realistic surroundings. This is the sentiment across the age range. This is not to say that fantasy or cartoon settings are not liked by the girls, as some girls do mention they would be fun also. The comment made by one girl, that if people are involved then it should be realistic, seemed to summarise the general feeling of all the girls' focus groups. However, this sentiment is contradicted by the many girls who consistently mentioned the *Sims* series of programs and how they enjoyed playing them. These programs specifically deal with people, however they are presented in a cartoon style, so their enjoyment in playing them tends to contradict the sentiment of the groups' non-preference for cartoon settings. Why this was so is not clear, but I believe the subject matter - the simulation of the interaction of 'human beings' - was enjoyable enough for the girls to be able to ignore its presentation in cartoon style. Also, the girls may have appreciated that what the program is presenting would not be possible in a realistic fashion. It did indicate that girls may be happy to play in a cartoon-based environment if the subject of the game is one they like.

Realistic or otherwise, the feeling among the girls' focus groups appeared to be that an 'outer-space' setting is not desirable. This is the only scenario that was specifically mentioned by a number of girls as not preferred. No other type of setting was mentioned with any consistency as being preferred. A similar result emerged from the boys' focus groups. Across the age range no particular style or setting was put forward as either desirable or otherwise. Again, it appears that the boys would have been happy to simply play a computer game and not concern themselves about where or when it was set.

Conclusion

The literature reviewed comes down on the side of realistic scenarios, albeit with some dissenting views present, a situation supported by my data. It was clear that when girls design for other girls they chose a realistic and domestic setting, indicating to me that if a girl observed a game with that type of setting she would probably believe that it was a game designed for her and one that she would probably enjoy playing. I would therefore have to recommend a realistic setting for educational computer games designed for girls. One caveat to this, however, would be a realistic game based in ‘outer space’. The use of ‘outer space’ appeared to be a general turn-off for many girls so a game using this as a feature could turn girls away before they even play it. Being space-based would indicate that it was a game designed with boys in mind. However, it still needs to be noted that fantasy settings was not shown by my data as a negative preference by the girls.

I do not recommend a realistic setting lightly, for I believe in relation to inclusiveness, games with that sort of setting could possibly not be appealing to many boys, who would see it straight away as a ‘girl’s’ game and therefore would choose not to play it. However, not withstanding that, it might be possible, if a compromise was sought, to use realistic settings but to steer clear of overtly ‘feminine’ spaces such as shopping malls and/or fashion shops. In this way boys could be included in the design brief of the computer game while still making it appealing to many girls. A constant theme throughout this analysis has been boys will play computer games under just about any circumstances, and so making a small comprise with the settings could allow them to tell themselves that they can enjoy a computer game that uses a realistic setting.

Recommendation: That the game should use a realistic setting.

Feedback

Receiving feedback from a program during play is not a prominent attribute arising from the interview data. However, it is evident that the style of feedback preferred by many of the girls was of a non-violent nature. The main form of feedback that was mentioned by girls involves either point accumulation or levels, with approximately one third of girls having mentioned those attributes as important. However, as mentioned in later sections concerning Challenge and Collaboration/Cooperation and Competition, the presence of the score, or the 'racking-up' of points, could perhaps be viewed by the girls as an element of competition rather than an element of positive or negative feedback. Slightly more girls mentioned levels as being something they like in games, and this can be construed as a form of feedback, as well as an indication of competitiveness.

As already mentioned, the girls preferred feedback to be presented in a non-violent manner, for example, by not receiving something rather than having to start over again. For example, when asked why she dislikes a particular game, Tammy (9, line 17) claimed, "when you get killed...you have to start all over again". This form of non-violent feedback is identified by the literature but does not figure significantly in my data (Cooper, Hall, & Huff, 1990; Hall & Cooper, 1991; Kafai, 1995; Miller, Chaika, & Groppe, 1996; Morse, 1995). However, when it is mentioned, the type and style of feedback directly relates to the definite dislike of violence in any form that my female students indicated throughout the interviews.

Another form of feedback - aural - is mentioned in the literature as a preference of girls (Cooper, Hall, & Huff, 1990). This, too, is not supported by my data. Only Melanie (8, lines 27-8) among the girls, stated that, if she could, she would add verbal feedback into her favourite game to make it better, having the game say "Nice try, but you didn't make it" when she does not succeed. Among the boys, only Jonathan (12, line 112) mentioned aural feedback when he stated, "When you get lots of diamonds [inaudible] the guy says 'Excellent'" as a reason why he liked playing *Diamond Mine*.

Feedback in the form of sounds did not appear to be favoured. Throughout the focus groups only a couple of girls mentioned that they like this element, because it allows them to concentrate on the game rather than watching the feedback. However, they did not receive any general support for this preference from other group members. This finding reflects the literature where this type of feedback is reported as a preference of girls in only one study (Cooper, Hall, & Huff, 1990). It appears that aural feedback is not a feature that is regarded as essential.

For the boys, the interview data indicate that feedback in the form of collecting objects or points is a desirable game attribute. As a group, the boys seemed to find that being able to score points, make a high score, beat a previous time, or collect objects as indications of their success are an important feature which adds to playing enjoyment and provides an indication of how they are performing in the game. Also, as with the girls, the completion of levels and progressing to the next level is a feature mentioned by a number of boys as being preferred.

Feedback that incorporates the player 'dying' did not appear to be favoured by many of the boys. Again, this is contrary to the literature. For example, Kafai (1995) found that when boys included feedback into computer games they designed it was generally violent in nature and tended to result in the 'death' of the player. My data indicates that, just as with the girls, the boys did not want the game to end simply because they failed to complete a particular section or task in the game. One boy, Kevin (8, line 19) indicated he did not like one particular game simply because he "kept on dying" at the beginning and so, eventually, he gave up playing that game. In this instance, the harsh feedback to his initial failures in the game meant that he did not pursue the enjoyment that the game might have offered. This type of sudden-death feedback was mentioned by a small number of boys as an attribute of games they did not like. Interestingly, this dislike by the boys contradicted much of the literature which put forward that boys prefer trial-and-error feedback which tells them immediately whether they are succeeding or failing (Kafai, 1995; Subrahmanyam & Greenfield, 1998).

The data generated by the focus groups tends to confirm the interview data. Across all the ages, the girls wanted to know how well they were performing during their playing of a game. The girls generally agreed they did not like it when a game finishes suddenly because a player 'died' or made a wrong choice. Rather, they prefer to lose slowly when they are not performing well, not cut short and dumped from the game. This preference is supported by the literature, being confirmed by several studies (Kafai, 1995; Miller, Chaika, & Groppe, 1996; Morse, 1995).

By far the most desired form of feedback reported by the girls was visual. There was strong agreement among the girls for feedback to be presented by small bars showing 'life' or 'health' that indicates either what time is left or how well they are progressing. There was no general agreement on the desirability of a numerical feedback mechanism such as scoring. It appears to these girls that points are not the reason to play a game as no interest was mentioned regarding achieving a high score. This finding may be associated with the elements of competition and challenge that I deal with in later sections. What was agreed, though, was a preference for collecting objects, a strategy that indicates how well, or otherwise, the player is performing. The positioning on the screen of visual feedback was also an issue for a number of girls which indicated it needs to be kept small and to the side, thereby not interfering with the presentation of the game itself.

Interestingly, some girls in the focus groups mentioned that they did not like any feedback as they felt it put them under pressure and detracted from their enjoyment of the game. This is an interesting point, and one that I wish had arisen during earlier interviews. I would like to have posed this question to the children to generate more perceptions. Possibly having the option of turning the feedback off, thus preventing it from appearing on the screen, may be a feature that some girls would find desirable. The ability to turn off feedback could also be related to public displays of success or failure. Actually designing a game without feedback may, in fact, be very difficult as that would appear to take away the element of challenge, an element mentioned by many girls as being an essential component of an enjoyable game.

The focus group data indicates feedback is an important element to the boys. The general agreement was that feedback is needed to inform you about how well you are going. The discussion among the boys suggested a feeling of urgency about the necessity of feedback that was not evident among the responses of the girls. It was apparent that to the boys, feedback is an essential element of the game. They felt that it not only indicates how well they are performing generally in the game, but it is also a source of reward for success.

For the boys, the important part of feedback is to gain something, be it a new weapon, more experience points and better skills, or artefacts and money that can be exchanged for better equipment. The feedback seemed to be about gaining something that helps them progress further into the game - they want to be rewarded for their performance. I believe that if the feedback incorporates only simple encouragement or a description of how they are performing, they will not care for it at all. This is, fundamentally, a different approach to the preference indicated by many of the girls.

However, similar to the girls, the boys generally agreed that the visual presentation of feedback, being able to see what you receive for succeeding, is preferred. Only a small number of boys mentioned a preference for aural feedback. This was not generally supported by the other boys in the different-age focus groups and probably supports the inference the boys want to receive something 'tangible' in the context of the game rather than audible platitudes for their success.

The combination of data sources indicates a different approach to feedback among the girls compared to the boys. This interpretation reflects the general thrust of the literature. The impression I gained from the analysis is girls perceive and want the feedback in computer games to be non-threatening, positive, and encouraging of them to continue playing the game. This is supported by Hall and Cooper (1991) and Miller, Chaika, and Groppe (1996), who both claim that girls perceive the computer as a more personal object, with feedback acting like an encouraging friend rather than a competitor to vanquish. Having feedback that 'kills off' a player or uses violence in any form will not appeal to girls generally, rather a more gentler style should be incorporated.

As well, the use of point scores or other competitive elements is not necessarily a feedback element girls find preferable. This again reflects the view that girls appear to treat the computer more as a friend than something with which to compete. They do not see the need for overt signs of success or winning being displayed for all to see, nor conversely, and perhaps more importantly, the opportunity for others to note they are failing. If they are using programs with which they are unfamiliar, public displays of failure would not be desirable. This brings me back to the suggestion by some girls in the focus groups that having a facility that allows the player to turn off visual feedback elements is an attractive option.

Indirectly, this interpretation is supported by work undertaken by Cooper, Hall, and Huff (1990) who reported that male-oriented software being used in a public space generates more situational stress in girls than in boys. If my premise is correct, that most computer games are designed with the preferences of boys in mind, then girls may become more stressed if the feedback from their game is not only on public display but is also in a form they do not like. As most of the interaction with the educational software at my two schools occurs in a public space - the computer laboratory - then the facility to turn off visual and aural feedback could be an important feature for reducing possible stress in girls. (The simple suggestion of using the volume control on the monitor to turn of aural feedback would mean players could miss out on the sound effects and music provided by the game. As described in a later section, sound effects and music are attributes deemed important to many players, particularly girls.)

The boys, on the other hand, generally perceived feedback as something that gives or withholds rewards, which in turn allows them to either continue in the game even more successfully or to fail ingloriously. Again, the data supplied by the boys generally agrees with the literature. The main area of disagreement between the boys and the literature is the aspect of 'dying' suddenly with the game ending. Although the literature maintained that this was acceptable to boys (Kafai, 1995; Subrahmanyam & Greenfield, 1998), my data indicates otherwise.

Conclusion

The style of feedback could be an important feature to consider when purchasing educational software which girls would enjoy using. While one of the aims of my research was to find attributes of educational computer games that both girls and boys would prefer in order to make the programs inclusive, this was one attribute that many of the boys may not like if it was selected on girls' preferences. There was a definite difference in the types of feedback preferred by the girls and by the boys.

Generally, the feedback should be presented visually. Feedback would need to be of an encouraging nature, rather than discouraging. This would mean that a point score, one of the most common forms of feedback, would not necessarily be desirable. A public display of points could lead to stress if the point score was viewed by others and was considered not to be high enough. Also, feedback that ended the game suddenly would not be appropriate as girls prefer time to become familiar with the game - sudden terminations would be both frustrating and discouraging to them. The facility of being able to turn the feedback off would also be desirable.

Recommendation: That feedback be presented visually with an option to remove it from the display.

Recommendation: That the sudden ending of the game through a wrong choice or move should be avoided.

Game Texture (Visual and Aural Aspects)

The texture of the game refers to the visual and aural elements that make up the game's appearance. The literature informs us that girls want a rich textured game that displays high quality graphics and sound. Both these elements are identified by the data as being important to girls.

A significant part of my role as the school librarian is to satisfy requests from my students for a "good book to read". Time and again, when selecting a book off the shelf and showing the child, s/he will reject my choice simply because s/he does not like the look of the cover. In other words, their first impression more often than not decides whether or not they think they will like the book. Often my detailing positive things about the book, or the author, or what other students have said, is ignored. It is what the cover looks like that, in many cases, decides whether or not the book is borrowed.

This is an experience that I have found very frustrating over the years, and this is why I believe the appearance of a computer game is very important. Children may dismiss a game simply by the way it looks. Throughout the interviews, it became very apparent that the look and sound of a game is crucial to whether or not it would be played.

Colours

The attribute of computer games mentioned most often by the girls is colour. Consistently, throughout the interviews, the girls identified bright colours as a positive attribute. A game that looked bright was attractive to the girls. Typical is Abigail (8, line 38) who, when asked about what colours she likes in a game responded, "Red, and colours of the rainbow". Specific colours were not mentioned with any frequency although when they were mentioned they were generally representative of the brighter colours of the spectrum. No age difference was identifiable in relation to preference for brighter or darker colours.

When darker or duller colours were mentioned by a girl it was generally in a negative sense, as Jane (11, lines 46-7) stated, "I like bright colours, dull, [it] just doesn't make it as interesting". These darker and duller colours generally seem to indicate to the girls that the game is uninteresting. The absence of colour was also viewed in a negative way. This is an interesting opinion as there are very few, if any, computer games on the market today that do not use colour. Possibly, the girls were equating the black and white illustrations they see in books with computer games, or they regarded the duller colours as being the same as no colour at all. Overall, a dull or dark appearance seems to be a negative attribute identified by a number of the girls, and again this was evident regardless of age.

This is also evident in the data about games girls would design for other girls. The frequency of colour being mentioned was high, with again the brighter colours being mentioned most often. Dark and dull colours were not viewed as desirable for girls, because as Elly (11, lines 112-14) claimed, "dark colours are not really what girls really like". Her comment encapsulates what the majority of girls seemed to believe other girls preferred. The literature supports this observation as a number of researchers have found that a high use of colour contributes to girls' positive feelings towards a computer game (Cassell & Jenkins, 1998a; Jakobsdottir et al., 1994; Miller, Chaika, & Groppe, 1996; Passig & Levin, 1999). Between them they concluded that the use of colour gives a rich texture that adds to other attributes of a game (such as music, atmosphere, voice quality) which contribute directly to the positive feelings girls may already have toward it.

This was not strictly the case with the boys, however. A number stated they like darker colours, claiming that it adds to the atmosphere of the game. This is not to say that brighter colours were not mentioned by any of the boys. A number did, but, in general, colours did not rate frequent mention during interviews with the boys and overall, when looking at the frequency that colour is mentioned by both sexes (Table 18), the girls made reference to colour approximately twice as many times as did the boys.

Table 18: Number of students who mentioned positive or negative aspects of colour in response to the question of what they liked in a computer game.

	Positive mention of colour			Negative mention of colour	
Girls (105)	46	44%	Girls (89)	17	19%
Boys (107)	22	21%	Boys (86)	7	8%

In relation to colour, another aspect emerged from the interviews that I find interesting. The colours pink and purple are often associated with girls' computer games, but they were mentioned infrequently by the girls when asked what colours they prefer. However, when the girls were asked what they believe other girls would like in a computer game the colour pink was frequently mentioned. I believe this indicates that these girls tend to conform to a stereotypical belief that girls generally like pink and purple, but individually, when asked what they personally prefer, the colours pink and purple seem not sufficiently important attributes to sway them one way or the other about the 'like-ability' of a game. This finding was confirmed when the boys were asked what colours they believe girls prefer. They responded strongly in favour of pink and purple, as well as the need for bright colours. This finding supports Kelly (in Cassell & Jenkins, 1998a), who reported that pink is seen as a colour for young girls, an age that my girls may view as associated with the Infants or pre-school. This observation has ramifications if 'pink' software is purchased simply because of the stereotyped presentation. As individuals, the girls' opinions indicate that they may be much more selective than the stereotype leads us to believe.

Graphics

The type of graphics preferred was not clear cut from the generated data. The literature reports that girls should identify graphical representations of people, animals, and plants as appealing elements of software (Jakobsdottir et al., 1994). However, in terms of animals, this did not emerge clearly from the data. Scant mention was made of a preference for what is pictured within programs. In relation to animals, horses gained mention only three times as being a desirable subject of a game. A preference for people characters, however, emerged from the data, although not directly. I inferred this preference from the popularity of the *Sims* series. As noted earlier, this series of programs revolves around human cartoon characters set in a domestic environment.

Perhaps more importantly when discussing graphics is the actual style of presentation. One of the distinctions that I asked the children to make was whether they prefer realistic- or cartoon-style graphics. More responded (23) they prefer cartoon-style graphics than realistic-style (14). Only three girls stated they like both. There was no age-related response in this question. A similar result was found when analysing the answers of the girls about what they believed other girls might prefer. The response was roughly 50-50 that other girls prefer cartoon- or realistic-style graphics.

It is difficult to make a clear recommendation from this data. Two of the programs that appear to be favoured by many of the girls, the *Zoombinis* series and the *Sims* series, feature cartoon-style representations of characters and backgrounds, however possibly the overriding issue is that of colour. Perhaps, as long as the colours are bright and mixed any graphic style may be acceptable to most girls.

One exception to this position, though, is the graphical nature of some violent games that were mentioned by many girls. A trend amongst the replies of what turns girls away from a game is the inclusion of graphical outcomes of violence (I am referring here how the violence is displayed rather than the violence itself. The issue of violence was treated in an earlier section). Many girls noted that they do not care for the explicit "blood and guts" depicted in many computer games. Nicola (10, lines 95-7) stated that if the front cover of a game "had somebody dying on it or something in blood all over the floor" she would choose not to play it. Rosemary (11, line 115) felt that "if it's blood and guts and violence that wouldn't really suit me" but, interestingly, that "it might suit a boy". Related to this was the small number of girls who indicated that 'scary pictures' turns them away from playing a game.

The latter concern is obviously not a direct issue in terms of graphical violent displays in educational computer games, but it may be important to remember that sometimes very realistic portrayals of action can be off-putting to many girls in this age group and that, if there is any violence within the game play, it should be restricted to a cartoon-style rather than a realistic depiction.

The boys were also roughly divided between a preference for realistic or cartoon graphics, with a small number stating that they like both. Again, no age-related preference was identifiable. This result is similar to what girls reported. Often, when listening to the replies provided by the boys and the girls, it became apparent that whatever graphical choice they stated as being favoured it was not overwhelmingly strong, and the general impression I gained is that it is not an important issue to either sex.

A small number of boys did raise the point, though, that whatever the graphical nature of the game might be, high quality graphics is desired for an enjoyable playing experience. Kafai (1995) reported a similar finding, that boys wanted sophisticated graphics, when she asked them to design their own games. This issue was not raised in this study by many girls so it is not possible to say whether the screen resolution and quality of the graphics was as important for girls as it appeared to be for boys.

Recommendation: That bright colours should be used throughout the game.

Sounds and Music

The presence of sounds and music was identified by the majority of girls as being important for their enjoyment of a game. In analysing the interviews, the aural aspect of computer games can be split into two different categories: sound effects and music.

Sound effects

Many of the girls' responses indicate a preference for realistic sound effects that mirror what is happening in the game, either to reflect movement on the screen or to provide atmosphere. This is a feature that adds to what Miller, Chaika, and Groppe (1996) described as the rich texture of the game. Alice (11, lines 18-19) described how realistic sounds make the game more enjoyable for her: "I like it how it's got all those sounds, how it's got shooting, like other people screaming and the screeching sounds of cars putting on their brakes". For her, the sounds contribute to the ambience of a favourite game, albeit a seemingly violent one. However, this is not the same for all girls. Karen (10, lines 159-61) viewed scary sounds as the province of boys because in a game she would design for girls, the music "wouldn't be like the boys' music [*How would it be different?*] It would be softer music and it wouldn't be so scary, 'cause girls can get scared more than boys can". This reflects and repeats the gender stereotype held by many of my students mentioned earlier.

Overall, boys reported similar responses although it was not a strong theme throughout the interviews. The addition of sound effects, for a small number of boys, adds enjoyment to the game play, particularly if it involves explosions. However, it is difficult to support Henney's (1986) report that boys find sound effects in computer games to be important. It is possible, though, to interpret the boys' general lack of response about sound effects as simply a feature that every game has and thus it is not an important or unique element on which to comment.

Music

In relation to the sounds of a computer game, the musical side of the program was mentioned most frequently by girls during the interviews, thus confirming Cooper, Hall, and Huff's (1990) findings that girls generally want music to be part of the computer games they play. However, defining what the girls like in music is more difficult. Generally, the girls could not explain what they meant when they talked about the music they like, but terms such as "funny and cool music", "bright music", or "boppy loud music", were used several times by a number of girls. Generally, the girls stated they like their music fast and loud. Unlike colours that can be named, music is an intangible feature that would need to be identified in particular games. However, a number of girls mentioned particular singers and groups, indicating that current music is preferred. This type of music is more likely to be found in merchandising products related to popular culture than in educational software and would obviously change with musical fashion making it a difficult attribute to include

None of the girls named a game as having what they class as good music, so it is difficult to infer anything more specific than music seems to be an important feature that contributed to girls' enjoyment of computer games.

Boys, once again, provided similar responses to those of the girls. The interview data indicates that they generally preferred medium to fast music and usually loud, with this preference evident across all ages. Interestingly absent, though, are any descriptors similar to those used by the girls that could assist in interpreting what they like in music. Generally, when a type of music was mentioned by a boy it was either Rock or Rap.

It is when I asked the girls what type of music they believe other girls would like that the issue becomes interesting but, possibly, obscures the overall picture. Two aspects to the issue of music in girls' games arose. First, all the girls that were asked if they would put music into a game they were designing for girls answered in the affirmative, indicating that music is an important attribute. According to my girls, you cannot have a girl's game without music. Second, the girls responded with a stereotypical view of what girls prefer. Many used words such as "sweet and lovely", "happy music", "music would be gentle and soft", which is played in a soft and slow manner. However, these descriptions did not dominate their opinions of what they like personally. Individually, they seem to like both loud, fast music as well as soft, slow music, but when asked about other girls a narrow stereotype emerged.

This stereotype is echoed in the responses of the boys to the question of what they believed girls like. They described girl-friendly music as being generally soft, low, and slow. It would be "pretty music" making "peaceful sounds", certainly not "rough and noisy" like boys' sounds and music. This result indicates that a game that has soft, slow, or gentle music may be labelled by the boys as a girl's game. This result has ramifications for my choice of an inclusive game.

Another issue that arose from the interviews was what girls did not like in music. Several girls mentioned that they do not like musical repetition. In other words, the same music played over and over again throughout the game. Obviously, the volume control could be used to overcome this but that would take the musical element out of the game; an element already identified as being desired by many girls, as well as removing any sound effects. Also, and in opposition to what many boys seem to prefer, Rap music was identified by many girls as being undesirable. In regards to the type of music not liked by the boys, the data provides only a small number of responses. Babyish music, classical music, or no music at all were among the few responses gained from the boys that indicate what they do not like. Given that they reported a strong liking for Rock and Rap music, dislike of these forms of music should not be surprising.

The literature does not shed a great deal of light on the question of the music and sound preferences of girls in computer software. Cooper, Hall, and Huff (1990) found girls preferred music, but they did not report which type of music, and no mention of sound effects was made. Agosto (2003) reported that the female subjects she interviewed spent more time discussing the multimedia (both audio and visual) aspects of web page design than any other features, and she came to the conclusion that "the importance of...[the] multimedia quality and quantity to girls cannot be overstated" (p.30). That report, combined with the girls in this study mentioning the importance of music, indicates that music should be present in the game, with an option to turn it off or, perhaps more importantly a feature that allows a selection of musical tracks that reflects different styles to be chosen by different players. This is not an unreasonable quest as there are non-educational games already on the market that offer the player a choice of music.

Conclusion

From the answers supplied by both the girls and the boys, it would be important that the game being considered for use with girls have a bright, colourful appearance. It would be difficult to exclude any particular colours (except, perhaps, pink) just as it would be possibly unwise to promote certain colours. The issue would be one of overall appearance, and that would be of a bright nature, that uses many varied hues and shades.

The presence of music would be an important, if not essential, attribute for many of the girls. The ability to select different tracks to avoid repetitious music would also be desirable. Although it would be difficult to translate what the girls meant when they talked about bright or happy music, it would be a fair conclusion to say that the style of music found in games that depended on suspense or horror, which is usually slow and dark, would be the type of music not preferred by the majority of the girls. Again, though, the ability to personally select musical tracks may satisfy the majority of the girls.

Recommendation: A variety of music should be available combined with a facility to select and play different tracks or styles.

Frequent mention was made by the girls in the focus groups that they liked certain things depending on their mood at the time. Musical track selection could be an ideal way for girls to use the computer game the way they feel at any particular time. Of course, it could be argued that potential science education programs would, perhaps, have no need of music. However, given the importance of the musical element to many of the girls, it certainly would not be a negative to have it at least available.

Narrative

Direct evidence of girls preferring a strong and well-developed narrative is not readily identifiable from the interviews. Only one girl, Nicola (10, lines 74-5) made mention of the narrative saying, "If it's got a good story line, if it's a quest one", then she would enjoy playing. In this particular instance, it did not surprise me that Nicola identifies narrative as important for her enjoyment as she borrows extensively from the fiction section of the school library. Obviously to her, a good story is something to be enjoyed and she carries this preference over to computer games she likes. The other girls, however, did not show any direct evidence for a preference for a strong narrative. I put this lack of evidence down to me not directly asking my students about the importance of the story within the context of the computer games they like or in the attributes they deem important. This reflects my stated desire not to lead any of the students in their responses through cues given by the questions.

Although there is a lack of direct evidence for the preference of a narrative, I believe there is evidence to be inferred from responses to other questions in the interview. One set of questions I posed to my students was to ask them to design a computer game for girls and also to design a computer game for boys. By examining their responses to these questions, evidence can be found regarding the importance of narrative.

When asked to design a game they believe other girls will like, many of the girls' responses indicated the importance of storyline. It was apparent that many of the girls were influenced by existing computer games, with their descriptions very similar to games already used in the school and by other commercial programs. However, notwithstanding this, the storyline is obviously an element considered desirable for girls by other girls, although within the limits set by the interview situation, most of the responses were simplistic and basic. Of the 68 responses recorded, the majority described scenarios that included elements such as non-violent action, social settings, sporting scenarios, dolls, or animal care. Many scenarios described by the girls incorporated problem-solving situations resulting from activities and incidents arising from the story. However, the significant thing to note is that all the girls based other game elements around the story - there was not a response that did not begin with a narrative orienting the game play.

The strongest style of story that emerged from the descriptions was one dealing with social themes, for example, shopping and fashion, or interpersonal relationships. For example, Carol (9, lines 123-4) had the girl players dress up dolls after which they would go out for tea and then return to their pink bedroom. Iris (10, lines 97-100) suggested a game where one group of friends in a school competes for points with a group that is not liked, and Kath (10, lines 91-7) combined adventures and problems with the purchase of clothing.

It would appear that the majority of the girls perceive other girls' preferences in a very distinct, stereotyped manner. Clearly a third of the responses indicate the purchase of clothing or designing and shopping with friends as central themes of the narrative. From this observation, it could be inferred girls believe that while it may not be for themselves, the domestic space is the place for other girls. Consistently, the girls described and designed a social world in which girls interact with other girls. This preference is supported by the literature regarding the types of settings and protagonists girls prefer: girls like to have a place where they can interact with their peers within a safe environment of familiar, often domestic, objects and places (Glaubke et al., 2001; Kafai, 1996; Subrahmanyam & Greenfield, 1998).

It is important to note, however, that although the central themes of games designed by many of the girls may appear shallow, the descriptions of the storyline strongly indicate thought has gone into the narrative element of their game design and that they perceive the story is an important element. This, too, supports the literature where a number of researchers found girls were attracted to computer games that demonstrate complex narratives which provide depth to their playing experience (Laurel, in Cassell & Jenkins, 1998c; Murray & Kliman, 1999).

Significantly, some of the girls indicated that the games they would design, and the stories that went with them, would not necessarily appeal to them personally. Barbara (11, lines 161-78), for example, described an action game she would design for boys that relied on a complicated detective scenario then, when she continued the interview and described the game she would design for girls, prefaced her remarks with, "Well, personally I would like that game I just described" (line 196) before describing a magic-based game dealing with a girl making decisions about her own actions in school. Carol (9, line 121) aimed her design squarely for "real girly girls" when she described the dolls and the dressing up in her girl game.

Throughout the descriptions given by the girls regarding their girl-game designs, I detected a very strong feeling that they were designing for a group that exists in their minds but not in their personal realities of how they themselves interacted with their environment and friends. My interpretation is that they were saying, "Yes, I know girls are supposed to be like this and play like this and through my game design I am acknowledging this stereotype, however, I personally reject that way of thinking for myself. I am an individual and want to be treated as such". To me, this is a clear demonstration of gender stereotyping by many of the girls. When asked these questions about what other girls would like, many of the girls seemed to rely on stereotypes in order to supply an answer. This does not surprise me for the literature informs us that stereotypes are a way of organising information and so become useful in situations where explicit information cannot be given, thus allowing generalisations to take over (Deaux & Kite, 1993; Hyde, 1996; Unger & Crawford, 1992). By using a stereotype to answer the question, I believe the girls may have thought that they were providing a socially acceptable answer to a query that they could answer satisfactorily regarding themselves, but not about another group; this was the safest way to supply an answer they thought would be acceptable to me.

This points to a larger problem that may need to be faced in environments other than the computer laboratory. If the stereotypes many of my girls appear to believe continue to hold sway, then social pressure will come to bear on my girls to maintain the stereotypes and publicly conform to them (Katz & Ksanak, 1994; Maccoby, 1990; Smith, 1987). This could force the girls, in some instances, to forgo computer games they might rather play and instead use computer games deemed more socially acceptable for them, but not individually preferred, thus robbing them of a possible enjoyable and educative experience. If so, then it is imperative that these stereotypes be challenged in the classroom for what they are, complex myths perpetuated by people prepared to support rather than challenge them. The girls, and the boys also, should be encouraged to look critically at social expectations about the types of computer games they are supposed to like in comparison to the computer games they actually do like, and make a claim for their own individuality. Doing this represents a reflection of Lincoln and Denzin's (2000) "seventh moment" of qualitative research that is a foundation for my overall search for more equitable outcomes for girls' involvement in not only science education but in their lives in general.

To me, particularly in light of what Connell (1987) has said about the greater differences within a gender group than between gender groups, I find the issue of individuality to be of strong interest. Without pre-empting any conclusions that I may derive from my research, I am inclined to assert that treating my students as individuals rather than a homogeneous group may pay greater dividends for their learning. Thus, a diversity of software (albeit with similar learning outcomes), being made available for individuals to choose may be a way to engage all my students.

In contrast to the domestic setting for girls, the storylines the girls incorporated into games designed for boys illustrated a strong emphasis on violence, sport, scary environments, and action. The responses also demonstrate that the girls seem to hold stereotyped views regarding preferences of boys. Recurring themes throughout these 'boys' games were fighting with weapons, racing with machinery, and basic violence against all manner of people and machines. Overall, the girls' responses indicate that boys require a shallow storyline, with the narrative usually serving simply as a vehicle to drive the action and violence of the game. Also, the storylines described by the girls as being suitable for boys give an indication of what they perceive as a boy's game and would probably avoid as being unsuitable for themselves. Thus it seems to be important to ensure that for potential educational games being considered for use with girls to not have these types of storylines as the driving force behind the game play if girls are to be part of the target audience.

Recommendation: The narrative should not be present simply to justify the presence of violence.

I also asked the boys what they would put into a computer game they might design for girls. From their responses it could be concluded that they too perceive a storyline as being important for a successful girl's computer game. Of the 59 responses to this question, many gave detailed outlines of what their 'girl's' game would be about, responses which painted mainly a picture of girls involved in domestic storylines. Shopping, fashion, dolls, and animals (particularly horses) were recurring themes in the storylines advanced by the boys. The lack of violence was apparent, and this also extended to a lack of action for the girls. The boys clearly perceived girls as preferring a much more docile and slower story than those they ascribed to boys. This is important to note, as games that demonstrate a domestic orientation may be deemed by boys as being suitable only for girls, possibly turning them away from certain game designs.

Because part of my research aim is to identify game attributes inclusive of all students, this finding needs to be kept in mind.

The boys also saw games they designed for girls as being simpler and easier than those they would design for themselves. Barry (11, lines 115-6) for example, claimed that a game he would design for girls "would be more easy going, not too challenging", implying that girls would not be able to handle the intellectual complexity of a boy's game. This indicates that a game design that is to appeal to both girls and boys should not appear to be simplistic or to be following a simplistic storyline.

Another source of data that shed light on the importance or otherwise of the narrative to my students was the survey of games that are liked and disliked. In examining the list of computer games identified by the girls as ones they liked, very few could be judged as narrative-driven. Of the 131 discrete titles[11] mentioned, only four games that can be considered narrative-driven were mentioned by more than one girl as being liked: the *Zoombinis* series (51 mentions), the *Carmen Sandiego* series (14), *Harry Potter and the Philosopher's Stone* (seven), and *Goosebumps* (three). However, this may indicate the dearth of narrative-driven computer games available in the marketplace. The *Sims* series was mentioned 23 times but I am not convinced the storyline is strong in this series of games. This series represents more of a cartoon simulation of real life, in which the story is basically supplied by the player and what they wish to do with their characters. The popularity of this set of programs may have more to do with the presence of multiple

[11] I am not claiming to be familiar with all the titles listed by my students. Although I am familiar with the majority of the titles through my own game playing and computer magazine reading there are still a small number of titles with which I am unfamiliar. When examining an unfamiliar title I relied on the student's written description of why the game was liked or disliked in order to make a decision about what genre the game fitted and the likely make up of it in terms of features and attributes.

characters and domestic settings, and the nurturing of characters, attributes discussed in other sections of the analysis.

Of the 79 games listed by the girls as being disliked, the *Carmen Sandiego* series (eight mentions), the *Living Books* series (seven), and *Goosebumps* (three) were mentioned by more than one girl. Obviously, due to the small number of games with a narrative mentioned, it cannot be determined from either of the 'liked' and 'disliked' lists that the presence or otherwise of a strong narrative was the reason why these particular games were liked or disliked, but the indication by the girls that more individuals mentioned narrative-driven games as liked may offer weak support for the presence of a storyline as a preferred attribute. However, an alternate view can be extrapolated from the same figures by postulating that the majority of games listed as liked do not have a storyline as the game's driving force. Other sources need to be examined in order to make a sound judgement regarding the attribute of narrative.

The third source of data also did not supply strong support for the presence of narrative. Data from the observation sessions indicated that, among the more popular game choices, only the *Carmen Sandiego* series and the *Living Books* series appeared in the top ten games selected by girls (Appendix 3). Although the range of games available in my schools is small, with few based upon a narrative, it appears that girls prefer to engage in arcade-style game play.

The data obtained from the focus groups, however, tended to confirm the importance the girls attached to the presence of a narrative in computer games. It was strongly agreed across all ages that a story is important. It appears that the main reason a storyline is important is that it orients the player about why they are playing the game and informs them what they are required to do in order to successfully complete the game. It was generally agreed that without this, there is little point in playing a particular game. Amaro and Moreira (2001) support this view with their research that indicated that girls need the narrative to assist them to make sense of the multiple events that happen throughout the playing of a computer game.

Of course, the girls acknowledged that some types of games did not require a story, with arcade games gaining mention several times. It was generally agreed that a story would not enhance the typical arcade game, which was perceived by many of the girls as something to be played simply to pass the time rather than to learn.

As stated in earlier sections, one of the aims of this research is to find attributes of educational computer games preferred by both girls and boys in order to identify programs that are inclusive of both sexes. Therefore, finding out about the importance or otherwise of narrative to the boys is equally important.

In examining the data derived from the interviews, a similar inference to that drawn from the girls' responses can be made in relation to the boys' preference regarding narrative. Again, direct evidence of the desirability of a strong narrative was not readily provided. As with the girls, only one boy made a direct reference to storyline as being desirable. Eric (11, lines 60-61) claimed the way the storyline is set adds pleasure to his game playing. He reinforced this claim when, in a reply to the question of what he did not like in a game, he stated, "It's usually the storyline and it's a bit like you have to do a whole lot of things, usually for no reason" (lines 77-79) indicating that, for him, if the story is not relevant to the game, but is just an excuse to move from one game area to another, then there is little point in having it.

When asked to design a computer game for other boys they, too, resorted to stereotypes, as did the girls. When asked to design a computer game that other boys might enjoy, as a group they opted for storylines that lent themselves to action, aggression, competition, and violence. Unlike the girls, many of the storylines provided by the boys were simplistic and appeared to be present simply to allow fighting to occur. It concerned me that the majority of these boys seem to perceive boys, as a group, as enjoying such violence-oriented games. This popular perception appears to be a stereotype held about boys and computer games. However, there was evidence that non-violent competition drove a number of preferred narratives, for example, car racing, sporting contests, and problem solving, thereby indicating that a storyline incorporating such scenarios could be acceptable to the boys, as a group.

In analysing the games 'liked/disliked' survey list provided by the boys, there is less evidence than supplied by the girls for narrative-driven computer games. Only a small number of boys mentioned games with this feature, with the *Carmen Sandiego* series (four mentions), *Harry Potter and the Philosopher's Stone* (four), and *The Lord of the Rings* (three), being the only narrative-based games to receive multiple mentions. In considering the 'disliked' games, several narrative-driven games were mentioned multiple times. I acknowledge that this is weak evidence, but I am suggesting, as with the girls, this pattern indicates that narrative is not a central feature preferred by many of the boys, particularly when considering the other games listed, noting that the majority were arcade-style games which depend on fast rather than thought-out responses for success.

Stronger evidence, however, could be found from the data that was generated in the observation sessions. With access to narrative-based games, would the boys be more likely to use them? It could be argued that the boys may not have had much access at home to narrative-driven computer games because the games purchased for them by parents could be the type of games parents believe fit the stereotype of boys' likes and dislikes.

Table 19: Narrative-driven games observed being played at school during lunchtime computer laboratory sessions. (F=127 / M=127)

Game title (or series)	Selected by individual girls		Selected by individual boys	
Carmen Sandiego	34	27%	28	22%
Living Books	13	10%	3	2%
Imagination Express	11	9%	5	4%
Goosebumps	9	8%	5	4%

Table 19 details the frequency of selection of narrative-driven games during the observation period. It is clear that the boys did not choose available narrative-driven games as often as did the girls. During the observation sessions only one narrative-driven game, *Myst*, was played only by boys. What is evident from the observations is that the boys enjoyed the arcade-style of game, a pattern that reflects their responses on the survey of games they liked and disliked. Arcade games, as I have already noted, do not usually rely on narratives to drive the action.

The focus group data presented a contradictory view when compared to the data generated by the other sources. The general agreement amongst the boys, and this was evident across all age groups, is that a narrative is an important element of a computer game. The same reasons given by the girls in their focus group sessions were evident amongst the boys. The perceived role of the storyline is to give the player a purpose, to explain why certain tasks need to be performed, or to inform why someone or something is the enemy. As one boy explained, "It helps you understand why you are doing it". Again, as with the girls, the boys seemed to be aware that some types of games do not require a storyline, with arcade games being given as an example.

Overall, the evidence indicates that the boys, although appearing to claim that a storyline is very important in a computer game, regularly nominated or selected games that either do not have a storyline or, if present a very weak storyline.

Conclusion

The preponderance of direct data indicates that the computer games many girls play for enjoyment do not incorporate a detailed storyline. Data generated through the focus groups, where the issue of narrative was directly addressed, indicates a strong endorsement for the presence of a storyline. This inference is strongly supported by the girls consistent use of a storyline as a design element for their games for girls.

Unfortunately, the need for a narrative is one of the few attributes that does not appear to be an attraction for many of the boys. Whereas in previous sections of this chapter it was shown that boys could and would accommodate girl-friendly attributes, in the case of narrative many seem to view it as a distraction and ultimately as a negative attribute for a computer game. However, the primary aim of my research is to identify girl-preferred attributes, and so I conclude that the evidence suggests strongly that educational computer games with relevant storylines need to be included in the selection criteria.

Recommendation: That the game should have a storyline that is integral to the game play.

Characters and Avatars

At the outset of this section it should be stated that the questions that deal with the main characters in students' preferred computer games focus on the gender of the character rather than on the importance of having a main character. Also, it needs to be remembered that many computer games do not have main characters that represent the player, for example, arcade 'shoot-em-up' games.

From the 137 (F=63 / M=74) students who were asked whether they prefer to play as a male character or female character in a computer game the responses in Table 20 were obtained.

Table 20: Preference for a female or male protagonist.

Girls who prefer main character to be male	15	24%
Girls who prefer main character to be female	28	44%
Girls who don't care/don't know about gender of main character	20	32%
Boys who prefer main character to be male	51	69%
Boys who prefer main character to be female	3	4%
Boys who don't care/don't know about gender of main character	20	27%
Total of girls and boys don't care/don't know about gender of main character	40	29%

From Table 20, a large majority of the boys seem to prefer a male character to represent them on the screen, whereas the girls do not seem to have the same strength of preference, with less than half indicating preference for a female character, and almost a quarter indicating preference for a male character. This is an interesting finding in relation to the literature, especially compared with the study by Littleton et al. (1998) who found that girls identified with the female characters they used in the 'girl' version of the game more than they identified with the male characters. From the results of that study (as well as Glaubke et al., 2001 and De Jean et al., 1999), I expected a greater indication by the girls of a preference for a female character. However, their reasons for preferring a male avatar became clearer when their answers to the follow-up questions were analysed.

When a child indicated a preference for a character with a particular gender h/she was asked why. The qualitative data provided by the students paints an interesting picture regarding how they perceive the game character under their control to be able to help or hinder them in successfully playing a game. It appears that some children believe that the gender of the computer character can make a difference to the success or otherwise of some types of computer games, for example, role playing and Real Time Strategy games that often utilise strong male characters. The responses of some girls indicate that they perceive a male avatar as being 'physically' better suited to playing a game - "Boys [referring to the gender of the computer avatar] are more adventuring than girls, they like exploring and stuff", claimed Helen (10, lines175-6), while Joan (10, line 137) stated: "they're more strong and stuff like that". Other responses indicate that by using a male avatar the chances of successfully completing the game were increased - "[male avatars] are able to [do] more stuff than girls 'cause girls usually are not very good on computer games", claimed Alice (11, lines 212-14). It seems that some of the girls believe that manipulating a male avatar will result in greater enjoyment because success is more likely. This may be a result of social conditioning that some girls experience in their everyday lives where they often see and read about male figures successfully engaging in physical situations, as well as their own social experiences of boys being generally more active while they are expected to be more quiet and conforming. Perhaps some girls may project this belief onto their on-screen characters.

This is a crucial point to note because if Agosto's (2003, p.28) claim is true - that girl characters can "bolster girls' feelings of assurance and self worth" - then having a perception that only a male computer character can guarantee success might damage girls' self esteem and be a factor that turns them away from computer games that rely on the main character's actions for success. Agosto's view gives rise to a call for the inclusion of a range of active female characters in educational computer games to be made available to girls.

These responses provide one of the sadder points I discovered through my research. It appears that a number of girls believe that the gender of the character on the screen dictates how the character performs. They seem to be unaware that the pixelated representation on the screen can do anything the programmer wishes it to. To many of the girls, if it is a 'male' character it can generally jump higher, move faster, and carry heavier objects when compared to a 'female' character. Although the choice of character has no real or direct effect on the game, many girls in my study perceive that it does. Perhaps I should not be surprised with this, however, because my earlier tertiary studies in children's literature indicated similar scenarios in the majority of books written for children, scenarios in which the male protagonist is smarter, stronger, and more adventurous than the 'average' female character (Baker & Freebody, 1989; Davies, 1989a, 1989b, 1993; Freebody & Baker, 1987; Gilbert & Taylor, 1991). If this is what girls are constantly being told by stories then, to them, it is likely to be true for computer games.

However, what disappoints me most is that this aspect of gender stereotyping in children's books is something that I regularly discuss with all the children in my two schools in order, first, to raise awareness that stereotypes can be found in a variety of places and that we must be alert to them and, second, to foster an understanding that although we continually see protagonists in stories doing certain stereotyped actions it does not mean that it has to be that way in real life. People can make their own decisions about what they do and say. However, these results indicate that either the children have not taken these discussions 'on board' as much as I had hoped or they are unable to transfer the discussions across media types and apply them to computer games.

I found this to be a sad and, in some ways, frightening finding. Sad inasmuch as some girls seem to believe that they cannot perform as well as boys, and frightening to see that some girls do not realise that the picture on the screen is only an image. In reality, the image can be of anything and still perform exactly how the programmer decides, having a male appearance does not necessarily increase the chance of success, nor does the depiction of a female necessarily detract from the enjoyment the game can provide. Although this finding is outside the brief of my research it is certainly one that I will keep in mind when talking to all the children during future sessions in the computer laboratory.

A number of girls, however, indicated a preference for a female character to represent them. The most common reason for this preference is that it is natural to choose a girl character. Other responses indicate an acknowledgement that girl characters can bring a different dimension to game play. Elizabeth (8, lines 134-5) indicated that she wants a girl character because "they can sometimes be smarter than boys", while Elsie (11, line 152) stated that "girls are more interesting than boys". Perhaps she sees a male character as being a one-dimensional stereotype that only uses brawn and muscle to succeed. Thus the choice of a female screen character is based on simple stereotyping and lack of understanding of programming. Although on the surface it is good to see girls choose girl characters, it appears to have been done for ill-informed reasons. This stereotyping was identified by one boy, Eric (11, line 252) who described male computer characters as being "too macho" and prefers a female character. In analysing the data from an age perspective there appears to be no identifiable trend regarding the preferred gender of the main character by different-aged children.

An interesting issue arising from the interview analysis is that 29% of the students do not seem to care about the gender of the main character or simply do not know or hold no opinion. Only one girl, Denise (9, line 21) mentioned that she does not like a particular game because "you have to be a boy". Equally, only one boy mentioned that playing as a girl character is a negative aspect. Neil (12, lines 52-3) does not like games "that are not very violent and maybe adventure games with girl characters". Overall, this pattern may indicate that the character gender is not a crucial aspect of a computer game for many children, a proposition which does have small support in the literature (Chappell, 1997; Joiner et al., 1996).

There is an identifiable trend between boys and girls in terms of the importance of game characters. Girls mentioned characters when describing their favourite games 30 times whereas boys mentioned characters only eight times. I inferred that the presence of a character is likely to be more noticed by girls than it is by boys, perhaps indicating that for an educational computer game to appeal to girls the use of characters to facilitate game play can be viewed positively.

The responses of the students also indicate two distinct types of characters as being important to them: (i) character(s) that can be created by the player and, (ii) character(s) supplied by the program.

For the girls, being able to create their own character is a recurring positive theme throughout the interview data and the data generated from the survey sheets concerning favourite games. This point is illustrated by the numerous times the *Zoombinis* series of problem-solving games was mentioned. The initial activity in which a player engages in this series is to create a party of 16 Zoombinis which the player guides through a set of problems with the objective of safely delivering them to their village. A variety of attributes can be assigned to each creature making them unique individuals. Their unique attributes are the features that key the logic puzzles. Girls who mentioned the characters used descriptors such as "cute", 'cool", and "funny", and it appears as though the girls were claiming ownership of the game through the character constructions. This appears to be a major contributor to their enjoyment of the game. In terms of age, the 10- to 12-year-old-girls made more mention of the importance and fun of creating their own characters. In relation to the boys, the creation of a playing character was mentioned only a small number of times and was spread evenly across the age groups.

It is not just being able to make creatures that appears to appeal to many of the girls, but also being able to make people in the game. This is demonstrated by the significant number of girls mentioning the *Sims* series of programs in the survey sheets as being liked. This series of programs involves a player creating a family, housing them and controlling their activities and social interactions with other characters who are controlled either by other players or by the computer's artificial intelligence script, within the game environment. Heather (10, lines 10-12) described it as a game she likes because, "there are like people that you can actually create and make them do things. And they can buy pets, and then [the] pets become part of the family", while Nicole (11, lines 10-12) likes it because "you get to design your own things and make the people do whatever you want and design people. You get to build houses". The popularity of the *Sims* series with the girls seems to reflect the feminine attribute of nurturing. They are able to develop their characters as a 'family' and watch them grow and prosper. This inference is supported by the literature which reports that girls want to build relationships with the characters they create in their computer play (Cassell & Jenkins, 1998c; *Purple Moon*, n.d.).

In contrast, when boys mentioned the *Sims* series in the survey they generally referred to the objects that can be built or collected, rather than to nurturing the 'human' characters in the game. Thus, even in a game designed with caring for the characters as the main purpose, the boys seemed to be mainly interested in how they could manipulate the computer-mediated environment to their own advantage. This interpretation is supported by Dalton (1990) and Passig and Levin (1999), who both maintain that boys want and need to control the computer in order to gain the maximum enjoyment from its use.

The data provided by the focus groups indicates that neither the girls nor the boys hold any dogmatic views on which gender the player's character should be. The girls generally agreed the gender of the player's character does not really matter. However, notwithstanding this, the girls indicated that they would prefer to have the choice of character gender rather than the program dictate it to them. This is particularly evident with the 11- to 12-year-old girls, where several indicated that, depending on their mood, they may choose a boy character or a girl character. For example, one 12 year old girl stated that, "sometimes you like being a boy if you want to blow something up". Again, stereotyping for character selection is evident, however, I would still recommend allowing the player to select or design their own character.

Recommendation: That a range of avatars should be available to players, with both genders being represented in the selection.

An extension to having the choice of the character's gender is the option of actually designing the character's appearance. Many of the older girls indicated that if a main character is available they like the opportunity to design its physical appearance and also to select its clothing. This preference suggests a continuation of the doll culture that many girls experience in their infant years. Perhaps adding this feature to an educational computer game would provide familiarity and encourage some girls to use particular programs. However, this does not mean that the characters should be able to be designed in pink only or clothed in dresses. I support Fiore's (1998) research which indicates that girls want to construct and dress their character in an adventurous and sporty manner that will befit the action found in many computer games. Their characters will be designed to reflect the action in which they partake.

Recommendation: Allow the player to design/create the appearance of their own avatar.

The focus group responses of the boys indicate that they take a more utilitarian position in regards to the gender of the main character; its gender does not appear to be of importance to them. Rather, they seem to regard as important what the different characters can do in the game. The boys generally agreed that they would choose a character that has the attributes needed to solve a particular puzzle or defeat a particular opponent. If the gender of that character is female, so be it. The boys seem to recognise that game designers often give different characters specialist ‘skills’ to use throughout the game and that the strategy to be successful means you choose the character best suited to the task in hand. Perhaps this demonstrates a better familiarity and understanding with how characters are designed in computer games than that demonstrated by many of the girls (Griffiths & Hunt, 1995). However, it was also generally agreed amongst the boys that if the skill attributes of all available characters are identical then they will probably choose a boy to be their avatar. This pattern is supported by the results in Table 20.

The focus group responses also indicated that both the girls and the boys are aware that not all computer games require a main character. A number of children pointed out that games such as *Aquanoid* and *Diamond Mine*, games typical of the arcade genre, do not need any characters. Thus the children tend to see the issue of character gender as relevant only in games that require a main character. The presence of a female or male character needs to make sense, not just being present in order to make the game appeal to one group or another. Perhaps this perception represents a certain sophistication in the children’s understanding of the role of the main character, be it literature or computer games.

Conclusion

From the data analysis I could not conclude that having the main character depicted as female is an essential attribute of girl-friendly software. Although this finding contradicts the majority of the literature, and my own personal ‘gut feeling’, it cannot be supported unequivocally by the data provided by my students.

The recommendation I would make in relation to the gender of the main character is two-fold. First, make available a selection of characters at the beginning of play representing both genders, thus allowing the player to select the character's gender with which they are most comfortable and, second, allow the players the option of actually 'creating' the character by selecting the attributes that make up the physical look of the character. This would allow ownership of the character by the player and, particularly for girls, allow nurturing of the character, thereby increasing interest in the outcome of the game. In the case of science education software, if girls could choose a girl character, and that character succeeds in 'winning' the game, then possibly the success of the avatar in science on the screen could encourage the girl player to enjoy and achieve in real-world science education.

The other recommendation I would make is one that does not concern the design of computer games. I would urge teachers to discuss with students the gender stereotypes presented by computer games and expose them for the falsehoods that they present to young children. Although this is outside my stated aim of providing a list of girl-friendly attributes, it does fall within the realms of Lincoln and Denzin's (2000) call for a moral perspective on research. While ever some girls hold the belief that boys are superior, many will want to play as a boy in their computer games. As teachers, we need to explain that the depiction of a male character on the screen does not necessarily increase the likelihood of success. Either gender could be a valid choice for the successful completion of a game.

Collaboration/Cooperation and Competition

The attribute of competition figures prominently in the review of the literature, with girls reported as not wanting competition and boys regarding it as an essential element. In the interview data, only a few girls described attributes of computer games that could perhaps be interpreted as competition being something they like. A small number mentioned high scores or point scoring as being an attribute they enjoy in a particular game, but in all cases the context indicates they like competing against themselves rather than against another person or the computer. Alison (12, lines 179-83), for example, gave as a reason that she enjoys playing a particular game as, "I just like to try and beat my last [score]...it's trying to make yourself beat what you tried to do last time". Alison, in this case, is clearly competing with herself. Only weak support for this result can be found in the literature, with Caftori (1994) reporting that younger girls, especially in Year Three, enjoy point accumulation and trying to achieve the highest scores.

A similar situation was found with the boys, where only a very small number mentioned attributes that could be interpreted as a desire for competition. Jeff (8, line 10) for example, likes a racing game because "you get to compete with other people in racing", and Shane (11, lines 64-8) likes playing one game in particular because "you've got a time limit and me and my friends always try and get better times than each other". Clearly to Shane and his friends, competition is an attribute that enhances their enjoyment.

Competing against themselves, though, does not seem to be a strong factor for many of the boys. Only one boy, Peter (12, lines 52-5), mentioned this aspect, saying that he likes a particular game because of "how it's so simple but...so addictive, like if you lose you want to play again just to beat what you did before". Interestingly, some boys do not seem to perceive playing against the computer as playing against themselves. They seem to perceive the computer as a legitimate opponent that needs to be beaten. Raymond (8, lines 16-18) likes playing a particular game because “you have to try and make up words that are really hard and you have to try and beat the computer”. He views the computer as his opponent and wants to compete against it and defeat it.

Competition in the form of collecting objects or points is more evident in the interview data gathered from the boys when compared to the girls. As a group, the boys appear to find scoring points, making a high score, beating a previous time, collecting objects, or going up a level as being a desirable attribute more often than do the girls. As reported above, very few girls mentioned points, or collecting objects, although a larger number did mention going up levels. However, once again, not enough evidence is available to infer that in general the attribute of amassing points or objects is essential for girls’ or boys’ enjoyment.

Whether the lack of evidence indicating a preference for competition or otherwise is due to the way my questions were worded or because my students do not think it is an important feature I cannot determine. However, some indication of whether the girls prefer cooperation or competition may arise from the quantitative data generated from questions asking whether they prefer to work on a computer or play computer games by themselves or prefer to do so with a friend.

From the 196 (F=97 / M=99) students who responded to the question of whether they prefer to work on the computer alone or with a friend the following figures were derived.

Table 21: Preference for working by themselves or working with a friend.

Girls who prefer to work alone	48	49%
Girls who prefer to work with a friend	38	39%
Girls who prefer to work 50/50[12]	11	12%
Boys who prefer to work alone	42	43%
Boys who prefer to work with a friend	38	38%
Boys who prefer to work 50/50	19	19%

Table 21 indicates a near majority of my students prefer to work on a computer by themselves. A small number indicated they did not mind either way. The figures in Table 21 indicate that both the boys and the girls generally prefer to use the computer by themselves and not share with another, although with the caveat that the difference does not appear significant.

From the 208 (F=106 / M=102) students who responded to the question of whether they prefer to play computer games alone or play with a friend, the following figures were derived.

Table 22: Preference for playing computer games by themselves or playing with a friend.

Girls who prefer to play computer games alone	50	47%
Girls who prefer to play computer games with a friend	37	35%
Girls who prefer to play computer games 50/50	19	18%
Boys who prefer to play computer games alone	44	43%
Boys who prefer to play computer games with a friend	42	42%
Boys who prefer to play computer games 50/50	16	15%

[12] 50/50 represents sometimes preferring working by themselves and sometimes working with a friend

Table 22 shows a near majority of my students prefer to play computer games by themselves. As with the figures in Table 21, a similar response is evident here in relation to playing although, interestingly, slightly more boys indicated that they prefer to play with others. I view this as a weak indication that the boys like to compete with friends, which is preferred to competing against the computer. Possibly, this allows social interaction but in a competitive environment. On the other hand, I interpret the girls' stronger preference for playing alone as indicating that they would rather play against the computer than to compete against their friends. I make this observation through the knowledge that most games do have a competitive element and so many girls perhaps try to avoid the confrontation that competition can often bring by avoiding playing with friends. Also, it may be that, as the figures on working alone or with a friend indicate, that many of the girls simply do not want to share the computer with anyone else. Possibly, they want to maximise their use of the often limited amount of time available at school for computer use, especially in the school environment. It appears from Tables 21 and 22 that cooperation or social interaction in regards to computer use is not a feature of great significance to either the girls or the boys in my study.

This does not mean, however, that programs that accommodate cooperative interaction will not be preferred by girls or boys. Data generated from the lunchtime sessions do lend weight to the belief that both girls and boys are willing to cooperate voluntarily on a computer. Part of my observation included noting the number and sex of students who either shared a computer or played alone. Over the 87 lunchtime sessions I observed that there were some girls sharing in all but 21 of the sessions and some boys sharing in all but 14 of the sessions.[13]

13

It should be pointed out, though, that in one of my schools there were enough computers for each child in a class and the computer teacher discouraged more than one user per computer. This may have spilled over to the lunchtime sessions at that school, with students going to a single computer although there was no requirement or direction from me to do this. What I did notice, though, was that many students

Whereas this does not prove that both boys and girls prefer to cooperate and share with other students or not, it does show that students are willing to share if not enough computers are available. The students could have returned to the playground if they did not want to share a computer with another student. Thus it may be inferred that including features that encourage cooperation between players will not necessarily deter either the girls or the boys from playing. One aspect from the observations that I noted, but which does not directly concern my research, was that in the 87 sessions only 14 had a mixed-sex pair sharing a computer, and this was usually the same pair. It appears that the boys are prepared to share with other boys and girls with other girls, but they do not wish to share with the other sex. This is something that perhaps I should be aware of when pairing up children for educational activities.

When discussed in the focus groups, preferences for attributes of competition and cooperation were again unclear. The younger girls, 8- to 10-year-olds, indicated a preference for cooperation when playing games, saying that being able to get suggestions from friends or help if stuck on something are reasons that playing cooperatively is enjoyed. Overall, they gave a strong indication that social interaction generated through playing a computer game with friends far outweighs any fun they might gain through competing with another person or with the computer. This is supported by the findings of Murray and Kliman (1999), as well as Miller, Chaika, and Groppe (1996) who, from the focus groups they conducted with girls, interpreted a similar preference for social interaction, with the computer game facilitating socializing within the group. However, it is contrary to Caftori's (1994) study that reported young girls were keen to compete and achieve the highest scores.

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sitting next to each other at this school selected the same game to play, so possibly they were, in an adaptive way, playing in a cooperative manner. The other school did not have enough computers for one student each and so the students there were used to sharing and this behaviour may have spilled over to the lunchtime session.

A preference for cooperation does not extend to the 11- to 12-year old girls where a preference for competition is more evident. There was no consensus regarding who they prefer to compete against. Some girls mentioned that they prefer to play against a friend whereas others prefer to play against the computer. Those who mentioned that they wanted to compete against a friend indicated that the computer was a too hard and frustrating opponent, whereas those who indicated a preference to play against a computer did so because they did not want to get into a conflict with their friends.

However, notwithstanding a liking of the competitive element, there is still a strong theme evident amongst the older girls of playing computer games by themselves. Various reasons given for this, and generally agreed to by other girls in the groups, include not wanting to argue over which game to play, not fighting over who uses the mouse or keyboard, and having a longer turn at the game. One girl mentioned that she often selects the two-player mode in *Aquanoid*, although she plays by herself, because the two-player mode gives her twice as long to play. Other girls in the groups indicated that they, too, adopt this strategy in order to play for a longer time. These opinions support the earlier figures which indicate that many girls want as much time on the computer as they can get, even if it means sacrificing social interaction with friends.

Data generated from the focus groups involving boys paints a slightly different picture. With the boys, the younger ones indicated a preference for competition while the older boys appear to prefer cooperation with their friends, particularly against the computer. Again, though, this does not mean that the older boys do not enjoy the competitive aspect that computer games supply. When analysing the type of competition they prefer, it is evident that playing alone against the computer is the first choice, followed by joining with friends to play against the computer, with the third preference being competing directly against a friend. It appears from the data that the boys, particularly the older ones, enjoy the social interaction facilitated by playing computer games as much as do the girls.

The data from the focus groups indicates strongly to me that the social interaction provided through computer game playing is strongly enjoyed by both the girls and the boys. There is no strong and consistent evidence that girls dislike competition per se, however competition that involves playing against a friend does not seem as popular as the enjoyment gained from competing against the computer. For many girls, keeping friendships intact is more important than the gratification gained from competing against, and perhaps defeating, a friend. Similarly, the boys indicated that if they are involved in competition they prefer it to be with a friend playing against the computer.

The information provided by my students echoes the literature, with both being ambiguous in the final conclusions. A number of researchers have reported that competitive elements in computer games do not turn girls away from playing (Caftori, 1994; Chappell, 1997; Malone, 1981; Signer, 1992), whereas other researchers have reported the opposite; first, girls do not like competitive elements in computer games and the presence of these competitive elements turn them away from the game, and, second, that boys, who want competitive elements in their computer games, are drawn naturally to them (Arch & Cummins, 1989; Kelly, in Cassell & Jenkins, 1998a; Lockheed, 1985, Serbin, Powlishta, & Gulko, 1993). My personal feeling about this attribute is that competition will not necessarily turn my female students away from playing an educational computer game.

The girls do not identify competition per se as a negative. Although the interview data is not conclusive in regards to this, other data indicates that competition is more than acceptable to many of the girls. In fact, through the focus groups, many of the girls mention it as an aspect they particularly enjoy. The way they want to compete may be different, however, to what would normally be understood about how boys like to compete. I believe the literature, when referring to competition, means competition against other people, and so tends to make the blanket assumption that competition is perceived by girls as a negative attribute. However, I interpret my data as indicating that it is not the element of competition that turns girls away, rather the form that it takes. To the girls, competing appears to be fine as long as they are competing against the computer, not a friend. This interpretation fits with Chappell's (1997) findings when she reported that her hypothesis that competition will turn girls away from a computer game could not be supported by the quantitative data she collected. My qualitative data also fails to support her hypothesis.

Although the quantitative data indicates that both the girls and the boys generally prefer to work and play by themselves, the qualitative data indicates that if they are required to share with others then they prefer to cooperate with them rather than engage in competition. However, this does not mean that they want to interact all the time with others. My data also indicates a strong preference for playing alone, without the hindrance or presence of others. This result also contradicts the literature which informed me that girls want to play computer games together, rather than by themselves (De Jean et al., 1999; Elliot, 1990; Hawkins, 1987; Henney, 1986; Laurel, in Cassell & Jenkins, 1998c; Murray & Kliman, 1999; Nicholson et al., 1998; Polak, 2001; Rubin et al., 1997; Shade, 1994). I believe that it would be safe to infer that the children will manipulate the features of competition found in computer games to suit the particular circumstances they find themselves in at any given time. If they need to share and cooperate, they will, and if they do not, then they are prepared to keep to themselves.

Conclusion

The interpretation of my data lead to a surprising conclusion particularly when the literature reviewed was kept in mind. Having a competitive element in an educational computer game would not necessarily turn girls away from playing it. In fact, a number of girls would welcome it. Conversely, the absence of a competitive element may have the girls not wanting to play. A similar situation could be interpreted in relation to boys. It appear that to have the game designed in such a way that players can choose either to play in a competitive fashion or work together may be the best option. However, even the purposeful design of choice may not be required because the children appear to use the games the way they want rather than the way envisioned by the designers.

Recommendation: Competitive elements can be included in the game without fear of alienating girls.

Having the ability to network the game, so that the children can play it together but without having to share computers, could be an attractive option. This may be especially viable in the problem-solving and simulation genres that have already been identified as favoured by the girls. This may detract from the social aspect of playing that many girls seem to like, but with the arrangement of the computers in both of my schools' computer laboratories, social interaction would be quite possible while allowing the children control of their own computer. Also, given that many scientists and researchers use networking with fellow workers to complete projects, this option may be good grounding for future cooperative behaviour.

Recommendation: That there should be an in-game facility allowing the networking of the game.

Activities

In discussing Activities I am referring to computer games that offer the user a number of different things to do within the one program. For example, a program may let the user choose a drawing activity, a writing activity, a reading activity, multiple 'mini-games', or other activities within the theme of the game.

Only a small number of girls in the interview data state directly that having different activities to choose from in a game is an important element for enhancing their enjoyment. Selecting your own characters is an activity that Jenni (11, lines 145-47) claims to enjoy most about the *Zoombinis* series, while Cassie (8, line 11) enjoys it when "you can make some fabulous cards, banners, invitations, awards and all sorts of things" in one of her favoured programs. Printing out items is not the only activity mentioned. Other girls like drawing within a program which, in turn enables them to add their own personal touch to a game's atmosphere and look.

In looking at the data from a different perspective, that is a negative view of what is not liked, a small number of girls reported that they dislike a lack of activities within a computer game. They responded that they do not like it when they "just had to write stuff" (Anne, 8, lines 46-7) or "you just have to do the same stuff over" (Naomi, 11, lines 47-8). When asked how she would make a game she did not like more enjoyable one girl (Lynne, 11, line 51) replied that she would "have some more games on it and things [*So more activities?*] Yes".

The interview data indicate also that girls do not perceive activities as being a design attribute that other girls necessarily would like in the computer games they play. When asked what sorts of elements other girls would prefer, only a small number of girls mentioned activities. When asked the same question, but in reference to what boys might prefer, no mention of including activities is made by any of the girls.

Data generated from the survey of games liked by girls add support to the interview data. A total of 140 girls completed this survey, resulting in 131 individual computer games being mentioned. Of these games, only a small number that have multiple activities as a feature were mentioned a significant number of times.

Table 23: Games mentioned by girls in the 'liked' survey that feature multiple activities.

Title	Times mentioned	
Thinkin' Things series	15	11%
Carmen Sandiego series	14	10%
Kid pix	9	6%

The figures in Table 23 indicate activity-based games did not gain a high percentage of mentions among the girls. On the other hand, a number of games that do not contain activities did get a high mention in the survey.

Table 24: Games mentioned by girls in the 'liked' survey that do not feature multiple activities.

Title	Times mentioned	
Zoombinis series[14]	51	36%
The Sims series	23	16%
Kung Fu Kim	15	11%

Table 24 indicates three games mentioned frequently by girls as being liked do not contain in-game activities, but rather have the same game play throughout, with either self-selected difficulty or progressively harder levels as the only change.

14 Although the *Zoombinis* series does feature 'mini-games' within the game, the player cannot access them independently but rather completes them sequentially. Therefore, I have not classed it in the category of offering multiple activities.

The data generated from the observation sessions, however, tend to contradict the interview and survey data. My observations indicated that a number of the games played multiple times by individual girls provided multiple activities. Of the 127 individual girls who used a computer during the observation sessions the following figures were derived.

Table 25: Frequency of games played by girls more than once during the observation sessions.

Title	# of girls who played the title more than once	
Carmen Sandiego series*	32	25%
Maths Circus series*	29	23%
Zoombinis series	27	21%
Kung Fu Kim	25	19%
Thinkin' Things series*	25	19%
*Toy Story 2**	25	19%
Diamond Mine	24	18%
*Hoyles Kids' Games**	13	10%
Imagination Express series*	11	9%

As can be seen from the figures in Table 25, games that incorporate activities (marked with an asterix) were observed being played multiple times by many of the girls.

The data generated from the focus group shed more light on the contradictions posed by this attribute. During the focus group sessions, the girls expressed a general preference for games with multiple activities. This general preference was evident across the age groups. However, reservations were expressed by some girls, with a small number indicating that either they prefer the 'one-idea' game that has harder and different levels, or they do not mind whether or not the game included smaller activities.

A recurring theme throughout the focus groups in relation to this attribute was having a choice of playing a game with activities or playing a game without them. This reflects an aspect that emerged from all the focus group questions, that is, what is played often depends on how the person feels at a particular time. Overall, I believe it is reasonable to infer that the general preference of the focus group was for the presence of activities within a game structure, with the caveat that if they are not present it will not be a matter of great concern.

Only a very small number of boys (five) mentioned having a variety of activities as a reason for liking to play a particular computer game. Of those responses, Larry (8, line 72) is typical when he claims that he enjoys the *Maths Circus* series because "there's heaps of little games and you get to choose them". In looking at the data in a negative way, that is at what the boys do not like, there is no mention of only being able to do one activity or play just the one game.

The data generated by the 'liked' and 'disliked' survey revealed that the boys did not appear to prefer games with multiple activities. Of the 165 games mentioned by the boys as being liked no games that offered multiple activities were mentioned a significant number of times. Conversely, a number of games that offer multiple activities were mentioned a significant number of times by the boys as being disliked. From the 148 boys who completed the survey the following figures regarding games with activities were derived.

Table 26: Games that contain activities mentioned the most in the boys 'disliked' survey.

Title	Times mentioned	
Maths Circus series	65	44%
Thinkin' Things series	53	36%

Table 26 indicates that a significant number of boys appear not to like these particular games. Only one other game, *Kung Fu Kim*, received double figure mentions (18) as being disliked. This can be seen as support for the inference of boys not liking games with activities.

Data from the observation sessions tends to confirm this inference. From the 127 individual boys who used a computer during an observation session the following figures were derived for games that were played more than once by the same boy.

Table 27: Frequency of games played by boys more than once during the observation sessions.

Title	# of boys who played the title more than once	
*Toy Story 2**	37	29%
Dynomite	29	23%
Maths Circus series*	28	22%
Kung Fu Kim	27	21%
Bow & Arrow	21	17%
Lego Island 2	20	16%
Diamond Mine	17	13%
Missile Command	15	12%
Aquanoid	14	11%

Of the 11 games shown in Table 27, nine are arcade-based, with only *Toy Story 2* and the *Maths Circus* series being games revolving around a selection of activities. Although the observation data indicates in-game activities are apparently not favoured, their presence would probably not turn the boys away. Possibly the type of activities might be a better guide to what they prefer. The activities in the two games, *Toy Story 2* and the *Maths Circus* series, reflect the arcade-style, rather than the creative activities described by some of the girls as the type they prefer. This indicates that although on the surface there is similarity in the preferences of the girls and the boys, a deeper consideration indicates a difference between them. This difference needs to be kept in mind when selecting educational computer games aimed at girls that revolve around discrete activities within the game play.

Recommendation: That discrete activities, if present in a game, should reflect creative activities rather than arcade-style.

The focus group sessions with the boys tended to confirm the interview and survey data in that, generally, they prefer the game to consist of one activity. Again, as with the girls, there was general agreement across the age range. It appears that the boys prefer the game to have the same activity or game play, with variety being supplied by the game becoming increasingly difficult to play as the player progresses, rather than relying on different activities to provide variety. One boy mentioned, to the agreement of others within the group, that having "more than one thing can be confusing", indicating that a game that has a single objective or a single way of playing without the distraction of other activities appears to be preferred.

The literature that touches upon this attribute indicate that the girls should have reported a liking for different activities (Hall & Cooper, 1991; Klawe et al., 1996; Murray & Kliman, 1999; Westrom & Super, 1996). However, the data does not reflect this. With reference to the interviews, only a small number of girls mentioned in-game activities as a feature they like. Also, they did not mention it either when describing what they perceive other girls might like in their computer games. The data gained from the 'liked/disliked' survey indicates strongly that the girls have a strong preference for the types of games that do not incorporate multiple activities, but rather provide consistent game play of the one type. The focus group data confirms this interpretation. It appears that the girls do not see multiple activities as a preferred feature of their favourite games. The only data to support the literature is derived from observation of the children at school where the range of available games was limited.

Reflecting on why my data seems to contradict the literature led me to several interpretations. The indication given by the observation data that many of the girls enjoy games with activities, which contradicts data generated through the interviews, the survey, and the focus groups, may be due to the limited time that was available at lunchtime and during class sessions. Because of these time limits the girls may have preferred to select games with short duration activities. The shortness of these in-game activities may have allowed them to succeed in the limited time available.

Playing a game that requires long-term commitment was not a viable option because many of the children knew from experience that they were not able to save their progress mid-game. Either the game did not provide that option or if they were able to save their progress, the saved game would not necessarily be there next time they played because other players may have written over the save-game slot, or they may not have been able to gain access to the same computer. Therefore, if they chose one of these games they would be likely to lose any progress or success they achieved when lunchtime was finished and they returned to class. Thus they may have gained more satisfaction from playing games which featured in-game activities that were generally shorter to play in terms of time.

Recommendation: That a facility to save the player's progress at any time should be available.

A second reason for girls appearing to prefer games to games with activities in them may be that the range of games at school was limited in comparison to those at home or at the homes of their friends. Possibly, these school games represent the more favoured of what was available and they happen to have activities within them. The restricted range of games available at school may have had a bearing on their preferences and could possibly parallel Huff and Cooper's (1987) observation that boys will play any computer game that is available, even if it may be one they do not particularly care for. In this instance, the girls may play them simply because they are available rather than because of any design preference.

A similar case appears in regard to the boys. With only a small number of boys mentioning a preference for different activities within a game, it appears that the boys generally prefer a game to be about one thing upon which they can focus all their attention - they may not want to be distracted by choices. Also, their apparent strong dislike for the two games that have in-game activities which must be selected by the player, the *Maths Circus* series and the *Thinkin' Things* series, gives a firm indication of their dislike for this feature. There may be, however, another reason for this apparent dislike of the two games. Both are presented in a cartoon-style and could be perceived by many boys as being aimed at children in the Infants section of the school.

One aspect that does bear mentioning from the literature is that boys' preferences for this aspect of game design had not been observed or, if it has, has not been reported. From my data it could be put forward that boys, generally, do not favour games that have multiple activities as a feature.

Conclusion

The observations gained from the data generated for this attribute surprised me. I was sure that it would have indicated that girls preferred multiple activities and that this feature would be one of my recommendations. I gained this pre-analysis belief from the strong agreement presented by the literature. However, as it turned out, it appears that both the girls and the boys do not particularly care about in-game activities, and may actually prefer that they are not available.

In terms of practice, though, this may not be clear cut because the time factor could be significant. Generally, the time available in either the classroom or the computer laboratory is limited, and often the programs cannot be saved successfully by the children. Thus, it might be prudent to select educational games that incorporate in-game activities if available because, as was shown by the observation data, both girls and boys, will use them.

Challenge

Challenge is a difficult concept to identify and define in relation to computer games. What one person finds challenging another can experience as easy or simply not interesting. However, it is an important attribute to consider in any learning situation and therefore is likely to be an important attribute in educational computer software. During my years of teaching, I have observed that children can become very bored very quickly and subsequently go off-task if what they are being presented with is experienced as neither interesting nor challenging.

The word 'challenge' was mentioned in a significant number of interviews with the girls. It appears that many girls want to be challenged when they play computer games rather than simply press buttons or keys in response to events on the monitor. Petra (12, lines 98-100) pointed out that her reason for not liking wrestling games is because "all you do is sit there and press buttons", with success depending on how fast you react. This view is supported by Sally (10, lines 229-31) who likes "figuring out things and using your mind rather than just sitting there and doing things like Minesweeper, I don't have much fun on that". Interestingly, *Minesweeper* is a logic puzzle game but uses explosions to indicate failure, with the player having only one 'life' to solve the puzzle. These explosions may indicate to Sally that it is an arcade-style game requiring a trial-and-error approach rather than application of problem-solving skills that she prefers.

The desirability of the attribute of challenge is strongly evident in the high number of girls who stated that they like having different levels to complete in games, levels that become more difficult as they progress. Approximately a third of the girls mentioned "harder" levels as being an important feature that contributes to their enjoyment. Achieving the right level of difficulty for every individual is a design challenge that, if addressed, might prevent girls' frustration levels from rising to a point where they turn away from playing and enjoying a game. Possibly the ability to adjust the level of difficulty within the game would be a feature that girls might find attractive.

Puzzles, mazes and quizzes were mentioned frequently throughout the girls' interviews, suggesting a desire amongst the girls for an element of challenge in the computer games they play. Support for this inference was provided by Doreen (11, lines 61-2) who prefers the type of game in which "you've got to use your brain to work out things". A preference for this style of game is evident in the number of girls who claimed to like adventure games, a genre that fits in well with the solving of puzzles, mazes, and quizzes - elements that challenge the player. The literature provides support for this type of challenge. Both Brunner et al. (1998) and Walker (1998) pointed out that girls generally prefer having to outsmart the computer rather than use violence or speed to succeed in a game. Adventures and simulations provide opportunities for this type of gameplay.

When asked to comment on what they perceive other girls would like in a computer game, many girls mentioned puzzles and problems in relation to challenge. A typical response was given by Kelly (10, lines 89-90) who claimed that other girls would like the *Zoombinis* series because "girls like [to] think about challenges and they think about what they're doing", indicating it is the puzzle and problem aspect that appeals to girls.

The responses supporting the inference of girls wanting puzzles, mazes and quizzes suggest that educational software with problem-solving as its foundation is likely to be a popular choice amongst the girls and could promote their engagement with the subject matter. As Beverley (10, line 112) replied, when asked if she could think of a computer game that girls would like to play more than would boys: "Any sort of thinking game".

Viewing this attribute from a different perspective, when the girls were asked about features to incorporate in a game they might make for boys, no significant mention was made of using problems, puzzles, quizzes, or mazes. Apparently, the girls do not believe that this type of challenge is preferred by boys, thereby reinforcing the inference that problem-solving games are perceived by the girls as being within their domain. To them, perhaps, games that rely on 'twitch' responses for success indicate a game designed for boys and thus one that does not welcome them.

The level of challenge is likely to be important because being unable to solve a problem seems to be regarded by some girls as a source of frustration. A small number of girls mentioned that they disliked being in a game situation in which they cannot find the last piece to collect or cannot solve the final clue to a puzzle. Frustration for girls can also be exacerbated by the length of the game. Some girls stated that when a game took too long to play and complete they did not enjoy the experience and generally tended to ignore it. Beverley (10, lines 39-41) claimed that she likes most computer games "except for ones that you have to play for ages and ages to get it finished". Probably to her, the time that needs to be invested in completing a long game is often not worth the end result. This finding may be related to the suggestion in the literature that being able to save a game at any time is an attribute that appeals to girls (Caftori & Paprzycki, 1997). Allowing the girls to save their progress at any time might not only enhance their enjoyment of a game but also open up other games they have not have attempted because of reluctance to invest long periods of time in playing and completing different levels.

Only a small number of girls indicated that gaining a high score is an important aspect of game play. This perspective is similar to the lack of desire for a point score in the feedback features of computer games mentioned earlier. This lack of desire for high scores as a preferred element of their gaming experience might reflect the girls' supposed preference for non-competitive game features. Possibly some of the girls see the presence of scoring as a competitive element rather than an element of challenge.

Related to the attribute of challenge is the replayability of the game. A small number of girls noted that being able to play the game over again, but trying different strategies or solutions to the problems, is a positive attribute. Beth (11, lines 11-12), when describing a game that she likes, noted that it was not only challenging but "once you go over it you can go over it again without knowing what to do". This confirms the views put forward by Bunderson and Christensen (1995) and Rubin et al., (1997), who noted that girls like multiple solutions to a puzzle or game, allowing them to revisit their favourite games a number of times. Also, they believe that this feature provides more opportunities for girls to engage in social interaction with their friends, especially through conversation and discussion over different possible solutions to the various problems.

The boys gave responses similar to those of the girls in relation to the notion of challenge, with the attribute 'challenge' mentioned by many boys. Laurence (9, line 74), for example, described the types of computer games he likes to engage with as those where "you use your brain rather than your hands" to play. Overall, there appears to be more of a call for challenging game play from the boys than from the girls. In total, the word 'challenge' and its derivatives appeared twice as often in the boys' interviews when compared to the girls' responses.

However, whether or not the type of challenge preferred by the boys is the same as that preferred by the girls is open to interpretation. Whereas the girls mentioned a number of times the words 'puzzles', 'mazes', and 'quizzes', indicating perhaps a preference for a more cerebral style of challenge, the boys did not use the same words with anywhere near the same frequency. As other sections of the data analysis indicate, many of the boys appear to prefer action-oriented games, therefore it could be inferred that the challenge they seek in a game might be associated with the quick-response and fast hand-action demanded by many arcade-style games.

Further evidence for this view may be gained from the number of times many boys, unlike the girls, mentioned the recording of high scores or the beating of a previous time as an incentive for continued play. Anthony (12, line 56) gave a typical response when he described why he likes playing *Kung Fu Kim*: "it's fun and you try and get a high score to beat it". This game is representative of the arcade genre that requires quick response and fast fingers to win. Also, many of the boys claimed they like games in which there are levels to beat in order to continue playing. They seem to see this not only as evidence of their success in the game but also as an incentive to keep playing in order to beat their last score, as well as a benchmark allowing them to compare their success with the play of other, usually male, friends. This inference supports the findings in the section dealing with competition and collaboration.

It is difficult to draw firm conclusions from the data generated from the 'liked' and 'disliked' survey sheets regarding the attribute of challenge. In analysing the 131 titles listed by 140 girls as games they like, only 11 (9%) can be described as having a problem-solving or puzzle theme. Of those 11 games, only the *Zoombinis* series and the *Thinkin' Things* series were mentioned by individual girls more than seven times (51 & 15 mentions respectively). Similarly, for the 148 boys, of the 165 games they list as being liked, only eight (5%) can be identified as problem-solving or puzzle based, and none gained more than nine individual mentions. Thus it is difficult to infer that either the girls or the boys prefer challenging games in the sense that the challenge is derived from problems and puzzles. In fact, in contrast to the interview data, the survey indicates that it would be safe to infer that generally both the girls and the boys do not prefer problem-solving computer games when other games are available to play.

In analysing the 'disliked' list the issue of challenge is still not clarified. The girls listed nine problem-solving or puzzle games as being disliked, with the *Maths Circus* series and the *Thinkin' Things* series gaining most mention (44 & 29 times respectively). The boys mentioned 10 games from this genre, with the *Maths Circus* series gaining the highest mention (65 times). All other problem-solving games were mentioned five times or less. Significantly, both the *Maths Circus* series and the *Thinkin' Things* series are presented in a cartoonish style that could be viewed as too young for these primary-aged children and thus might account for the high number of mentions in the 'disliked' survey. The aspect of a game appearing 'babyish' is discussed in a later section dealing with age appropriate software.

Further inferences can be made from the observational data although any inferences need to be tempered with the knowledge that, first, the range of games available for the children to use in the computer laboratories was limited and, second, these games are biased towards problem-solving programs.

Table 28: Top ten games observed being played by girls during the observation sessions.

Title	Times played
Zoombinis series*	61
Kung Fu Kim	43
Thinkin' Things series*	38
Maths Circus series*	38
Diamond Mine	37
Carmen Sandiego series*	34
Toy Story 2	26
Dynomite	18
Hoyles Kids' games	13
Living Books series	13
Aquanoid	13

Table 28 shows that of the ten games most frequently played more than once by the same girls, four are from the problem-solving genre (marked with an asterix).

Table 29: Top ten games observed being played by boys during the observation sessions.

Title	Times played
Dynomite	48
Thinkin' Things series*	46
Kung Fu Kim	46
Toy Story 2	39
Lego Island 2	39
Bow & Arrow	36
Zoombinis series*	35
Aquanoid	34
Missile Command	28
Maths Circus series*	28
Carmen Sandiego series*	28

Table 29 shows that of the ten games most frequently played more than once by the same boys, four are from the problem-solving genre (marked with an asterix).

Although both the girls and the boys have four problem-solving games in their respective top-ten list, girls played them more frequently than did the boys, offering evidence, albeit weak, that more girls than boys prefer problem-solving over other genres of computer games. The higher frequency use of arcade-style games by the boys could, perhaps, provide evidence boys achieve the challenge they desire via a different path than the one chosen by many of the girls. Boys might find their challenge being catered for by the arcade-style game which provides opportunities for quick response, high scores and fast times, whereas the girls demonstrated a preference more for the games that have the challenge generated through solving puzzles and problems.

The observational data also give indirect support to the inference that girls prefer problem-solving games, especially when taking into account the difficulties the players face in saving their progress. As mentioned earlier, it is not always possible for a player to reliably save their place in a game, and so often they simply end their game without saving. Thus they lose any progress they may have made. That many of the girls return to and restart the same game the following day indicates that they appear to favour problem-solving games over the readily-available arcade-style games that generally supply a quick challenge and result for the player.

Data generated from the focus group sessions provides supporting evidence that girls prefer a different type of challenge compared to the boys. The girls, across all age groups, consistently indicated a liking for challenges to be in the form of puzzles and problems. Playing a game through their minds rather than their fingers was clearly shown as a preference. Both Bruner et al., (1998) and Walker (1998) support this observation, both reporting that girls would rather out think the game than blow it up.

However, a number of girls indicated that, depending on how they feel at the time, arcade-style challenges that depend on fast reaction times can be an acceptable form of challenge. As one girl stated, “I like puzzle ones, but when your brain is tired I prefer arcade”. Both types of challenge seem to be considered as ‘hard’, but they are perceived as different kinds of ‘hard’, one that requires you to think, while the other has the thinking removed. However, the girls who mentioned this were not supported verbally by others in their groups, although I observed other girls indicating sympathy for their view.

Throughout the focus group, boys were consistently firm in their claimed preference for challenge being delivered by games that require fast fingers and quick thinking, a stand opposite to that indicated by many girls. This preference was evident across all ages of boys. To the boys involved in the focus group sessions, challenge is supplied through faster action, more opponents, or levels that increase the overall difficulty of the game. It was generally agreed that games which have problems that rely on logic would not be popular with most boys.

The focus group data is at odds with what is reported by the literature. Sherman, Divine, and Johnson (1985) reported that boys from their study enjoyed puzzle-based computer games. In considering the year of that research, it could be argued that this observation was made because of the lack of alternatives. The capacities of computers of almost 20 years ago do not compare well to the fast, colourful and detailed arcade action that today's computers deliver to the player. If the boys in their 1985 study had today's computers and software, possibly they would not have shown a preference for puzzle-based games but rather would have opted for the faster, flashier arcade games now available.

However, another recent study provides support for the view that boys enjoy problem-based challenges in computer games. Klawe et al., (1996) reported that both boys and girls appeared to enjoy the puzzles incorporated in a new educational computer game being trialed at a summer science museum exhibit. However, as the game had evolved from their own research, *Phoenix Quest*, it could be surmised that alternative games were not available and so the boys played simply because it gave them a reason to use the computers. Through my research and general observations, I have come to agree with Huff and Cooper's (1987) study that boys will play just about any computer game that makes itself available to them simply to give themselves more time interacting with computers. This could have been the case with Klawe et al.'s (1996) research. I believe the weight of the other literature and the data generated from my research indicate strongly that boys prefer their challenge not to derive from problem solving but from arcade-style computer games.

The different types of challenge seemingly preferred by the girls and the boys in my study reflect, I believe, the style of general play I observe in the primary school playgrounds. Generally, the boys play in a more physical and rushing manner than do the girls. I feel that their preference for the arcade-style challenge is associated with their normal non-computer game playing style. Perhaps the arcade-style of challenge can be regarded as a metaphor for the physical play boys appear to prefer, reflecting the viewpoint of Jenkins (1998) about how, for many boys, computer games have become a substitute for the physical play of yesteryear. Conversely, the girls observed physical play patterns are generally less robust than the boys, perhaps leading them to prefer the more cerebral approach of many puzzle-based games.

Conclusion

The evidence of this study points to the girls wanting the computer game they play to challenge them. However, there seems to be a strong preference for the challenge to be derived from applying thinking and logic to solve problems posed by the game rather than from the game getting faster or throwing more opponents against the player. The girls appear generally to want to succeed by using their minds rather than their fingers. This finding has implications for the high incidence of popular drill-and-practice software that relies on the element of speeding up the game to make it increasingly difficult. Playing this type of program might constitute a boring experience for many of the girls and could turn them away from using computers in a teaching-learning environment.

Recommendation: That the challenge provided by the game be based around puzzles and problems that require the application of logic to solve.

The type of problems posed to the girls should have a variety of solutions enabling them to experiment with different ideas as well as provide the opportunity to replay the game several times. This prevents the player, be they a girl or a boy, to simply 'discover' the solution to a problem deemed to be the only correct one by the programmer. Part of the constructivist way of learning is putting the learner into a situation where they have to play with and modify their ideas in order to fit into their schema viable solutions to problems posed to them. If the player knows that there is only one correct solution, as dictated by the program, then they could simply slip into a trial-and-error approach to find the 'correct' solution in the shortest amount of time. In this instance, the challenge becomes one of beating a time, something that many of the girls indicated they did not like.

Recommendation: That the problems and puzzles presented by the game have multiple solutions.

An attribute that would be difficult to integrate into a problem-solving game, as opposed to an arcade-based game, would be a variable challenge level. The data indicated that this would be welcomed by many of the girls. One program, the *Zoombinis* series, does have this feature, where the player can select levels from easy to difficult, and this could be one reason why the game is very popular with players, especially girls.

Recommendation: That a facility be available for the player to modify the level of difficulty of the problems or challenges present in the game.

Finally, an interesting conclusion that can be drawn from this data is that, although boys generally indicated they liked their challenge to come from arcade-style computer games, they were still quite happy to play problem-solving games, making this style of game one that could be used for both genders.

Genre

The analysis of preferences by girls for particular genres should be read with the caveat that many of the girls may not have experienced significant exposure to games that represent all genres. As discussed earlier, many of the computer games played by the girls may have been purchased for them by interested adults, such as parents and relatives. Thus these computer games may reflect the adult perceptions of what their daughters may enjoy and may be of benefit to them, in other words, 'pink' software. Therefore, when analysing the data regarding preferred genres, particularly the data generated through the 'liked/disliked' survey, it would be prudent to keep in mind the possible inexperience among girls of computer game playing and a lack of exposure to a variety of games (Griffiths & Hunt, 1995). Also, it needs to be remembered that the number of games in particular genres varies. For example, a casual inspection of games software in a general computer shop is likely to reveal many more examples of the arcade genre than the simulation and problem solving genres. Therefore, it should be expected that more mention is made by the children of arcade-type games.

Among the girls, no particular genre, or theme, of computer game emerged from the interview data as a major preference although a number of girls did mention enjoyment of the simulation genre that involves building objects such as houses and cities. Generally, the responses indicate that this preference is usually in the vein of wanting to "build buildings" or "design your own city". The girls in my study appeared to show more interest in constructing environments which enable their 'human' computer characters to prosper and grow. Heather (10, lines 10-14) stated that she likes the *Sims* series "because they are, like, people that you can actually create and make them do things. And they can buy pets, and then [the] pets become part of the family". This reflects Glaubke et al., (2001) who reported that girls are interested in things that mirror what is happening around them in their own lives. Being able to control people and their environment seems to appeal to many of the girls, indicating the nurturing aspect of their lives, a general expectation of society as being a desirable attribute of a girl's character. I do not believe that supporting this preference necessarily panders to a societal stereotype as it is the girls themselves who identify their personal liking of simulation games, particularly ones that utilize human characters, rather than identifying what they believe other girls may prefer.

The slight preference for simulation-style games indicated by a number of girls probably reflects what Subrahmanyam and Greenfield (1998) reported: girls appear to prefer games that use a realistic setting for their game play. Most of the simulations mentioned by the girls, and in particular the *Sims* series, are based around realistic scenarios with which the girls could easily identify. Although the *Sims* series is cartoon-based, it reflects a domestic or social setting. Jenkins (1998) postulated that children often use a computer game as a means to expand their area of physical play into a larger, more available virtual area, thus the simulation game could be interpreted as expanding a safe area of play for the girls.

Evidence supporting the girls' preference for the simulation genre is provided from the data generated by the 'liked/disliked' survey. Similar simulations that deal with 'people' in a caring, non-violent environment, such as the *Sim City* series, were mentioned multiple times by the girls as games they like. Few girls list these as games they did not like. Of course, this should not to be conflated as evidence for a liking for all games categorised in the simulation genre. Simulations that deal with managing sports teams or that encompass vehicles or military flying were mentioned by only a few girls.

The complexities that simulation games can offer may reflect and support Brunner, Bennett, and Honey's (1998) findings that many girls prefer the intricate plots and action offered by puzzle and adventure games, action that is considered 'intelligent' when compared to the mindless blasting or racing offered by many other types of games. Perhaps my girls were indicating a desire for this intelligent action through their preference for simulations. This inference may be supported by Neumark (1991) who reported that many girls he questioned indicated a desire to be part of the game, a feature offered by a simulation. From my own experience of playing games such as *Sim City 3000*, I know that the player can start to 'care' about their city, wanting it to successfully grow and thrive, an emotion that I could envisage my girls also experiencing.

In the interviews, the boys generally indicated a strong preference for particular types of simulation games, especially those oriented around sports and empire building. Generally, the types of sports mentioned by the boys involved physical activity (for example, soccer, snowboarding, and skateboarding), or racing objects on the screen (for example, racing cars and boats). Games that are less physical, for example chess or board games, were not listed frequently by the boys as games they like. Also, unlike the girls, the boys indicated that the Real Time Strategy genre of empire building and conquering provides a great deal of enjoyment. Many of the boys indicated that they enjoy building their own civilization and then attacking and conquering their opponents, who are either computer-controlled or controlled by a friend.

In contrast to the data from the interviews, the data from the liked/disliked survey indicate a difference in genres of computer games favoured by the girls and the boys that was not evident in the interviews.

The data generated by the 140 girls who completed the survey on naming three computer games they liked generated the following figures.

Table 30: Genre reported as 'liked' in survey of girls.

Genre	# of titles mentioned	
Arcade	52	40%
Activities	22	17%
Problem solving	11	8%
Simulation	8	6%
Real Time Strategy	7	5%
First Person Shooter	7	5%
Role Playing	6	5%
Unclassified	18	14%
Total Games Mentioned	131	100%

Table 30 indicates that arcade-style games and games incorporating activities are most popular. This provides a different view to that generated by the interviews, where the popularity of arcade games was not evident. A similar contradiction arises with the Activities genre, one which the literature reports girls prefer (Cooper, Hall, & Huff, 1990; Kafai, 1995; Klawe et al., 1996; Westrom & Super, 1995), whereas the interviews indicated otherwise. The genres that appear unpopular with many of the girls are those that generally have violence as an integral part of the game play.

Unfortunately, the picture of which genres are most popular with the girls becomes further clouded by the data about the games the girls do not like. From the 140 girls who completed the survey on naming three computer games they disliked the following figures were derived.

Table 31: Genre reported as 'disliked' in survey of girls.

Genre	# of titles mentioned	
Arcade	23	29%
Activities	20	25%
Problem solving	10	13%
Real Time Strategy	5	6%
First Person Shooter	3	4%
Simulation	3	4%
Role Playing	2	3%
Unclassified	13	16%
Total Games Mentioned	79	100%

Table 31 indicates that a significant number of girls do not like games from the Arcade genre, nor the Activities genre, the two genres that were reported in the 'liked' survey as being the most liked by the girls. What can be concluded from this is unclear and requires further questioning related specifically to the genres involved, as well as closer examination of the individual games mentioned in both surveys. Tentatively, I interpret this result as indicating that many of the arcade games cited in the 'disliked' survey are violence-based or have significant amounts of incidental violence, whereas the activity games may have been viewed by many of the girls as being 'too young'[15], a problem discussed in the sections on Challenge and Age Appropriate Software.

15 The *Maths Circus* series and the *Thinkin' Things* series were mentioned frequently as disliked. Both these games are presented in a way that could have been interpreted by many girls as being for Infants children.

The boys' preference for particular genres was a little more clearer. From the 148 boys who completed the survey on naming three computer games they liked the following figures were derived

Table 32: Genre reported as 'liked' in survey of boys.

Genre	# of titles mentioned	
Arcade	60	36%
Real Time Strategy	22	13%
First Person Shooter	18	11%
Simulation	11	7%
Role Playing	10	6%
Problem solving	8	5%
Activities	7	4%
Unclassified	29	18%
Total Games Mentioned	165	100%

Table 32 indicates that arcade games are popular with many boys and, to a lesser extent, so are strategy-based games. The popularity of arcade games correlates with what Jones (1997) reported, that many boys enjoy the "twitch" aspect of playing fast-paced computer games that rely on hand-eye coordination. The liking of the Real Time Strategy genre may also reflect the reported liking by boys of violence in computer games (Caftori & Paprzycki, 1997; Canada & Brusca, 1992; De Jean et al., 1999) as most of the games listed deal with territorial expansion, invading and conquering the 'enemy'. The problem-solving genre received very little support from the boys, however, as mentioned in the previous section on Challenge, the boys may be getting the challenge they seem to want from the action supplied by games in the Arcade genre.

From the 148 boys who completed the survey on naming three computer games they disliked the following figures were derived.

Table 33: Genre reported as 'disliked' in survey of boys.

Genre	# of titles mentioned	
Arcade	30	34%
Activities	21	25%
Problem solving	9	10%
Real Time Strategy	4	5%
Role Playing	5	6%
Simulation	2	2%
First Person Shooter	1	1%
Unclassified	15	17%
Total Games Mentioned	87	100%

Table 33 indicates Arcade and Activities as being the most disliked by the boys, a result that partially contradicts the 'liked' survey. This observation goes against most of the other evidence, which indicates that arcade games are popular. Perhaps it is the presentation style of some arcade games that the boys do not like, similar to the way in which the girls may not like the presentation-style of the *Maths Circus* series and the *Thinkin' Things* series.

The focus group data did not provide any definitive answers to the style of games preferred by the girls. The girls generally indicated a leaning towards both the Simulation and Arcade genres. There was no apparent age difference regarding preferences for genre, although the nine-year-old girls appeared to be fixated on the *Sims* series, with almost all reference to what they like relating to it.

The data generated from the boys' focus groups was more disparate, with the general consensus being that if it is a computer game a boy will play it. The elements of action and sport were frequently mentioned as preferred, and an observation was made that it may simply depend on the mood of the boy deciding which genre/game he might want to play. As one boy put it, "[it] doesn't matter how many people you ask, they will like something different". Sadly, it was generally agreed by the boys that if the game looked educational it would not be popular. That would indeed be a design challenge for any game designer.

Conclusion

The majority of the data indicates that simulation games may be a preferred genre for the girls and one that would be acceptable to the boys. There also seems to be acceptance of arcade-style games, games that are typically used for drill-and-practice, however it is questionable whether this type of game can be successfully used in a science education environment. The Simulation genre, with its ability to construct engaging virtual environments or worlds, could provide an interesting and strong foundation for the introduction of, and practice with, science concepts that are difficult to demonstrate in a traditional classroom environment.

Recommendation: That the game be from the Simulation genre.

The finding that simulation games are accepted by many of the girls is very positive in terms of educational opportunity. Simulation computer games can, by their nature, 'transport' the player away from the normal everyday classroom environment and put them into play spaces that offer a great deal more than what is normally viable in the physical world. They can allow children to try ideas and hypotheses without fear of damaging anything real and return to a certain point in order to try a different hypothesis, thereby seeking comparisons and improvements.

Miscellaneous Attributes

Instructions

The lack of instructions was seen by a small number of girls as a negative aspect of computer game design. They indicated an experience of frustration when they are unable to understand what a game expects of them in order to succeed. In describing one of the elements of a computer game that makes playing enjoyable, Barbara (11, lines 71-2) stated, "it might come up with the instructions at the beginning of how to play". This supports the literature which found that the frustration many girls experience from not knowing what to do lessens the enjoyment gained from playing computer games (Lancy, Forsyth Jr., & Meeks, 1987; Lancy & Hayes, 1988).

The focus group data indicate that girls prefer information being easily accessible regarding the different buttons that are found in games. This mirrors a feature found in many productivity programs where the user can hover the mouse pointer over a button for a short while prompting the appearance of an explanation of the button's functions or purpose. Having this facility of help could make a game easier to access and hence more enjoyable for some of the girls. This feature would negate the need for constant reference to a manual when learning to play a game, a feature that Miller, Chaika, and Groppe (1996) reported girls do not want to do.

Surprisingly, and contrary to the literature, more boys mentioned that they find the lack of clear instructions to be a frustrating experience which often turns them away from playing particular games. For example, Jeremy (11, lines 45-6), when asked what things in a computer game make it enjoyable for him, claimed "...things that can help you while playing the game. Like instructions or a tutorial to go through the game if it's your first time".

In the earlier analysis of data regarding narrative, I found that many of the children relied on the storyline to provide instructions for the game. However, it would be important to have specific help available to explain all the technical, non-story related features of a game to enable the children to gain the maximum enjoyment and learning provided. Also, the presence of instructions could help overcome the lack of experience many girls have had with computer games (Griffiths & Hunt, 1995). Unlike many boys, whom the literature reports, often use trial-and-error approaches (Greenfield, 1996; Revelle, 1986) or ideas they have gained from extensive computer game playing, many girls may need in-game assistance in finding out the operation of various game controls. It seems therefore, that having in-game access to clear and concise instructions, rather than a cumbersome manual, may be a positive feature for both girls and boys.

Recommendation: That instructions and explanations on all aspects of the game be accessible from within the game itself at any time during play.

Length of play

The length of time to play and complete a computer game was reported by a number of girls as being an important feature. They indicated a preference for games that continue for a relatively long time, allowing them adequate time to enjoy the experience. Games that play for a short time, particularly those that end when a character's life is lost, do not appear to be favoured by many of the girls. Typical is Nicole (11, lines 12-14) who likes the *Sims* series because, "the game doesn't end straight away, it just keeps on going", allowing her an open-ended experience that she develops and controls.

A similar number of boys indicated the same preference regarding the length of game play. One aspect of *Myst* (1993) that Alan (9, lines 41-3) finds appealing is that "it takes a long time to work it out", requiring him to write down clues and answers in order to solve the mysteries. With both the boys and the girls indicating preference for longer duration games it may be another supporting indicator of both genders preference for challenging, puzzle-style games, a genre that was identified in both the earlier sections of this analysis and the literature. The puzzle and problem-solving genre of games generally takes a significant amount of time to successfully complete.

Recommendation: That the game should not be able to be completed in a short time.

Age appropriate software

Throughout the interviews the word 'babyish' was mentioned frequently by many of the girls in reference to why they do not like a particular game or a particular element found in a game. When asked to describe how they knew that a game was 'babyish' many of the girls found it very difficult to verbalise their perceptions, and thus it is difficult to ascertain what aspects make a game 'babyish' to them. Only Gillian (10, lines 89-90) was able to gave an example of what she perceived as 'too young' when she stated that she did not like a game where "characters talk on it, they talk, like, you are like really, really, really, really little". This, too, seems to be an issue for a number of the boys, who mentioned that they do not like games they perceive as 'too young'. And, as with the girls, it is difficult to ascertain how the boys gauge what is or is not 'babyish' as they, too, had difficulty in verbalising their perceptions.

As individual children had difficulty in explaining how they knew a computer game was too young for them I attempted to use the focus groups to ascertain how they gauged the age appropriateness or otherwise of particular computer games.

The responses from the focus groups enabled a number of 'babyish' elements to be identified. The main element gaining general agreement with both the girls and the boys is the type of characters used in the game. If characters associated with infants television programs or picture-books are used then straight away the game was labelled as being 'babyish'. Examples given of this type of computer game are the television program *Play School*, and the children's characters Bananas in Pyjamas, Barbie, and Winnie-the-Pooh.

Interestingly, a number of children referred incorrectly to titles of some games indicating their suitability only for younger children. The prime example is the labelling of the *Maths Circus* series. Three programs make up this series, *Maths Circus 1*, *Maths Circus 2*, and *Maths Circus 3*. A theme that occurs in the interviews, the observations, and the 'liked/disliked' survey, is the strong unpopularity of these particular programs. During the observation sessions, a number of children perceived the numbers 1, 2, and 3 in the titles of the *Maths Circus* programs as indicators of school grade levels. However, this is not the case as the numbers refer to the chronological order in which the programs were published. However, once again, the children have used their own understanding, or misconception, combined with the presentation of the actual program - cartoonish characters and simple, repetitive circus music - to categorise the program as not suitable for their use. Unfortunately, because of the publisher's unimaginative naming of the programs, many children are likely not to experience the benefits of a series of puzzles which, in light of what has been reported in the challenge section of this analysis, deliver an enjoyable and challenging learning experience.

Other attributes were also identified by the children as being better suited for use by younger children. Having the computer game control the pace and direction of play, overly-bright colours, simple graphics, small choice of activities, short duration of play, and simple sounds were attributes deemed as being for young children.

This is an important issue to explore because, through my library experience of recommending books to children, it is very important for them to believe that they are receiving a book that is suitable for their age and not one that could be viewed as babyish by their peers. This issue is of importance to book publishers wishing to market high-interest, low-reading ability books to school libraries. These books are designed to look like 'grown-up' books and orient the narrative around subjects that are deemed to be of high interest to children, for example, sport action for boys or horse riding for girls. The belief is that books with these kinds of subjects combined with a simpler, more accessible vocabulary, will encourage the reluctant or poor reader to try them, thereby practising their reading and, ultimately, perceiving reading to be an enjoyable pastime, without the risk of being held up to ridicule by their peers because they are reading 'baby' books.

There is also the issue of remedial programs. A number of primary children at my two schools participate in remedial literacy and numeracy programs. Some of the lessons in these learning programs involve using computer games in order to provide both novelty and incentive. Generally, I have observed that the use of computer games with these children does indeed provide the incentive to apply themselves more than perhaps they normally would in the traditional classroom learning situation. One important criterion of the success of the remedial programs, I believe, is that they are not presented in a fashion that makes the child perceive they are doing Infants' work, something that could significantly affect their self-esteem and which in turn may negatively affect their success at learning. Even though the general use of remedial programs is restricted to literacy and numeracy programs, there is no reason why they might not be successfully used in science education, as well. Therefore, it would be important to have programs presented in an age appropriate manner.

This translates to the educational computer game where it is important to have the children feel comfortable using specific programs. For example, in talking casually to students during the observation sessions, I discovered many of the senior children perceive the *Maths Circus* series and the *Thinkin' Things* series of games as babyish, for reasons already detailed above, although the problems posed by both sets of programs challenge the brightest students. As pointed out earlier, children are missing out on some very challenging logic and problem-solving exercises simply because they have made a negative judgement of the programs based on their appearance.

Recommendation: That the characters, graphics, music, and title not reflect images and sounds associated with infant-aged children but rather reflect the age of primary school students.

Cover design

A facet of game design that relates to the texture of the game is cover design. This aspect is not addressed in the literature. A small number of girls mentioned that the cover of the box in which a game is packaged influences their decision on whether or not to play. To these girls the look of the cover includes the description, or blurb, found on the box. Some girls claimed that a plain cover indicates that a game is not worth playing and some indicated that it was the title that might turn them away. Generally, the girls seem to be looking for the same attributes on the cover as in the game - bright colours and interesting pictures. Although the box cover is not usually seen by my students - most software is either loaded directly on to the network server or stored in jewel cases in a CD rack - it does lend credence to the view that the appearance of a game is the first thing some girls interact with, and if the appearance is not a pleasant one then it may not matter how well the game is constructed and implemented, it will probably not be used.

A small number of boys mentioned how a box cover, or game title, could influence their desire to play. When Duncan (8, lines 36-8) was asked what things or parts of a computer game made it enjoyable for him to play he responded, "Well, if you just look at it and look at the back it's kind of fun. [*Do you mean the box it comes in?*] Yes". It could be inferred that for some boys, just as with some of the girls, the first impression needs to be pleasant and encouraging.

Speed of play

From the data generated through the interviews, the pace of the game preferred by the girls could not be determined. Only a very small number of girls (four) mentioned a fast game speed as an attribute they find attractive. One of the few girls to mention this aspect, Iris (10, lines 31-2) claimed that one reason she enjoys playing *Aussie Maths Invaders* is "trying to get the least time". This possibly relates also to the competitive attribute of the game, although Iris did not indicate whether she was trying to beat her own times or times set by other players. Although not directly related to speed, a small number of girls mentioned that they like games that feature hand-eye coordination and pressing buttons on the keyboard, which may indicate a preference for fast-paced game play. However, again, this was only a small number and it is difficult to draw any support from the interviews.

Some evidence that does support preference for slower paced games may be inferred from the answers supplied by the girls when asked how they would design a computer game for other girls to enjoy. The speed of the game was not mentioned by many girls, but of the 16 who did, eight claimed that their 'girls' game would be slow-paced, three medium-paced, and five fast-paced. This result may indicate, albeit weakly, that girls perceive other girls preferring a slower game. In contrast, when the girls were asked to design a computer game that boys would enjoy playing, three believed their game would be slow-paced, five medium-paced, and six fast-paced. In contrast to the girl-design, this indicates that amongst the girls who mentioned the speed attribute, more perceive that boys prefer a medium-to-fast pace. Also, many of the girls mentioned they would incorporate a time limit in the 'boy-game' that they designed, indicating again that they perceive the presence of time elements as being a preferred attribute for boys. In contrast, no girls mentioned putting in a time limit to a game they would design for other girls. However, the small numbers of girls who mentioned these time-related attributes tend to make me wary of drawing any strong conclusions about the pace of a game designed for girls. Any conclusions regarding preferences for speed may have to be drawn from the literature rather than the data of this study.

In the data generated though the boys' interviews, a similar conclusion to that of the girls may be put forward. For this attribute, only a small number mentioned the pace factor. Only 11 boys mentioned this attribute, with most of those references indicating a preference for fast-pace. Also, a similar number mentioned hand-eye coordination and skills for calculating "the exact right time to shoot the arrow to blow up the balloon and all the monsters" (Colin, 9, lines 55-7) which, again, may indicate a preference for a fast-paced game. This seems to correlate with what Jones (1997) reported, that many boys enjoy the "twitch" aspect of playing fast-paced computer games that rely on hand-eye coordination.

The pace of the game preferred by the girls could not be determined through my data, so I turned to the literature to provide a recommendation. Overwhelmingly, the literature indicates that girls prefer games that do not rely on fast action or beating an artificial time limit (Caftori & Paprzycki, 1997; Inkpen et al., 1994; Kafai, 1996; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Rubin et al., 1997; Scott, Cole, & Engel, 1992). Girls are reported to be more interested, and to find it more enjoyable, to be able to consider their actions and moves in a game without time constraints or restrictions. This game strategy fits comfortably with the puzzle genre that many of the girls indicated they enjoy and prefer. However, for games that do rely on a time or speed element I feel that a facility for the player to adjust game speed should be included.

Recommendation: That a facility be available that allows the player to adjust the speed of game play.

CHAPTER TWELVE

FINDINGS REGARDING DESIGN ATTRIBUTES OF COMPUTER GAMES PREFERRED BY GIRLS

Introduction

Ten major findings have emerged from my study that are relevant to the unique situation found in my two schools. It must be emphasised that I do not purport that these findings are universal facts or absolute truths. Instead they are relevant to my situation in my two schools, and they are trustworthy and authentic knowledge claims that I have derived from close analysis of the data and the interpretations and inferences resulting from those deliberations. Although I make no claim that what I have constructed can be transferred directly to other situations, I do believe that they can assist other professional educators to devise their own criteria for the selection of girl-friendly educational software suitable for their own relatively unique environments. As the main aim of my research was to identify girl-friendly design attributes of computer games that can be incorporated into educational computer games, particularly those relevant to science education, my findings reported here deal only with the girls' preferences.

As well as summarising my findings I have included comparisons and contrasts with the published research literature, thereby enabling the reader to see where my claims differ from those already in the public domain. A tabularised summary of these comparisons and contrasts can be found in Appendix 8. Finally, in the Afterword, I speak briefly about how I personally have been affected by this research.

Girl-friendly Design Attributes

Violence

The relationship between the element of violence, girls, and computer games is not clear according to my research. While it may be easy to state that the presence of violence in an educational computer game will discourage girls' interaction with it, it would not be an accurate statement. It appears from what my girls have reported that it is the type of violence and who or what it involves that is important, not the actual presence of violence itself.

The majority of the girls indicated that if the violence involves cartoon characters or is obviously cartoonish in its presentation than it is acceptable and can be responsible for part of the fun that can be derived from playing computer games. This is not to say that violence is a necessary requirement, something that could be interpreted from the responses of most of the boys, just that its presence in cartoon form is acceptable. Human-oriented violence, on the other hand, seems to provide a very strong discouragement to the majority of the girls and therefore should not be present.

It is also important that a distinction between violence and action is made. Many of the girls expressed a desire for their computer games to have action - action derived from sporting simulations, for example - rather than violence, and it could be that the inclusion of such action in educational software may be an attribute that will attract girls to play.

When compared to the literature my findings differ somewhat significantly. The majority of the literature indicates strongly that the presence of violence in computer games discourages girls' play (Brunner et al, 1998; Butler, 2000; Copper et al., 1990; Dempsey et al., 1998; Glaubke et al., 2001; Morse, 1995). These papers, however, do not distinguish between human violence and cartoonish violence, treating them as one in the same. Only one study, by Funk & Buchman (1996b), specifically looked at the aspect of cartoonish violence and they reported that girls did not find its presence unwelcome.

Settings

This aspect deals with the background upon which the game play is based. It is clear from this study that my girls prefer their computer games to use a realistic setting. Being able to base their play in an environment that they can relate to appears to be an element that encourages girls' engagement with the educational outcomes of the game. Additionally, the combining of a realistic setting with a mystery could enhance their enjoyment. The use of fantasy was only very weakly supported by the data. The one realistic setting that could not be recommended is an 'outer space' setting. This setting seems to be strongly disliked by many of the girls.

In relation to this design element my findings correspond with some of the literature. The majority of the cited research indicates that girls prefer computer games set in a fantasy world (Brunner et al., 1998; Cesarone, 1998; Funk & Buchman, 1996b; Gailey, 1992; Martinez, 1992; Neumark, 1991), a conclusion my study does not support. Also, Dempsey et al.'s (1996a) finding, that girls prefer multiple scenes, is not supported. Variety, it appears, is not important to my girls. A smaller number of papers indicate that a realistic setting is preferred by girls (Glaubke et al., 2001; Kafai, 1996; Laurel, in Subrahmanyam & Greenfield, 1998), which is a finding my study does support.

Feedback

In professional teaching it is widely believed that it is important for students to receive feedback on their learning development. Encouraging a player to continue playing a computer game may be equally important. This study found that the type of feedback preferred by my girls is non-violent and visual rather than sound-based. Non-violent feedback refers to a style of feedback that does not end a game suddenly if a wrong decision is made. Girls want the option to continue playing and to 'save' their character or situation, thereby enabling them to get on with the task of completing the game successfully. My findings indicate that a major setback in the game is likely to be acceptable, but not the termination of it.

My findings provide some support for the literature which indicates a strong preference amongst girls for verbal feedback (Cooper, Hall, & Huff, 1990) conveyed to the player in a positive manner (Glaubke et al., 2001; Hall & Cooper, 1991; Miller, Chaika, & Groppe, 1996; Morse 1995). Although my findings do not directly agree with the literature's claim of girls' preferring positive feedback it could be inferred from the girls' preference for games to continue rather than end abruptly that positive rather than negative feedback is preferred.

Game Texture (Visual and Aural Aspects)

Graphics

My findings indicate that the use of bright colours is a feature that is considered to be important by the majority of girls. An educational computer game that does not incorporate this attribute is not likely to be successful with my girls. Generally, it seems that the brighter the program's appearance the more desirable it would be. No particular colour was found to be favoured by a majority of girls, although it seems wise to avoid over use of pink. I did not find that my girls prefer large detailed graphics as suggested by the literature (Freedman, 1989; Jakobsdottir, Krey, & Sales, 1994; Passig & Levin, 1994). Perhaps the sophisticated graphics offered by modern computer games makes this observation redundant, as I believe the girls have an expectation of excellent and highly detailed graphics being provided in any computer game they choose to play. The literature cited was published at least 10 years ago at a time when it may be safe to assume that graphical offerings in computer games were variable and poor or low resolution graphics were prevalent.

Music and Sound Effects

I found that my girls have a preference for the presence of music, although this could not be said to be an essential element. Perhaps more important to the girls is the ability to, first, select from a range of musical tracks that reflect different styles of music and, second, have the option of turning off the music without effecting the other sound effects designed into the games. Having a variety of music takes away the difficult task of identifying the actual style of music preferred by girls. Music, it may be fair to say, involves individual taste so allowing the player to select from a variety of offerings could be an important criterion.

My findings correspond strongly with literature which maintains that girls view music as an element they want to have available in computer games (Cooper, Hall, & Huff, 1990; Malone & Lepper, in Wilder, Mackie, & Cooper, 1985), but disagrees with literature which maintains that girls find music annoying. The annoyance factor, which was mentioned by some girls, relates to repetitive playing of musical tracks, and could be avoided by making available a variety of music from which to choose.

Narrative

The girls of my study seem to want a storyline that not only gives a purpose to playing the game but also enhances their enjoyment. This is a finding that directly supports the research literature (De Jean et al., 1999; Inkpen et al., 1994; Krantz, 1997; Laurel, in Cassell & Jenkins, 1998c; Miller, Chaika, & Groppe, 1996; Murray & Kliman, 1999; Polak, 2001). A caveat to this finding is that the storyline must be meaningful and relevant to the game, not just an add-on that does not effect how the game unfolds and is present simply to connect together a serious of random events.

Characters and *Avatars*

This is an interesting finding that runs counter to what I had expected. The girls appear not to want only female characters to control or female avatars to represent them in their computer games. Rather, they indicated that, as with their music, they want to select the sex when choosing an avatar. This finding contradicts the majority of the literature (De Jean et al., 1999; Glaubke et al., 2001; Jakobsdottir, Krey, & Sales, 1994; Klawe et al, 1996; Littleton et al., 1998). A number of girls mentioned that the character they wanted 'to be' at any particular time often depended on the mood they were in at the time.

A second finding, and one not mentioned in any literature that I am aware of, is the apparently strong desire for girls to be able to create or design the appearance of their avatar. This facility is likely to provide a major boost to the desirability of a particular piece of educational software, in the eyes of many of my girls. It is likely to be an essential design feature of software packages being evaluated for girl-friendly appeal.

Competition/Cooperation and Collaboration

In light of what has been written widely about girls' dislike of competition, the findings in this section are, to my mind, quite surprising. The presence of a competitive element in an educational software package is likely to be an attribute welcomed by most of the girls, and in particular the 10- to 12-year olds. My findings indicate that if a computer game is developed that eliminates any competitive element in order to appeal to girls then the opposite effect might be achieved - a lack of appeal. However, as with other findings, there is a caveat - it seems that the competition should be against the computer rather than against fellow players.

This finding contradicts the majority of the literature which states that girls prefer to collaborate in their computer use (De Jean et al., 1999; Elliot, 1990; Hawkins, 1987; Henney, 1986; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Murray & Kliman, 1999; Nicholson et al., 1998; Rubin et al., 1997; Shade, 1994) or simply do not like competitive elements in computer games at all (Arch & Cummins, 1989; Kelly, in Cassell & Jenkins, 1998a; Lockheed, 1985, Serbin, Powlishta, & Gulko, 1993). Only a small number of researchers agree with my findings (Caftori, 1994; Chappell, 1997; Malone, 1981; Signer, 1992). In the context of my study, I view this as one of the more significant findings because I feel that, as teachers, we are constantly told through both research results and the experiences of others that girls shy away from competition, inferring that the best way to engage them is to make their learning tasks collaborative.

In relation to educational software, it could be argued that a design that incorporates collaborative player behaviour aimed at beating the computer may be the direction to go, however a simple design of one person against the computer in a competitive environment is just as likely to appeal to the majority of my girls.

Activities

The presence of activities apparently is not needed by the girls in order to enjoy using a particular computer game. My findings indicate that this feature is likely to be welcomed only if there are time constraints, such as school timetable concerns, on the use of the software and if the facility to save the player's progress at any stage of the game is either unreliable or unavailable. My girls appear to enjoy games that give them extended play of the one type and that do not require them to jump around the playing environment completing unrelated tasks or activities.

My finding in relation to this design element contradicts the literature, which concludes that the presence of multiple activities is a girl-friendly feature of educational computer gaming that encourages their play (Cooper, Hall, & Huff, 1990; Kafai, 1995; Klawe et al., 1996; Westrom & Super, 1995). In my situation the opposite seems to be true.

Challenge

Girls do seem to enjoy the challenge provided by interacting in a competitive way with a computer game. However, my findings indicate that they prefer their challenge to derive from solving puzzles and applying logic to problems rather than through battling more and faster opponents. One important finding relevant to the type of challenge they prefer is that apparently there needs to be multiple solutions, all of which allow the player to successfully complete the game. This finding correlates positively with the literature that investigated the attribute of challenge (Brunner, Bennett, & Honey, 1998; Bunderson & Christensen, 1995; Caftori & Paprzycki, 1997; Cooper, Hall, & Huff, 1990; Subrahmanyam & Greenfield, 1998; Walker, 1998). Also, part of the challenge attribute relates to girls wanting to compete against the computer, with their friends assisting in solving the problems, thereby enabling them to gain the competition they seem to want without the social risk of competing against a friend.

Genre

Of all the genres available in computer games the one that appears to fit best with the other claimed preferences of my girls is the Simulation genre. This genre allows the player to explore different avenues and ideas and is an ideal host for problem and puzzle solving that my girls seem to enjoy playing as well as being a conduit for group competition against the computer. Unlike most other genres, simulations allow different ideas to be tested and modified if the current idea is found wanting. Often, the use of multiple solutions is supported in a simulation game whereas most other genres have only limited ways in which the player can successfully complete a level or whole game. Indirectly, the preference for simulations supports the contention of the literature that girls prefer slow game play (Caftori & Paprzycki, 1997; Inkpen et al., 1994; Kafai, 1996; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Rubin et al., 1997; Scott, Cole, & Engel, 1992), as simulations often do not depend on time limits.

The preference for the Simulation genre is not present in any of the published literature that I reviewed and so may represent a unique finding in this area.

Miscellaneous Findings

Instructions

Having access to instructions and help throughout the game is likely to be a desirable attribute. Although this feature should not be regarded as essential, its presence might be positive for many of the girls and could assist them in their general inexperience with computer games.

Game Saving

The ability to save a game at any time appears to be an element that many of the girls would welcome, particularly when time constraints exist in the classroom situation. Being able to return reliably to the place in the game that a student had left previously because of lack of time for completion is likely to assist in lowering frustration levels of the girls and subsequently encourage further play at a later stage.

Humour

The presence of humour may enhance the enjoyment of using educational computer games for girls. As many of the girls did not mind sharing computers with their friends the opportunity to share humorous moments could be a positive experience.

Emergent Criteria

From these recommendations I have constructed a simple 'YES/NO' checklist (Table 34) that I can use to assist in selecting appropriate educational software. I have listed the criteria as a series of questions for me to answer when considering a potential addition to the educational software collection. Although my research has been under the umbrella of science education these criteria could be used for any educational computer game designed for any of the Key Learning Areas. The questions preceded with an asterix indicate an essential element.

Table 34: Criteria used for selection of girl-friendly educational computer games.

*Does the action derive from non-violent or comical violence events?	YES	no
Does the setting of the game encompass a wide virtual area of play?	YES	no
* Does the game use a realistic setting and background?	YES	no
Is the feedback presented visually?	YES	no
*Can the visual feedback be turned off or hidden?	YES	no
*Does the game continue if a wrong choice is made by the player?	YES	no
*Are bright colours used throughout the game?	YES	no
* Is there a variety of music available?	YES	no
Can individual music tracks be selected by the player?	YES	no
*Does the narrative drive the gameplay and is it integral to the game?	YES	no
*Is there a range of avatars for the player to select?	YES	no
Are both genders represented in the characters available for selection?	YES	no
*Can the player design their own character?	YES	no
Can the game be networked with other computers?	YES	no
Are discrete creative (non-arcade) activities available in the game?	YES	no
*Can progress in the game be saved at anytime?	YES	no
*Is the challenge supplied by puzzles and problems?	YES	no
*Do the puzzles and problems have multiple solutions?	YES	no
*Can the level of difficulty be modified by the player?	YES	no
*Is the game a simulation?	YES	no
Are instructions accessible from within the game?	YES	no
*Does the game take substantial time to complete?	YES	no
*Are the images and sounds age-appropriate for the audience?	YES	no
*Can the player adjust the speed of play?	YES	no

Implications of Using the Constructed Criteria for Science Education at my Schools

Earlier I cited research undertaken by Johnson-Eiola (1997) which confirmed that skills honed from educational computer games can be transferred to other non-computer based areas of education. In light of the criteria constructed in Table 34, I believe his research becomes very relevant to my situation. The application of the criteria presented in Table 34 to the purchase of educational game software for use in the science education curriculum in my two schools may result in software that appeals to the majority of girls. Skills and knowledge gained from using this software may be transferred by the girls to the classroom-based science education program developed by classroom teachers. Also, especially in the light of the discussion of teacher attitudes to science education discussed in Chapter Five, the supply of science education software for use by staff at my two schools in their teaching and learning program may stimulate those who are reluctant or not confident to teach science to introduce concepts and ideas in a more enjoyable, comfortable and relevant way.

As it stands at the moment in both schools, no specific science-based computer software is used by the teachers or students. At one school only one program, *I ~~hate~~ love science*, is available in the computer room and, as the observation data indicated, it was not used the girls and was used only twice by two boys. Further, although I have not observed any teachers taking classes in the computer room, I assume that it is not being used in those learning situations. Having criteria available with which to evaluate potential science education software may result in more relevant and useful software being purchased that students, especially girls, will want to use. By using the medium of computer games, which my data has indicated is very popular with girls, a subject that research indicates may not be favoured by them could become one that they find interesting and challenging, thus assisting their participation, enjoyment, and achievement in the subject.

Comparison of Selection Criteria with Games Observed as Popular with Girls

Arriving at the criteria in Table 34 has resulted from a long process of recording, interviewing, reading, observing, and interpreting. However, the criteria produced remain theoretical, reflecting my interpretation of what attributes could encourage girls to use a particular piece of educational software. Comparison of the criteria to real world software that my observations indicated are popular with female students may indicate the extent to which the criteria are potentially useful and relevant as a selection tool for future purchase.

In order to compare programs that are popular with my female students to the criteria I have taken games that were observed being played most frequently by girls (Table 25). Of the nine games listed, three could be incorporated into a science lesson or science program. They are the *Maths Circus* series, the *Zoombinis* series, and the *Thinkin' Things* series[16]. I will also compare the game observed being played most frequently, the *Carmen Sandiego* series, as well as an arcade game, *Kung Fu Kim*, that was popular with the girls. How do the attributes of these games compare to the criteria in Table 34? Would the use of the criteria have resulted in their purchase?

[16] Descriptions of these games can be found in Appendix 1.

Table 35: Evaluation of the *Maths Circus* series using the constructed criteria.

*Does the action derive from non-violent or comical violence events?	YES	
Does the setting of the game encompass a wide virtual area of play?		no
* Does the game use a realistic setting and background?		no
Is the feedback presented visually?	YES	
*Can the visual feedback be turned off or hidden?		no
*Does the game continue if a wrong choice is made by the player?	YES	
*Are bright colours used throughout the game?	YES	
* Is there a variety of music available?		no
Can individual music tracks be selected by the player?		no
*Does the narrative drive the gameplay and is it integral to the game?		no
*Is there a range of avatars for the player to select?		no
Are both genders represented in the characters available for selection?		no
*Can the player design their own character?		no
Can the game be networked with other computers?		no
Are discrete creative (non-arcade) activities available in the game?	YES	
*Can progress in the game be saved at anytime?	YES	
*Is the challenge supplied by puzzles and problems?	YES	
*Do the puzzles and problems have multiple solutions?	YES	
*Can the level of difficulty be modified by the player?	YES	
*Is the game a simulation?		no
Are instructions accessible from within the game?	YES	
*Does the game take substantial time to complete?	YES	
*Are the images and sounds age-appropriate for the audience?		no
*Can the player adjust the speed of play?	YES	

Of the 17 criteria that I identified as important to be present in educational software in order for it to be considered 'girl-friendly', the *Maths Circus* series demonstrates the presence of 12. On the surface this indicates that this series of software would not be a strong contender for being a favourite of the girls, yet it was observed being played by 23% of the girls who chose to use the computer room at lunchtime at the school which had it installed in the computer laboratory. However, it must be remembered that the range of software from which the girls could choose was not broad. I believe the observed use of this program demonstrates the girls choosing the best of a bad lot. It is also important to remember that during the interviews many of my students mentioned that they considered the graphics and music presented by this program to be 'babyish'. The reworking of the graphics and the changing of the simple and repetitive circus-theme music to a variety of other styles is likely to increase the satisfied criteria to eleven.

If I had been carrying out a pre-purchase evaluation on this software I feel the presence of 12 of the criteria would have indicated that girls would probably enjoy using it and so I probably would have purchased it. I believe its relative popularity with the girls, as indicated by Table 25, supports this assumption.

Table 36: Evaluation of the *Zoombinis* series using the constructed criteria.

*Does the action derive from non-violent or comical violence events?	YES	
Does the setting of the game encompass a wide virtual area of play?		no
* Does the game use a realistic setting and background?		no
Is the feedback presented visually?	YES	
*Can the visual feedback be turned off or hidden?		no
*Does the game continue if a wrong choice is made by the player?	YES	
*Are bright colours used throughout the game?	YES	
* Is there a variety of music available?		no
Can individual music tracks be selected by the player?		no
*Does the narrative drive the gameplay and is it integral to the game?	YES	
*Is there a range of avatars for the player to select?		no
Are both genders represented in the characters available for selection?		no
*Can the player design their own character?	YES	
Can the game be networked with other computers?		no
Are discrete creative (non-arcade) activities available in the game?	YES	
*Can progress in the game be saved at anytime?	YES	
*Is the challenge supplied by puzzles and problems?	YES	
*Do the puzzles and problems have multiple solutions?	YES	
*Can the level of difficulty be modified by the player?	YES	
*Is the game a simulation?		no
Are instructions accessible from within the game?	YES	
*Does the game take substantial time to complete?	YES	
*Are the images and sounds age-appropriate for the audience?	YES	
*Can the player adjust the speed of play?	YES	

This series of programs satisfies 15 of the criteria which, I believe, indicates that it could appeal to girls. This appeal was borne out in both the observation sessions, where it was played by 21% of the girls, and the interviews, where it was stated by a number of girls that they enjoyed creating, playing and saving the "cute" characters that inhabited the game. Interestingly, the *Zoombinis* series was not one of the nine games observed being played most frequently by the boys. Did it have too many 'girl' attributes?

Because of the nature of the game a number of the criteria could not be satisfied and perhaps this indicates a need for a 'Not applicable (N/A)' choice in the evaluation. It was not a simulation, nor was the game built around a player's avatar. Perhaps the only attribute that could be added to make it more girl-friendly is music. As with the *Math Circus* series, I believe a pre-purchase evaluation of this program using my criteria would have resulted in its purchase, a purchase that would have been justified by its general popularity with the girls.

Table 37: Evaluation of the *Thinkin' Things* series using the constructed criteria.

*Does the action derive from non-violent or comical violence events?	YES	
Does the setting of the game encompass a wide virtual area of play?		no
* Does the game use a realistic setting and background?		no
Is the feedback presented visually?	YES	
*Can the visual feedback be turned off or hidden?		no
*Does the game continue if a wrong choice is made by the player?	YES	
*Are bright colours used throughout the game?	YES	
* Is there a variety of music available?		no
Can individual music tracks be selected by the player?		no
*Does the narrative drive the gameplay and is it integral to the game?		no
*Is there a range of avatars for the player to select?		no
Are both genders represented in the characters available for selection?		no
*Can the player design their own character?		no
Can the game be networked with other computers?		no
Are discrete creative (non-arcade) activities available in the game?	YES	
*Can progress in the game be saved at anytime?	YES	
*Is the challenge supplied by puzzles and problems?	YES	
*Do the puzzles and problems have multiple solutions?	YES	
*Can the level of difficulty be modified by the player?	YES	
*Is the game a simulation?		no
Are instructions accessible from within the game?	YES	
*Does the game take substantial time to complete?	YES	
*Are the images and sounds age-appropriate for the audience?	YES	
*Can the player adjust the speed of play?	YES	

This series of problem solving programs satisfied 13 of the criteria. Again, because of the nature of the program several of the criteria are not relevant. For example, I believe the use of an avatar, the designing of that avatar, and the use of a realistic setting would not be appropriate for the intent of the game. However, a majority of criteria was satisfied and, once again, a pre-purchase evaluation for girl-friendly software would probably have resulted in its purchase. This series of programs demonstrates the difference between what the girls appear to prefer and what the boys appear to prefer when the observation data are considered. The *Thinkin' Things* series, which has a majority of apparently girl-friendly attributes, did not feature in the top nine programs selected by the boys during the lunchtime observation sessions.

Table 38: Evaluation of the *Carmen Sandiego* series using the constructed criteria.

*Does the action derive from non-violent or comical violence events?		no
Does the setting of the game encompass a wide virtual area of play?	YES	
* Does the game use a realistic setting and background?	YES	
Is the feedback presented visually?	YES	
*Can the visual feedback be turned off or hidden?		no
*Does the game continue if a wrong choice is made by the player?	YES	
*Are bright colours used throughout the game?	YES	
* Is there a variety of music available?		no
Can individual music tracks be selected by the player?		no
*Does the narrative drive the gameplay and is it integral to the game?	YES	
*Is there a range of avatars for the player to select?		no
Are both genders represented in the characters available for selection?		no
*Can the player design their own character?		no
Can the game be networked with other computers?		no
Are discrete creative (non-arcade) activities available in the game?	YES	
*Can progress in the game be saved at anytime?	YES	
*Is the challenge supplied by puzzles and problems?	YES	
*Do the puzzles and problems have multiple solutions?		no
*Can the level of difficulty be modified by the player?		no
*Is the game a simulation?	YES	
Are instructions accessible from within the game?	YES	
*Does the game take substantial time to complete?	YES	
*Are the images and sounds age-appropriate for the audience?	YES	
*Can the player adjust the speed of play?	YES	

The *Carmen Sandiego* series reflects 14 of the criteria deemed to be girl-friendly by my research. This series of games was the most popular selection by the girls at my two schools during the observation period, with 25% of the girls being observed playing the game at one time or another. This series of games did not feature significantly in the selections made by the boys during the observation period. Self-pacing, use of puzzles, the simulation of being a detective along with a narrative that make the puzzles relevant to the game are, I believe, the attributes that make this game appealing to many of my female students, and would justify its purchase.

Table 39: Evaluation of *Kung Fu Kim* using the constructed criteria.

*Does the action derive from non-violent or comical violence events?		no
Does the setting of the game encompass a wide virtual area of play?		no
* Does the game use a realistic setting and background?		no
Is the feedback presented visually?	YES	
*Can the visual feedback be turned off or hidden?		no
*Does the game continue if a wrong choice is made by the player?		no
*Are bright colours used throughout the game?	YES	
* Is there a variety of music available?		no
Can individual music tracks be selected by the player?		no
*Does the narrative drive the gameplay and is it integral to the game?		no
*Is there a range of avatars for the player to select?		no
Are both genders represented in the characters available for selection?		no
*Can the player design their own character?		no
Can the game be networked with other computers?		no
Are discrete creative (non-arcade) activities available in the game?		no
*Can progress in the game be saved at anytime?		no
*Is the challenge supplied by puzzles and problems?		no
*Do the puzzles and problems have multiple solutions?		no
*Can the level of difficulty be modified by the player?		no
*Is the game a simulation?		no
Are instructions accessible from within the game?		no
*Does the game take substantial time to complete?		no
*Are the images and sounds age-appropriate for the audience?	YES	
*Can the player adjust the speed of play?		no

The presence of *Kung Fu Kim*, an arcade game that relies on speed and hand-eye coordination, in the list of games most frequently played by girls in the observation session (19%) could, on the surface, be seen as evidence unsupportive of the usefulness of my criteria. After all, it meets only three of the girl-friendly criteria I have established from my research. However, I believe the presence of this game in the list of games most frequently observed being played by girls reflects an aspect that emerged from the girls' focus groups. In the focus groups a number of girls made the point that what they enjoy playing often depends on how they feel at the time. Often some stated that they simply want to play something where they do not have to think or work. As one girl stated, what she plays "depends on the mood I am in". Obviously, though, a game such as *Kung Fu Kim* is not going to be considered for any educational content and so the application of my criteria would not have been undertaken.

Table 40: Evaluation of *I ~~hate~~ love science* using the constructed criteria.

*Does the action derive from non-violent or comical violence events?		no
Does the setting of the game encompass a wide virtual area of play?		no
* Does the game use a realistic setting and background?		no
Is the feedback presented visually?	YES	
*Can the visual feedback be turned off or hidden?		no
*Does the game continue if a wrong choice is made by the player?	YES	
*Are bright colours used throughout the game?	YES	
* Is there a variety of music available?		no
Can individual music tracks be selected by the player?		no
*Does the narrative drive the gameplay and is it integral to the game?		no
*Is there a range of avatars for the player to select?	YES	
Are both genders represented in the characters available for selection?	YES	
*Can the player design their own character?	YES	
Can the game be networked with other computers?		no
Are discrete creative (non-arcade) activities available in the game?	YES	
*Can progress in the game be saved at anytime?		no
*Is the challenge supplied by puzzles and problems?	YES	
*Do the puzzles and problems have multiple solutions?		no
*Can the level of difficulty be modified by the player?		no
*Is the game a simulation?		no
Are instructions accessible from within the game?	YES	
*Does the game take substantial time to complete?	YES	
*Are the images and sounds age-appropriate for the audience?	YES	
*Can the player adjust the speed of play?	YES	

This program was the only piece of software directly related to science education. It satisfied 12 of the 17 criteria, indicating perhaps, on the surface, that it should have been safe to assume that it would be at least used occasionally by some girls. However, over the observation period it was only played once each by two boys. No girls chose to play this game during the observation period. The only reason I can put forward is that the title of the game turned girls away from even sampling it. Perhaps the use of the word 'Science' should be avoided in any title being developed for girls.

On the surface it does look like a program full of promise and fun for a child or parent looking for a piece of educational software for their child. However, upon loading and playing the player discovers a program that is static in its presentation, and although colourful it does not supply any movement or action to the player. It is perhaps more a tutorial, listen-and-learn style program dressed up in a colourful game-like package. I think that the lack of success of this program reinforces the value of the criteria that I have constructed. Having the presence of less than half of the identified attributes (8 from 17) appears to be an indicator of a software package's lack of desirability by girls.

Implications for the Design of Science Education Computer Software

I believe that having four of the five science relevant games observed being played most frequently by my girls as satisfying the majority of my criteria is a positive indicator that what I have constructed has the potential to be a very useful tool for the selection of girl-friendly science education software. By using the criteria a range of software that aims to encourage the participation, enjoyment, and achievement in primary science could be identified and purchased.

However, this can happen only if there is a range of software available from which to choose. Unfortunately, it appears that this is a curriculum area that is not well catered for by commercial producers of software. A brief look at any commercial catalogue dealing with educational software shows a broad selection of educational game software for literacy, mathematics, and problem solving, whereas the specific area of science, and in particular primary science, is poorly resourced. Using my criteria as a guide, software developers may be able to produce software that is attractive not only to girls, but as my research shows, also to boys, who will basically play any computer game that is available.

Obviously the production of software that children enjoy playing and using will result in higher sales for the developer. By using a reverse-design principle, that is, starting with the desired attributes and basing the game play around them in a meaningful way, seems likely to produce a successful end product.

Conclusion

The purpose of my study was to ascertain whether there are particular design features of computer games preferred by girls and, if so, could incorporating them into science education software raise girls' interest, participation, and achievement in science. My study does indicate that girls have preferences for particular design features found in computer games, and these are listed in Table 34. The research detailed in Chapter Two, regarding the significance to a user of how a game interface is designed in relation to their engagement or otherwise with it, underlines the importance of the 'girl-friendly' criteria I have identified. Overall, I believe the incorporation of the identified criteria in the development of educational computer games relevant to primary science education could lead to teaching and learning programs that enhance girls' participation, enjoyment, and achievement in primary school science.

Afterword

The following is a personal view on how I feel my professional practice has changed due to the experiences gained from this research.

Introduction

Table 34 seems to be an insignificant product for all the work I have completed over the previous four years. It looks so small and inconsequential when compared to the pages and pages of background research and data analysis that produced it. However, upon reflection, it is not only the table of criteria for selecting girl-friendly educational software that has emerged from this work but also other indirect and significant elements have emerged for me, both in my professional practice and personal life.

Origins of My Enquiry

As mentioned in the Introduction to this thesis, it was the studies that I carried out at Deakin University that first crystallized the notion that I could actually investigate in a formal systematic manner the reasons that many girls appear to suffer from inequitable educational outcomes. I believe that I might have had this notion in my mind earlier than this but it was not until my Deakin studies that it came to the fore. The perception of inequity derived from my teaching experiences.

From the beginning of my teaching career I have felt that girls do not experience the same range of opportunities that boys experience in our schools. Often I see girls being overshadowed by the behaviour, actions and demands of boys, in both the classroom and the playground - in fact in most environments found in schools. I have tried through my teaching practice to reduce this imbalance but I do not think that I have ever fully had the skills, strategies, or knowledge to undertake this task successfully or satisfactorily. I feel now that the knowledge gained from my research has assisted me greatly in not only improving my skills in this area but also made me aware of various strategies that may allow me to successfully bring more equitable outcomes for all my students, both at school and in their lives generally.

Gender

My perception of gender has certainly changed over these years. I had viewed girls and boys in a traditional and conventional manner, as separate and distinct groups with very little in common. However, notwithstanding this, I still dealt with my classes as a homogenous group, treating them all in the same manner simply in the name of expediency - I had a syllabus to take my students through and to do it as a group was, to me, the quickest and most efficient way. Through my readings on gender and on teaching and learning strategies for girls, I see now that what I was actually doing was treating all my students as though they were boys. I was unaware of how many girls approach their studies differently to boys and how different teaching styles may be helpful to them. This observation, too, extends to some boys who prefer different learning styles in order to capitalize on their inherent strengths.

Now I find myself trying various teaching approaches that rely on different senses, or intelligences, as well as various types of assessment tasks, allowing students to select the way they wish to produce their work for marking. I find myself being more patient when seeking responses from all students, allowing them extra time to give an answer rather than moving on quickly if no response is immediately forthcoming and, as artificial as it may appear, I ensure that responses are sought alternately from girls and boys so as not to allow any one group to dominate the session. Use of the computerized catalogue in both of my libraries is more closely supervised in order to prevent boys from pushing the girls away from the terminals or interrupting a girl when she is using one. Of course, I also watch for boys pushing or interfering with other boys who are using the catalogue. I must admit that I have not yet observed a girl interfering unduly with another person using the catalogue. It appears that it is the boys who regard the computer, still, as their domain. Ultimately, I now try to see each child not in terms of gender or biological sex, but rather as a unique individual. I suppose this is an approach that is expected of teachers anyway but, in my view, the reality is that boys and girls are still generally treated as discrete groups.

One major element of my teaching program that I may need to modify is my discussions with the children regarding gender stereotypes. I take any and all opportunities that arise in to discuss with my students the presence and effect of stereotypes they meet in their everyday lives, whether they are in books, movies, or in general life. Possibly I have become too zealous in this and the children may be switching off. There may be evidence for this observation in the analysis section that deals with characters and avatars used by the children in their computer game playing. Many of the children seem to believe that having a ‘male’ character helps their quest for success, something that I have been explicitly targeting over the years as not true. If this message is not getting across as I had thought, then perhaps I need to be more subtle because I do not believe I can be more explicit. I know that I am battling against stronger, outside cultural forces (for example, mass media, parental expectations) but I would have hoped for a more informed view from the children than what I continue to observe.

Reflection

Learning to take time to reflect on what is going on around me is one of the two most important elements that have arisen from my studies. I have found that stopping for a period of time and mulling over things in my mind often led to new interpretations and insights regarding how I viewed my data and subsequent analysis. This is something that I did not have time to do during my previous studies - having strict deadlines for multiple assignments often meant limited thinking/reflecting time due to approaching ‘due dates’. Although the requirements for this thesis are infinitely more stringent and demanding, the extra time available (as a part-time student) meant that there was often time to put the work down and walk away for a while and simply think about it from different viewpoints. Often what I would describe as mini-revelations popped into my head at the oddest times, delivering insight into a previously troubling aspect of my analysis. Reflection, I believe, has become a very powerful tool for me.

Reflection has certainly led to a more critical thinking approach to many aspects of my professional practice. As educators we are constantly bombarded with research informing us of the 'best' ways to educate our students. Research is often backed by views and opinions of interested parties and it can be difficult to separate 'fact' from opinion. I now find myself looking much more critically at what is presented as research and I try to look beyond what is written to what the hidden agenda may be - something I admit I have not often done in the past. Increasingly I can see that there are always two sides, at least, to research and that one person's facts are another's opinions.

This is not to say that I am looking at new research with a cynical eye or with an arrogant view of my 'superior' knowledge, certainly not. But I am approaching it with a mind willing to at least give a chance to the voice inside the research to be heard. However, I am much more reluctant to accept at face value what is presented and I often find that I am asking questions to myself about how data could have been interpreted differently or how a different set of conditions may have led to slightly different conclusions. One phenomenon that has amazed me is the amount of, what I can only describe as, 'shonky' and unsubstantiated material sent to schools that is presented as fact to teachers, especially in terms of what they should be doing in their classrooms, and I continually worry about how many of my colleagues are swayed by it. I feel that in times past I, too, would have accepted the material without question - now I take the time to consider what is being said and the veracity of any claims made.

I find now that I continually take time out to reflect on my teaching. I no longer quickly jump into situations without giving thought to what I am going to say or do. Professionally, I often think later about what I have done in class and I go over parts that seem successful and not so successful trying to understand why success or lack of success occurred. I have found on a number of occasions that it has been my error, misunderstanding, or poor explanation that has led to an unexpected or undesired outcome, and I have been able to change elements of my teaching in order to avoid repeating those same mistakes.

Reflection is an activity that I could not say I consciously took part in in relation to my earlier years of teaching. I feel that I have certainly become a better teacher in terms of technique and understanding of the dynamics of both the classroom environment and the interaction between the class and myself as a whole, as well as with individual children. It is an odd but interesting and challenging exercise to undertake to view one's self from a distance, to evaluate your behaviour while you are conducting a class, but I have found it to be a rewarding activity and one that provides insights into my abilities and shortcomings, giving me a base for what I hope is improvement in my teaching.

The Notion of Truth

The second and equally important element that I have taken from this study is the concept of truth. I have arrived at the conclusion that the only truth is that there is no truth. I think this view has arisen from my exposure to Constructivism, both through the coursework section of my course, and directly through the research involved in my thesis.

I have to confess and admit (quite happily) that in my pre-thesis life I would have fitted perfectly into the Positivist model: All things could and should be measured and all responses and results could be predicted. Life was much easier to cope with if you did not have to grapple with shades of gray. However, it became apparent through the

Constructivism coursework unit that what was being put forward by a variety of theorists - that reality is what is agreed to and experienced within a particular community (remembering, of course, that this is my personal construction of Constructivism - it may not fit exactly with what others may regard as 'pure' Constructivism). My reality is not going to be exactly the same as another's although many similarities will exist if we share common beliefs, views, and environments.

My acceptance that the only truth is that there is no truth led to another paradox in my personal life. I believe that I have become significantly more tolerant of other people's views but, at the same time I have become very intolerant of people who hold dogmatic views - views they simply will not change or modify and insist on pushing onto others. More and more, when confronted by a view or perspective that I do not agree with, I find myself trying to understand the perspective of the person putting the view forward and empathizing with their outlook. This is not to say that I will change my mind and agree with them, but it does tend to make me more tolerant and accepting of differing views held by others. I believe that if more people would do this we may have a better functioning, safer and tolerant society.

The most interesting manifestation of my belief in the absence of an absolute truth that I have experienced is in the interpreting of my data. I undertook four major edits of my data analysis (along with continuous minor editing) and I found that I was constantly changing, albeit slightly, the claims that I was making. In comparing the first analysis with the final fourth edition, I identified many subtle but significant modifications in my final interpretations, inferences, and recommendations. In some cases Peter (my supervisor) suggested slightly different interpretations of the data resulting from his greater experience with analysis techniques and background knowledge of the subject. Often I would subsequently modify my interpretations to produce what I freely admit were tighter and more concise observations (a good example of the benefits of collaboration with others). I sometimes speculate that if I were to put my analysis away for a period of time and then return and re-analyze my data would I make significant changes to my interpretations? I believe I may. Obviously the analysing, the interpreting, and the writing must stop at some stage and a thesis handed in, but it is still a tantalizing idea in my mind to re-visit my research at a later stage to see if my interpretations still stand up to my own scrutiny.

My Contribution

Initially I was concerned that the area of my inquiry was not going to be 'big' enough to support my research. However, I was constantly surprised at just how large the area that I had selected to study turned out to be. Although compared to other areas dealing with computers and girls, software was not a big issue, however there was enough earlier research to work from and to use as a launching pad for my own interpretations and findings. I feel this observation is supported in my conclusions when compared to earlier research. I did not simply end up confirming already established views, but found contradictions to earlier findings as well as some original interpretations that had not been previously proposed or examined. Of course, I am not directly generalizing my interpretations to other situations but I would be confident to take what I have 'discovered' to another school if I happened to be transferred. I think my conclusions and recommendations could be modified to support teaching programs in similar schools and to assist other teachers in forming their own opinions about their particular situation.

Coda

Was it worth it? Yes, I believe so. Intellectually I feel that it was a very worthwhile exercise. The skills I have brought from within through undertaking this research will always prove useful, particularly in my professional life. The ability to be more tolerant and open to other viewpoints and opinions, the best aspect to emerge, can only be a positive for myself.

Am I smarter? No. In fact the whole process has been humbling. The reading of other peoples' works and interacting with my supervisor showed me how little I know. I feel now that I am much more circumspect about offering an opinion about matters I simply do not have information about whereas before I would quite confidently give my opinion about anything to anyone whether they needed it or not.

Would I do it all again? No. Undertaking this research proved to be such a draining experience that to tackle another project alone could not be justified. I now see from this experience the benefits of collaboration and cooperation. Further research would be wonderful but only as a partner with other researchers. Because of this I have implemented into my teaching and learning strategies greater use of collaborative and cooperative tasks. Rarely now do I ask children to complete work by themselves. Generally, I have the children work in groups of three to four so that they all take responsibility for what is produced. This has taken a while to implement satisfactorily as the children generally had poor skills when it came to sharing the work equally and allowing other members of their group to say their piece. However, the results that most of the children now produce has made the long task of demonstrating and practicing the necessary skills worthwhile. I am satisfied about the journey I have completed.

APPENDIX 1

DESCRIPTION OF COMPUTER GAMES MENTIONED IN THE THESIS

Age of Empires - Players select an ancient civilization, for example, Roman or Egyptian, then build up there power and strength by constructing buildings, increasing their population, and forming armies. When they believe they are strong enough they attack and try to defeat other players, conquering their lands and destroying their civilization. The player left standing is the winner.

Aquanoid - Players hit a ball against a wall of bricks, with the brick disappearing when it is struck by the ball. The ball rebounds of the bricks and the player has to hit the ball back. If the player misses the rebounding ball then a 'life' is lost. The object is to clear all the bricks on each screen, allowing the player to progress to the next, more difficult screen. Points are accumulated for the number of bricks destroyed.

Aussie Maths Invaders - Covers a number of mathematical areas, including algebra, multiplication facts, and formulas. Players are faced with a descending formula inside a 'spaceship'. They are required to work out the problem enter an answer, and then 'shoot' the answer at the descending spaceship. If the answer is correct the space ship is destroyed. If the answer is incorrect, the space ship draws closer to the player's base. If the spaceship touches the player's base the game is over. The player scores points for the spaceships they destroy.

Battleship - Players place their warships onto a grid. They then take turns in 'firing' a shell' at their opponent's grid. If they 'hit' a ship it is partially destroyed. Play continues in alternate turns until one player destroys the other's fleet.

Bow & Arrow - The player controls a on-screen sprite, which has only vertical movement, and lines it up to shoot arrows across the screen at object either rising vertically or coming towards it. As the arrow strikes an object the object is 'killed' and points are awarded to the player. The game is over if the player runs out of arrows before all the objects are hit, or an object touches the player's character. Levels become progressively harder as they are cleared.

Diamond Mine - Players have an 8X8 grid of coloured gems which they are required to place three identical ones in a row, either horizontally or vertically, by switching adjacent gems. If they match three they disappear and the gems above them all move down to take up the vacant space. New gems are added from the top of the screen. Play continues until no matching of three can be achieved. Music is provided which can be turned off.

Dynomite - With an animated slingshot, players 'shoot' coloured eggs at a descending wall of coloured eggs. If they are able to place an a coloured egg so that three eggs of the same colour are touching, an explosion occurs dislodging other eggs and slowing the descending wall. If the player blows up all the eggs, another screen starts with the descending wall of eggs travelling slightly faster. The game is over when the wall of eggs touches the player' slingshot.

Gizmos & Gadgets - By solving scientific-based puzzles the player collects parts to vehicles that, when all are collected, they can build and race. The puzzles assist in developing understanding of force, magnetism, electricity, gears, balance, and energy sources. It combines arcade play as well as thinking and problem-solving. with over 260 puzzles to complete, some of which a very difficult indeed for the targeted age-range, a long playing experience is guaranteed.

Goosebumps - The player controls a group of characters trapped in a haunted fun park. By solving puzzles and problems the player is able to slowly extract the characters from their predicament and save them from being destroyed by classic monsters such as werewolves and vampires. Graphics are photo-realistic and there are nine levels of difficulty.

Harry Potter and the Philosopher's Stone - The player takes the part of Harry Potter, and through interaction with other computer-controlled players, seeks to solve a variety of puzzles in order to find who or what is after the Philosopher's Stone.

Hoyles Kids' Games - This is a collection of traditional board and card games such as checkers and snakes and ladders. Each game is presented in a highly-coloured, animated form. Players can choose which activity they would like to play.

Imagination Express - Players can create a story and illustrate it with the graphics provided. The topics covered by the series includes, Castles; Rainforests, Oceans, and Ancient Egypt. Each package has graphics that can be placed onto the screen and modified in relation to size and position. Space is provided for the player to add text to advance the story. The story can be saved and read by other children.

Kid Pix - This is a drawing program that allows both free drawing or drawing with the variety of tools provided. In comparison to other drawing programs, it extends the tools available to the user with stamps and animated icons. Pictures can be either printed out, saved, or emailed to other children.

Kung Fu Kim - The player controls a character that is placed in the centre of the screen. Objects move around the character in a circular fashion and randomly strike at the character. The character has to fend off the objects by using either his hands or feet, which the player controls via the keyboard. If the player misses an object and is struck, part of his 'life' is drained away. If all the objects are pushed away the player goes to the next level with slightly more and faster objects. Play continues until the player's 'life' is completely gone.

Lego Island 2 - This is a 'twitch' game where the player controls, via the keyboard, a male Lego-shaped character, Pepper, who moves throughout a Legoland of obstructions. The player must outwit an evil character, Brickster, who is trying to destroy Legoland. Pepper must find clues, use various types of mechanical transport, and fight of his enemies in order to save the world. Ultimately, it is a platform game set in a 3D world. A total of 18 levels are available to play.

Living Books - A series of animated stories in which the player can either read the story and electronically turn the page or have the story read to them by the computer. Each page also holds a number of objects that can be clicked on by the player using the mouse which results in animated sequences appearing.

Maths Circus - A series of puzzles presented in with a circus theme. The players are presented with mathematics and logic problems which they have to solve by manipulating a number of objects on the screen that may have several variables. The higher the level of difficulty, the greater the number of variables involved. Music is supplied.

Minesweeper - A puzzle game where the player tries to clear a number of squares without selecting an explosive ‘mine’. As each square is uncovered, clues are given as to the status of surrounding, uncovered squares, based on the clues, the player selects another square. Play continues until the player is ‘blown up’ or all the clean squares are uncovered.

Missile Command - Players defend six cities from nuclear missile attack by attempting to intercept and blow up missiles descending from the top of the screen. The player has a limited number of anti-missiles to use on each level. As each level is completed the player receives points for the number of cities and anti-missiles left. Each level has more faster descending missiles for the player to defend against. The game ends when all the player’s cities are destroyed..

Myst - This is a first-person view, interactive game world set on an graphically and aurally-rich island environment. The game poses problems and puzzles for the player to solve using logical thinking, with the player going backwards and forwards in time. Sophisticated interaction with computer-controlled players is available. As the game progresses more and more of the mystery that needs to be solved becomes apparent. the program provides multiple ways of successfully completing the game

Saddle Club - This is a puzzle-solving game oriented around horses. It is appears to be primarily aimed at pre-teen girls. Over 30 characters are available for the player to interact with whilst exploring the game area, the Willowbrook Stables. The player simulates riding a horse through the environment provided by the game in search of clues.

Sim City 3000 - The player builds a city from scratch by zoning different areas either residential, industrial, or open space. As the city develops the player must manage such things as electrical power distribution, waste services, police and fire services, and taxation rates. The player is basically an all-powerful mayor, in charge of all decisions. The program responds to the decisions with either population growth (success) or shrinkage (failure). It is an open-ended game, with the player continuing for as long as they like. A variety of disasters can be inserted into the game either randomly or selected by the player.

The Logical Journey of the Zoombinis - 16 cartoon characters that are created by the player are guided through series of logic puzzles. The puzzles are keyed by the attributes of the created characters. The player must deliver 16 characters to the end of the game. Any characters that are rejected by the logic puzzles are eliminated from the game with the player having to return to the beginning to create more characters. The new characters have to go through the same logic puzzles (with different solutions each time) until 16 characters arrive at the finish. There are three programs in the series.

The Lord of the Rings - A role-playing game where the player adopts the role of a hobbit and attempts to destroy the ring of power. The players have to navigate the same dangers that are found in the movie of the same name. The action derives from the movie content, rather than the book. Players develop skills and strengths as they progress until they are strong enough to face the final task of destroying the ring.

The Sims - The player creates a virtual family and builds a residence for them. The player decides where the player may work, what they may do for recreation, and with which other virtual characters they may interact. The player is responsible for all their character's needs and wants. It is an open-ended game that can also be played on-line with other people's virtual characters resulting in virtual communities.

Thinkin' Things - This series comprises a variety of logic puzzles that the player must solve. There is no common theme linking the puzzles. Puzzles deal with musical themes, matching themes, and object manipulation. The games use bright colours, large illustrations and cartoon characters to explain the problem. Different levels of difficulty can be selected by the player.

Toy Story 2 - A series of discrete games using Toy Story characters. Players can select either a version of Chinese checkers, a road-crossing game, a platform game, or a drawing/colouring book to play.

Where in the World is Carmen Sandiego - The player has to track down the international criminal, Carmen Sandiego. They are provided with clues to her whereabouts that uses the player's general knowledge to solve. Also, throughout the game, puzzles need to be solved to gain further evidence and clues about the fugitive.

APPENDIX 2

FOCUS GROUP QUESTIONS AND NOTES

Focus Group Starter Questions

Is the presence of multiple activities a positive for you?
Do you prefer a game where there is competition or where you have to cooperate to succeed? Would you prefer to compete with other people or just the computer?
How important is a storyline to you?
Do you mind violence in a computer game? Do you prefer violence, if it is present, to be human violence, cartoon violence, or it doesn't matter?
What type of challenges do you prefer in computer games? Puzzles, problems, brain puzzles or do you prefer challenges that involve timing and jumping or just simply beating the computer?
How can you tell a game is not the right age for you? (Babyish mentioned many times)
How would you prefer to be told you are succeeding or failing at the game ? What type of feedback mean as something to you? Is feedback important to you?
What types of games do you prefer to play - problem-solving/real time strategy/first person shooter/arcade/activities/simulations/role playing?
What type of character would you like as the main character in a computer game? Does it matter if it is a boy or a girl or would you rather be able to choose which gender?
What type of settings do you prefer in a computer game? Space/cartoon realistic/fantasy? Does it really matter where the game is set?

Boys - Focus Group Notes

Activities

Different things the whole way through but the same theme the one topic
gets harder and harder
just the one activity
like Dynomite - just one thing
not as good as Dynomite
just keep on going doing the same thing
one didn't mind different activities
a mix is better if game is good the same thing can be good
enjoys games with little changes - Zoombinis
doing more than one thing can be confusing

Competition

playing against a friend
play against the computer - everyone agrees
computers are stupid
computers are easier
beat the friend rub it in their face
harder against the computer

you can select easy medium hard
prefer to play against the computer - most agreed
competition you can challenge your friends
I like versing my friends in computer games
I like the ones that doesn't have competition
you can practice
you can race your friends
play with a friend against the computer
verse your friends and the computer
you can race your friends as well as computer players
play together - share the keyboard to verse the computer
play against the computer
you don't like to play each other at the end
beat the computer but not your friends
we race together we don't race against each other we race a s a team
work together - cooperate with each other - pinball one share the keys
OK to cooperate
rather play against a live person
like all three - competition vs. computer, a friend, and cooperate
prefer competition - general agreement
rather verse someone / computer
playing with friends to beat computer
prefer to play with people rather than against people
versing the computer first then play against your friends
a variety of ways - no teams / competition / cooperation
team up with someone
no one to kill - no point

Storyline
prefer with a story
it lets you know what is happening
what you have to do
you can play it more easily because it tells you what to do
doesn't mater if it doesn't have a story (Kung Fu Kim)
wouldn't make Kung Fu Kim better if it had a story
Kung Fu Kim doesn't need a story cause all you are doing is kicking things - arcade style
I like story to get up to harder levels
the story is a reason to play
confuse storyline with levels
sometimes it makes it a bit more exciting cause you know what you are doing
it shows you the path where to go
it doesn't need a story cause you know what to do, you know all the things to do (Aquanoid)
depends on what type of game it is
prefer to have a story but it's not that important
depends on what game your playing

if it did have story it might make it a bit better
if it doesn't have a story you might not know what to do and you might do the wrong thing
story gives you an idea of what to do
Civilization and Age of Empires has to have a story
just need objectives not a story
some games need a story - Harry Potter needs a story otherwise you wouldn't know what's going on
sport/racing games do not need stories
want to know the plot before playing the game so you know what you are doing
games with levels would need a plot sport game would not
arcade game doesn't need storyline - agreement
problem game needs storyline
story is important
easier to follow with storyline
you don't know what is happening without a storyline
story line gives a history to the story and gives a point
provides more interest
you wouldn't know why you are doing certain things
it provides understanding
two types of games - games where you know what to do all along and games where you have to find out what to do
like having a storyline but you have to discover what is happening/what to do
arcade games don't need storyline
if you have an enemy you need to know why they are the enemy
wouldn't enjoy the game as much without the story explaining why I am doing it
it helps you understand why you are doing it

Violence
don't really pay attention to people dying
don't play a game just to watch people dying
if there's no-one to kill what's the point of the game
player keeps eye on the game
don't linger on the dying figure
games are still fun if you just knock them out they just roll they don't bleed
wouldn't be as good if it didn't have violence
people don't need violence in every game
violence sometimes matches the game
violence doesn't make it a better game it's the adventure
sometimes you have to kill to find something to get to another level
you shooting people but doesn't show it graphically
I reckon it's better without the blood and guts
in Halo there's a lot of violence it's MA
blue blood is good - fantasy not real violence
sometimes characters just explode
robot violence explodes into nuts and bolts - prefer that

lots of weapons in it
just turns into nuts and bolts
exchange nuts and bolts for money for upgrades
non-graphical violence in 007 game
happy with cartoon violence - animated violence
kill animals for food in Age of Empires - appeared to be necessary violence part of the story/game
prefer graphic violence - realistic violence
little kids shouldn't have graphic violence
non-graphic violence is OK so long as it is realistic
little kids should have cartoon violence
would depend on the age
need for violence depends on the game - fighting/wrestling game would need it
violence should be age sensitive
violence needs to fit into game style
like sword fighting and gun fighting
if it involves a movie it needs to be the same
violence is good but if it looks stupid and it is no good
over the top stuff is fun but unrealistic
I like violence
like guts going everywhere but it needs to be realistic to the weapon
violence is not necessary
like violence but you don't need it
many games have violence - recognises in 'non-violent' games like Sims - people can die, electrocuted, fist fits
violence makes it a bit more interesting
violence has to suit the game
comparison of Aquanoid vs. Jardinians - Jardinians is more interesting than Aquanoid

Challenge
figuring out what to do
if challenges are too easy you get bored
collect things
gets harder each level
problems can still be fun
little kids might like it - math puzzles
prefer the game action gets harder rather than problems
beaten one level and each level gets a bit harder
like harder and harder levels so you get better at the game
like Space Invaders - gets faster and harder to hit
levels get harder and find stuff
look around puzzles
sometimes they get harder and sometimes they get so hard you need to try stuff randomly
no time limit - you shouldn't have a time limit
levels represent different environments
don't like puzzle problem solving too hard

levels aren't connected don't like that
avoid being detected - careful where you move
collect objects to assist you play
prefer to collect things rather than solve a logic problem
prefer game to get harder as you go through - harder levels
don't care for problem solving
like quick response - arcade style
game gets more difficult - more opponents like Kung Fu Kim
arcade games more challenging suits it
levels get harder or faster
not a thinking game
shooting games need a challenge
getting faster and harder
like a little bit of logic combined with faster action and more enemies
fighting harder animals
like having to make a decision about my own game behaviour - where to go
harder levels

Babyish
if it's too easy
simple questions like 1+1 or singing 1+1
characters just for babies
characters tell you the age although not all the time
characters "pooh bears adventures" indicate age range
they follow a story the computer reads you the story and then a little activity
tell by the types of activities
educational games for maths and spelling
set on shows that little children watch
can't always tell by the characters, should play the game
cover description
poor graphics
title can indicate
easy play
characters can indicate
subject matter - 007 versus Winnie the Pooh
type of characters
characters aimed at little kids
you still have to play the game
level of problem asked - 1 + 1 would be too easy
main character is important
no character means it can be for any age - Aquanoid

Feedback
feedback is important
because if you don't know you are dying the game will be over
you don't know when you go to the next level

like to be verbally told
likes getting points - agreement
like bonus levels as feedback
like collecting things/objects
games with swords and things when you kill something you know you are getting better
compliments on what you do and says where you went wrong
comes on the screen with a voice, I like that
tells you what you have collected
don't like when it tells you that you haven't got everything
prefer to receive things like money
gaining something like a gadget or new robot or new car
feedback is getting better weapons exchanged for collected nuts and bolts
like the program to tell you congratulations
like to know how you are doing
high score points rewarded with something - agreement
visual and aural reinforcement
levels get harder
feedback needs to improve/get better as the game progresses
something that helps you progress through the game
graphical feedback - statistics
rewarded with a cheat
receiving something
spoken and written comment from program
scores are good to indicate how close you are to your goal
visual indicators - coloured bars
objects that are picked up that can help you in the game
advise from the game to indicate if you are good enough to beat enemy
gain skills by beating monsters
don't like getting objects that make you better
experience points

Styles of games
games where you fight without swords like punching and kicking
arcade games where you have quick fingers
wrestling rugby games - sport games
snowboarding and skateboarding do tricks to get points
gaining levels
adventure games - catching things with nets - problems to solve
games with human characters and you rescue them
shooting games
adventure games get the idea from the first level and you know what to do
games with stories
civilization games
arcade games beating levels
racing games
adventure games and shooting games, depends on how I feel

long time to play
with shooting in it
strategy
problem solving
action
building genre - disagreement
full on action all the time / wanting something to happen all the time
quick response games
play anything
wouldn't play educational games - agreement
action role-playing games
depends on the person
Real Time Strategy
depends on the mood I am in
simulation game - The Sims
doesn't matter how many people you ask they will like something different

Characters
doesn't matter if it is a boy or a girl - agreement
sometimes characters have different skills
it matters how strong they are not whether they are a boy or a girl
fun in characters playing out of stereotyped role
would choose boy character if they were exactly the same - agreement
would still play a game if there is only a girl character available - agreement
doesn't matter
in Pokemon you can pick a boy or a girl
you can be anything it doesn't change the game at all
doesn't matter which character you pick the game still plays the same
I have a game where you can choose a boy or a girl [what do you always choose?] I don't know, I just choose anything
design your own character
depends they have different weapons whatever one I need for the different levels
chooses the weapons rather than the male or female character
Tony Hawks II - girls don't usually have good stats but you can improve them
doesn't bother me
it doesn't change the game
doesn't make a difference to me
don't like it if the girl's character changes the game
Tomb Raider like playing it
whatever character comes up
probably choose guy if choice is available
different characters have different attributes
more concerned with what the character has in terms of equipment rather than gender of the character
Tomb Raider has a female character
however, would usually choose boy although doesn't really matter

depends on the game if it is good would play even if it was a girl character
doesn't matter what they are
characters can do something slightly different - different skills
characters not to show stereotype
if they both got the job done it doesn't matter
different attributes to male and female characters - choose the skills to suit the challenge
like not having a choice just take what the program gives you
if characters were exactly the same - wouldn't matter
choose one character and play a little while then choose another
if you are a boy so long as the girl is hot it would be OK

Setting
cartoon games - agreement
doesn't matter where its set
space just as good as fantasy
don't really care about the background
if it has a good storyline it doesn't matter where it is set
no preference so long as it suits it and is set out well
cartoons would be OK
would prefer realistic
cartoons alright but realistic is better

Girls - Focus Group Notes

Activities
some like full game some like different ones
can choose the ones you like
like one game
prefer a game of levels with lots of different activities
a bit of both
like different activities
gives a choice
playing the same game over and over it gets boring
different activities - agreement
prefer game with different things - general agreement
like to choose whichever ones they want to play
quest type game with sub-games that get harder
like one big game with little games inside it
likes one single game that gets harder as you play
you can change games and you don't get bored but like the one game with different levels
depends on the game
likes Dynamite - has harder levels as well as different games
like one idea game you get into a routine so it easier to play it
like just one game
both pretty good
little games provide a variety of things

like a couple of different things - same subject but different activities - Maths Circus

Competition - collaboration
work together as a group
suggestions from the other person
if you get stuck on something friend can help
should work together
other person could help you
work together
good to have a go yourself and good to help each other
rather share with friends
sometimes its good but not usually
The Sims - just like playing it without competing
you don't need two players
we just take turns
Aquanoid - don't like competing prefer one player you get a longer turn
like playing the computer
like playing single player
prefer to play against a person through a network
when you play against a friend
playing against the computer is a challenge cause the computer knows everything
computer can be predictable rather play against a person they will do something you don't anticipate
you can change the levels when competing against a computer
most prefer competing against somebody rather than the computer
prefer competitive things rather than working with someone - general agreement
prefer playing the computer
if it's a hard game prefer to do it with someone else and help each other
fun against another person cause computer always wins
prefer playing against a person
hard if you have to share the same computer
sometimes they want to play a different game to you
would rather use the computer by itself
prefer to compete against - don't have to fight over the mouse
like against both person and computer
rather against a computer cause if you play against a friend you may get into an argument
you don't get frustrated with a friend but you can against a computer
when you play with somebody they always hog it
believe boys hog the computer - general agreement

Storyline
story not important
can have a goal sometimes
story helps get to you the goal
objectives rather than a storyline
prefer story makes it easier

you need a story to know what to do
you have to know about the game in order to play it
it tells you what the challenge is
the story orients the gameplay
the story provides the information for the game - the reason to play
boring to have a storyline
arcade games don't need stories
map in Zoombinis takes the place of the storyline
storyline gives you a reward to reach the end
gives you a reason to continue
Maths Circus is just a collection of problems doesn't need a storyline
storyline is better
makes it easier to play cause you know what and why you are doing it
it was really good to know the story
it tells you how and what to do
general consensus is a story is needed
Maths Circus doesn't need a story line - doesn't have characters in it
arcade games don't need storyline

Violence
cartoon violence is better instead of real people getting shot
makes me sick
cartoons are fake
killing germs is ok
don't mind cartoon violence
don't like person to person violence
most people wouldn't be allowed to look at it
don't mind when you don't see any guts - not graphic
some people don't like seeing real people getting shot
it's all right in cartoons
can tell when it is pretend
cartoon violence is a bit funny and you know it's not real
mostly boys like violence and tom-girls but girls don't like it
might give violent ideas
cartoon violence is ok
don't like graphic violence
The Sims violence is covered up by a 'cloud' - prefer that
sometimes violence is ok but without the blood
like it with no blood
boys like stuff with guts but girls get sick when that happens - some girls do
not with all the guts it is ok if someone gets hurt if there is no graphical depiction
violence makes it more interesting if it has no violence it is boring you just have to concentrate
it's kind of funny to watch so long as there is not too much realism
cartoon violence 'stars around the head' doesn't look realistic
cartoon violence can be funny - like Itchy and Scratchy because it is obviously silly

blood and guts is fun - general agreement
depends on what game it is
I avoid the violence and swearing in GTA by driving around it
like see computer people being blown up but in cartoon fashion - realises it is a computer person
non-graphic violence is quite ok like in fighting game
Tony Hawke when falling over blood appears - that is ok
violence doesn't suit Zoombinis and so I wouldn't play it if it had violence
if it is a violent game that you would expect violence
violence if it is in the context of the game it is ok
the girls can distinguish between reality and fake
cartoon violence seems ok
wouldn't choose a violent game and then turn the violence off - doesn't make sense to do that
don't like violence just for the sake of violence - should fit the storyline

Challenge
like question and answer game - multiple choice
quiz game
problem solving game
quick reaction game liked - arcade
likes levels
arcade - don't like that prefer the thinking game
finds the platform game challenging (Mario Bros) makes me want to play
like finding clues
Zoombinis like the puzzles
like Aquanoid
problems make it challenging
both good in different ways
like setting levels easy/hard/harder
some games are hard when you have to use your fingers
like puzzle ones but when your brain is tired I prefer arcade
dislike arcade style challenge
arcade style - keeping my character alive
twitch games
like puzzles and problems makes your brain think more
harder levels
fun has to be included to make it challenging
just because it is hard doesn't make it enjoyable
problem solving - Carmen Sandiego
it can be fun to have more people coming in to fight but it gets boring after a while
problems keep changing makes it more interesting
like a challenge for your head rather than your fingers
I like solving things with my mind
like faster twitch games - fair agreement
seems to be 50/50 between problem solving and arcade type

Babyish
gender identified artefacts, e.g. Barbie dolls for girls as viewed by boys
boys like boyish stuff girls like girlish stuff
easy questions like 1 + 1
subject of game like Play School - agreement
the name of the game like Winnie the Pooh would indicate - agreement
name and cover of the game indicates
cartoon drawings can indicate wrong age
older games are more detailed younger games are more simple graphically
characters can indicate - Bananas in pyjamas
covers a lot paler for older kids
bright colours indicate young game although some older kids might like bright as well
graphics indicate - too simple
goody goody nice nice
no challenge - too easy
baby games don't have fighting - it is always happy
no conflict - nothing is trying to hurt you
you couldn't die - there is no bad stuff
too many bright colours, there is nothing dark
everyone is always happy in a babyish game cause no one can die
you do die but you turn into a butterfly (tables game)
easy activities
sheep and cows
simple instructions and directions
repetitive instructions
same activities over and over
very little choice
it's easy
little bunnies hopping around - fairies
you need more reality
not many levels - too easy to finish - too quick to finish
colours - pink fairies or tonka trucks - young persons toys represented

Feedback
visual indication of status - general agreement
collection of objects - the more you have the better you are going
vibrating controls
tells you how many more things you have to collect
bar indicator to show you how you are going
colour feedback - The Sims green = everything going ok
hint button
numerical score
visual feedback - The Sims = love heart is good
symbols indicate success - visual
generally like visual symbols/pictures for feedback
information buttons to tell what buttons do

visual indicator
colour indicator in visual bar on screen
number on the side of the screen - like a score or a bar indicator
always available but small - don't want to be distracted from the game
don't like to die and having to start again would be just boring
prefer to start losing slowly and to have chances
prefer a bar - visual indicator
rewarded with lives
written instructions or feedback too long and boring - just click on it and continue
visual numbers telling how you are going
don't want it in the middle of the screen
like an audible sound to warn you
don't like the pressure feedback can put on you - may refer to twitch games
like to hear the feedback so that you can concentrate on the screen

Types of games
simulation - more than just fighting you actually build stuff and help people
simulation - better than just pushing one button
keyboard game
like fast finger like typing game
simulation games
fun and challenging with violence in them
like to defeat stuff to move along in the game
also like simulations - real life
The Sims seems popular - general agreement
being a character is way better
typing type game
problem solving games
depends on time - arcade game for short periods or if you are tired
arcade games cause they are fun
simulation games
also like thinking games as well as arcade games
depends how you feel
sometime you just feel like blowing things up

Character
don't really mind which one as long as you have fun
the game is not about the person it is about having fun
wouldn't really matter
probably choose a girl
there should be a choice a boy might not like being a girl in a game
it doesn't really matter - general agreement
better to have a choice for boys and girls so that they will play it
generally good to have a choice - strong agreement
both characters
girl character

like to be able to choose
doesn't really matter - general consensus
depends on the game
depends on your mood
if you are in a fighting game you wouldn't choose a girl
depends on what you are going to use the character for
stereotypes evident - 'men are stronger' / 'men look after the girl'
doesn't matter what gender
better if you could choose your character
girls normally prefer to be girls and boys prefer to be boys
having to be a boy doesn't take away enjoyment but generally they were quite hesitant
prefer a choice of gender for characters
if a girl is angry they might want to be a boy depends on how you feel
girl has to look like a girl - long hair, feminine attributes
multiple choice about what you look like - want to be able to design your graphic
more enjoyable if you have choice
depends on your personality on the day - angry choose a boy, happy choose a girl - not agreed to
most boys would choose boys and would not choose girls - they would be embarrassed
star sign you want to be - generally reflects dressing up dolls
in real life you can't choose what you look like the game gives you a chance to look like somebody else
don't care - general agreement
different characters have different strengths and skills
choose the character that is best suited to winning it doesn't matter about the gender
exactly the same characters - wouldn't matter would switch alternate times playing
only a boy character wouldn't turn you away
depends on the game if it is good it don't matter about the character
gender of character is important
like to be able to choose gender
like to construct character's appearance
if you cannot see the character it doesn't matter
sometime you like being a boy if you want to blow something up - depends on mood
girls are more peaceful - boys are more destructive - no disagreement

Setting
like set in the future with new technology
don't like set in olden days cause you wouldn't have too much of a choice
prefer futuristic setting
prefer make believe game rather than a realistic game
need for a variety of different settings to prevent boredom
9 year olds caught up with The Sims
realistic / domestic settings
background you are familiar with
like inside houses cause outside you can't do much
fantasy but also like both fantasy and realistic

anchored on real life but allow you to do fantasy things
cartoons are ok
don't like space - general agreement
prefer to choose your setting
underwater is cool
different levels set in different places
can skip level if you don't like the setting
boys might like space - seen as a boy's environment
fantasy environment
if people are involved should be realistic
cartoons can be fantasy
as long as it is fun it doesn't matter
likes to explore areas that may not even be part of the game
setting must fit in with the characters - cartoon character so cartoon background
bright background - general agreement
don't like it when all you can see is their face cause it is so dark and dull
shooting game wouldn't have a field of flowers
don't like a dark setting - can stop you from finding things
don't read instructions - too much to read - just see what happens
doesn't appear to be a anything specific regarding setting
prefer realistic setting although it can still be cartoonish
like to be able to choose your background

APPENDIX 3

FREQUENCY OF GAMES PLAYED DURING OBSERVATION SESSIONS

Frequency of Girls' Choices of Program Available At School

1 Computer Classroom
1 Reading & Phonics
1 MS Dangerous Creatures
1 Make a masterpiece
1 Arts & Letters
1 Reading for literacy
1 Year 3 Maths
1 Blinky Bill
1 Disney pinball
1 Gomku
1 Wordzap
1 Pinball
1 Hearts
1 Solitaire
1 Rub a dub
2 Peggy's party
2 Pirate ship
2 Lego Island 2
2 Thinking games deluxe
2 Wendy's Word Game
2 Creatures
2 Why do we have to?
3 Sim City series
3 Missile Command
3 Lunch box drop
4 Renee's resort
4 Cluefinders 6th grade adventures
4 Aussie maths invaders
5 Gizmos & gadgets
5 Paint
6 Fran's frog leap
6 Balloon pop
6 Nightingale games
6 Mission THINK
7 Jewel jam
7 MSB series
7 Save the Tassie tiger
8 Colouring book
8 Chess
8 Kid Pix
9 Word jumble
9 Goosebumps
9 Hot dog stand
11 Ned Kelly
11 Imagination express
11 Bow & arrow
11 Sim tunes
12 Snowbound Sheri
12 Gumball machine
13 Living books series
13 Aquanoid
13 Hoyles kids' games
18 Dynomite
26 Toy story 2
34 Carman Sandiego series
37 Diamond mine
38 Math Circus
38 Thinkin' things / Frippletown
43 Kung Fu Kim
61 Zoombinis

Frequency of Boys' Choices of Program Available At School

1 New way how things work
1 MS dangerous creatures
1 Why do we have to?
1 Wendy's word game
1 Blink Bill adventures
1 Minesweeper
1 Crayola
1 Rub a dub
1 Claris Works Painting
2 Croc 2
2 Nightingale games
2 My lost dog
2 Battleship
2 Pinball science
2 Schoolhouse rock think/games

2 I love science
2 Olympics
2 Myst
2 Balloon pop
2 Train town
3 Renee's resort
3 Solitaire
3 Living Books series
3 Aussie math invaders
3 Disney colouring book
3 Computer classroom
4 Word jumble
4 Fran's frog leap
4 Thinking games deluxe
5 Paint
5 Goosebumps
5 Peggy's party
5 MSB series
5 Save the Tassie tiger
5 Imagination express
5 Kid Pix
7 Ned Kelly
7 Hot dog stand
8 Sim tunes
8 Sim tower
8 Cluefinders 6th grade
9 Jewel jam
9 Disney Pinball
9 Snowbound Sheri
11 Gizmos & Gadgets
13 Hoyles kids' games
15 Gumball machine
15 Sim city series
15 Pinball
17 Mission THINK
21 Chess
25 Diamond mine
28 Math Circus
28 Carmen Sandiego series
28 Missile Command
34 Aquanoid
35 Zoombinis
36 Bow & Arrow
39 Lego island 2
39 Toy story 2
46 Kung Fu Kim
46 Thinkin' things / Frippletown
48 Dynomite

APPENDIX 4

ORIGINAL QUESTIONS AND FINAL QUESTIONS

Questions Asked At the First Interview - 29th October 2002

1. Do you have a computer at home that you are allowed to use?
2. Do you enjoy using computers at school?
2a. What do you like best about using the computers at school?
2b. What do you like least about using computers at school?
3. Do you have a favourite computer program at home?
3a. What do you like about that program?
3b. What do you dislike about that program?
4. Is there a computer program at home that you don't like?
4a. What makes you not like that program?
4b. If you could with that program what would you do to make it better more enjoyable?
5. Do you have a favourite computer program at school?
5a. What do you like about that programs
6. Is there a computer program at school you do not like?
6a. What makes you not like those programs what things?
6b. If you could, what would you do to make it better and more enjoyable?
7. Do you think boys might like different types of computer programs than girls? If yes, what type of programs do you think boys might like?
8. Do you think girls might like different types of computer programs than boys? If yes, what type of programs do you think girls might like?
9. Do you prefer to work on the computer by yourself or do you prefer to work with a friend?
10. And when you playing a game, do you prefer to play on the computer by yourself or do you prefer to play with a friend?
11. If I asked you to describe a computer would you describe it as boy, a girl, or as an it?

Questions Asked At the Last Interview - 7th April 2003

1. Do you have a computer at home that you are allowed to use?
2. Do you have a favourite computer game at home? (If yes, what is it called?)
2a. What do you like about that computer game?
2b. What do you dislike about that computer game?
3. Do you have a computer game at home you do not like? (If yes, what is it called?)
3a. What makes you not like that computer game?
3b. If you could, what would you do to make it better and more enjoyable?
4. What do you think about using computers at school?
5. What do you like best about using computers at school?
5a. What do you like least about using computers at school?
6. What do you think about computer games?
6a. Generally, do you like to play computer games?
7. Do you have a favourite computer game at school? (If yes, what is it called?)
7a.What do you like about that computer game? Is there anything about how it is made

that appeals to you?
8. Is there a computer game at school you do not like? (If yes, what is it called?)
8a. What are the things or parts of a computer game that make it enjoyable for you? What is it that they put in games that you like?
9. Do you think boys might like different types of computer games than girls?
9a. What sorts of things in computer games might boys like? How they are made?
9b. What sorts of things in computer games might girls like? How they are made?
10. Can you think of a computer game that boys would like more than girls? Why?
11. Can you think of a computer game that girls would like more than boys? Why?
12. If you were making a computer game for boys what would you put in it? How would you make it? What would it be about? What features would you put into it; music, sounds, graphics?
12a. What sort of graphics and colours am I going to see? Realistic or more cartoon style graphics?
12b. Would you have a point-score?
12c. Would the levels gate harder for the boys?
12d. Would you have a time limit?
12e. 1 player or 2 player?
12f. Would it be a fast paced gamed or a slow paced game?
12g. Would the main character be a boy or a girl?
13. If you were making a computer game for girls what would you put in it? How would you make it? What would it be about? What features would you put into it; music, sounds, graphics?
13a. What sort of graphics and colours am I going to see? Realistic or more cartoon style graphics?
13b. What am I going to hear when I play your game?
13c. Would you have a point-score?
13d. Would you have a time limit?
13e. 1 player or 2 player?
13f. Would the main character be a boy or a girl?
13g. Would it be a fast paced gamed or a slow paced game?
14. If you had a choice, would you prefer a girl or a boy as the main character in a computer game? Why?
15. Who do you think enjoys using computers more, girls or boys? Why?
16. Thinking of computers in general, are computers made for boys or for girls? Why?
17. Thinking of computer games in general, are computer games usually made for boys or for girls? Why?
18. Do you prefer to work on the computer by yourself or with a friend? Why?
19. Do you prefer to play computer games by yourself or play with a friend? Why?
20. In just one word, how do you feel when you are using your computer at home?
21. In just one word, how do you feel when you are using your computer at school?
22. If I asked you to describe your computer at home would you describe it as a he or a she? Why?

APPENDIX 5

ORIGINAL PROPOSAL

Title
The effect of educational computer software on girls' attitudes and participation in primary science education.

Abstract
Research suggests that girls' participation and success in science diminishes as they proceed through their primary and secondary schooling. Many reasons have been put forward to account for this disturbing phenomenon. This two-part study will investigate (a) the extent to which the design attributes of computer software used in the primary science curriculum reflect the preferences of girls, and (b) whether or not the software is a contributing factor to the lack of participation and success amongst girls in science education.

The first stage of the study aims to identify the design attributes of general educational software that are preferred differentially by girls and boys. The second stage compares girls' and boys' software preferences with the attributes of commonly available educational software used within the primary science curriculum.

The interpretive study will use both qualitative and quantitative research methods. In order to ascertain the attributes of software preferred differentially by girls and boys, children across grades K-6 will be observed in school using a range of software packages and will be interviewed to explore their perceptions. Focus group discussions will be used as a supplement. From these data sources, identification and coding of girls' and boys' common and distinct preferences will be constructed.

From these results, a checklist will be designed and then used to evaluate commercial educational software packages available for use in the primary science curriculum.

Objectives
The objective of this research program is to ascertain:

the design attributes of educational software preferred differentially by girls and boys, and

the extent to which educational software used in the primary science curriculum encourages or hinders the participation and success of girls in science, especially in comparison with boys.

Background
On the surface, this study is about computer software used in primary school science and girls' interaction with it. However, it goes beyond that. It goes to the heart of one of the principles of education that we, as educators, should be trying to engender in our classrooms at all times: equity. In my experience as a professional teacher, I believe that,

in science education, lack of equity between girls and boys is a major obstacle facing many female students.

Although this proposal deals ostensibly with the issue of girl-friendly educational software, the underlying foundation is the search for equity. What, then, is equity? Henney (1986, p.6) states that equity in "educational opportunity means that each student is given an equal opportunity to pursue his or her own personal interests and to develop his or her own abilities". From an educational perspective, equity is "the concept of equal access to school education, and the fair and just distribution of benefits from [that] system" (National Strategy for Equity in Schooling, 1994, p.1). This concept is based on the belief that all children, regardless of their individual circumstances, have a right to an effective education. The reason we seek equity is simply answered by acknowledging that it is a moral given that all are equal and all deserve opportunities that allow the full potential of each individual to be realised. No individual or group should be disadvantaged in our society by the actions, subconscious or otherwise, of our educational institutions.

Sanders (1990, p.182) gives us a plan of action to assist in achieving equity; "[t]he process of equity is quite straightforward: awareness of a sex imbalance to the detriment of girls and women, concern about it, action to correct it, and results that eliminate it, thus achieving equality". This research proposal falls into the category of taking 'action to correct it' by seeking to find those attributes that should be incorporated by designers into computer software which result in the encouragement, rather than discouragement, of girls in their science education.

School performance, experiences and impressions are very important for the future success and participation of an individual in particular areas of society (Spear, 1984). The perceptions and experiences that a child gains in their education can govern how they participate in society as an adult. Thus, the experiences girls are having in school science today may be a significant determinant of their attitude to science in their adult life. If their attitudes are unfavourable, and science is deemed to be undesirable, then a significant part of society may find itself disenfranchised from making societal decisions on the role science plays in their lives (Barr & Birke, 1994; Brickhouse, 1994).

Numerous studies have been carried out dealing with girls and science in schools. Research reports that, in many ways, girls are not able to fulfill their potential in school science because of factors such as: boys monopolising the teacher's time and receiving more teacher feedback (Greenfield, 1997; Jones & Wheatley, 1990; Sadker & Sadker, 1986), materials used in school-room science reinforce the masculinity of science (Bazler & Simonis, 1991), out-of-school experiences reinforce science ability in school to the benefit of males (Erickson & Farkas, 1991), and assessment grades that are influenced by teachers' perceptions of gender, with males generally receiving higher marks for identical work (Spear, 1984). Thus, for many girls, the path to enjoyment, success and satisfaction in school science is likely to be hampered by masculine roadblocks. Such an obstacle to participation can be detrimental to the individual female student and to society in general, which is deprived of womens' ways of looking, studying and thinking about the world around us (Franklin, 1990). As Keeves and Kotte (1985) point out, barriers to participation in school science are likely to influence a girl's decision to opt out of science study as soon as she is allowed the choice.

As educators, we may be wondering how we can assist in helping girls achieve in and enjoy school science. How can we have a role in influencing positively girls' attitudes to science and computers, particularly when girls' existing unfavourable attitudes may be shaped by societal influences over which we have little or no control? The first thing that we must reject is a belief that we are incapable of becoming involved.

Educational achievement is the result of many complex factors (Hartel, Walberg, & Weinstein, 1983); too complex, perhaps, on the surface for us to modify or change. But, as Brickhouse (1994) states, although we, as teachers, cannot act directly on the social conditions that surround our schools, we can wield influence by the way we shape our curricula and by the experiences we provide to the children in our care. From this perspective, educators can be directly involved in the selection and provision of gender-inclusive educational software for primary school science.

In my role as teacher-librarian at two suburban primary schools, I have been able to observe the borrowing patterns of students as well as their use of computers in my schools' computer laboratories. From these observations, I have noticed several things that have laid the foundation for my enquiry.

I have noticed that girls and boys appear to have different preferences when borrowing books from the library. Boys seem to borrow more non-fiction texts than do girls, and girls seem to borrow more fiction books than do boys. The small amount of available literature suggests that this may indeed be true and that it may have some bearing on girls' attitudes to science in their later school years (Kahle & Akes, 1983).

The significance of reading preferences and success in school science has been suggested by research as an important factor (Linn and Hyde, 1988; Murphy, 1996). Murphy maintains that the style of reading a child is familiar and comfortable with can influence their ability to successfully carry out assessment tasks. If boys are more familiar with factual styles of text, typical of written answers in traditional science assessment tasks, then they may have an advantage over girls who prefer literary styles of text. As Gilbert (1988) argues, girls' writing is closely linked to girls' reading, and narratives are not the usual response required in science assessment writing tasks.

Greater interest and experience with factual texts could be a factor in making the world of science a more comfortable one for males. Keeves and Kotte (1985) reported that, at the 10-year-old level, boys expressed greater interest in science and more favourable attitudes towards science than did girls. Possibly, their greater exposure to self-selected factual texts could play a small but significant part in this positive reaction. This assertion is reinforced by findings discussed by Rhedding-Jones and Atkinson (1991) who believe that the genres children become familiar and comfortable with are important to their developing self-images. Hence, if girls are more familiar and comfortable with literary texts than factual texts, they are more likely to miss out on developing attitudes, skills and information that can be gleaned from non-fiction texts, and also have the belief reinforced that they do not belong in the world of science.

A manual library book circulation system at my two schools had made it impractical to research this observation more fully in my local situation. However, with the recent introduction of a circulation system that records the titles of books borrowed, I conducted a study which found that, in general, girls and boys borrowed different types of texts as outlined above (Rich, 1999). Could this be a small but relevant contributing factor to the lack of participation and success in science experienced by these girls in their subsequent high school years? It was this finding that led me to reflect upon other observations I had made regarding the use of computers in the school computer laboratory which, in turn, led to formulating this proposal.

I had noticed that girls often volunteer to work with other girls on a computer, especially when ‘doubling up’ is required due to lack of available computers. Rarely do they elect to work with a boy when choosing a partner. Also, boys rarely volunteer to share a computer with another student, whether boy or girl. These observations led me to wonder whether, in general, girls prefer to work with a partner and boys prefer to work alone. If this is the case, then does the software selected or preferred by girls work better with multiple users or is it designed primarily for the individual user? Are girls choosing a girl partner because they want to work collaboratively, or is it because the computer programs they prefer are more successfully enjoyed when more than one person interacts with them?

I have noticed also that girls often choose similar programs, especially when not directed by a teacher to a specific program. This appears also to be the practice of boys. And, when directed to use a particular program for a particular lesson, both girls and boys tend to express their displeasure if it is a program they dislike. However, I have the impression that the programs girls dislike, in general, are the ones that the boys would rather use, and vice versa.

These observations have led me to ask if there are certain attributes and styles of computer programs that appeal more to girls, and certain attributes and styles of computer programs that appeal more to boys. And, if this is the case, are girls being disadvantaged if the style of program they don’t like tends to deal with particular disciplines, such as mathematics learning or science learning? Does one of the contributing factors of some girls’ bias against science arise partly because the educational computer programs they use for learning in these subjects are constructed in a way that does not appeal to them? Could this actively turn them away from the discipline?

Many educational computer programs found in schools are not written with all students in mind, rather they are unknowingly designed for boys (Huff & Cooper, 1987). This may be a factor in the alienation many girls feel regarding computer use. Greenfield’s (1997) study supports this suggestion. She found that girls’ willingness to participate and achieve in science may be related to their early experiences with science. If their experiences were positive they were more likely to continue in the subject in their high school years. The lesson that can be drawn here is one of ensuring that the educational software that girls interact with in their science lessons provides them with an enjoyable and positive experience that will contribute to their successful participation and achievement in science in their later years. One aim of this research program is to identify what criteria should be used to select educational software for primary age students that does not alienate girls from computer use in schools, but rather encourages and enhances it.

This is an important facet not deeply explored in the literature when compared to other strategies and ideas. Researchers have proposed plans of action for schools to ensure equitable access to and experience with computers. Fisher (1984, p.25) suggested providing special computer time for girls, noting “every teacher who has tried it reports success”. Henney (1986) recommended having female teachers conduct computer sessions, acting as a role model for girls. The building of “safe female-only spaces” was suggested by Sofia (1993, p.55) thus allowing “girls to invent and play with knowledge and technologies on their own terms”. Another suggested strategy is avoiding the impression that computing is a male domain by talking about ‘people’ using computers rather than ‘men’, thus avoiding the idea of ‘ownership’ of computers by boys (Girls and Computer Education, 1984, p.9). Also, the guide suggests using timetabling strategies that avoid scheduling traditional male subjects at the same time as traditional female subjects, for example, scheduling computers and literature classes at the same time.

Although these strategies are well justified, they overlook the agent that facilitates the interaction between user and computer - the software. This is too important area to be neglected because, as Gill (1993) points out, there are differences in the learning styles of girls and boys and, therefore, the type of software supplied can assist in catering for these differences and, thus, promote equity. Although educators may be getting the children to the computers, what girls experience when interacting with available educational software doesn’t seem to be included in the equity question. There may be a critical shortage of software that is relevant to all learning styles and preferences. It is this problem that this proposed research aims to investigate.

So, the main focus of my concern is that although educators may be actively providing equitable access to computers, we might not be providing the right tool (i.e., the software) for the benefit of all students. Despite implementing policy for promoting equity in educational computing for girls, girls’ successful use of computers in learning science may be hampered by software that is of little or no interest to them. We are not, as El-Messidi (in Alu, 1996) observed, encouraging the production and supply of software that appeals to females so that they may become more comfortable with computer use.

Research has found that, through socialisation processes, girls and boys conceptualise computers in different ways (Giacquinta, Bauer, & Levin, 1993; Miller, Chaika, & Groppe, 1996). This is significant because, if what Perry and Greber (1990) suggest is true, that the social patterns of computer use are not inevitable, then it may be feasible to change girls’ patterns of use of computers by supplying software that is informed by girls' preferences. The production and supply of this software, therefore, could be crucial.

So, in accepting the premise that students increasingly will be using computers as part of their science curriculum, the questions that must be addressed are: "What are the design attributes of science education software that is typically used in our primary schools?" and "How can we ensure that the software is suitable for all students, regardless of gender?". This is the focus of the first part of my research.

Research Method

The underlying paradigm of this proposed study is Constructivism. Constructivism is a set of beliefs about knowing and learning that recognises and emphasises the active role of learners in constructing their own knowledge (von Glasersfeld, 1989). Constructivism maintains that the learner is the central actor on the stage of learning and, in an attempt to coalesce existing understandings with new experiences, knowledge is constructed by the individual. The focus is on the individual and their environment, rather than the knowledge or content of any subject or discipline.

As a methodological referent for this study, constructivism directs the researcher to strive to understand what is going on inside the learner's mind when he or she interacts with software. Thus, a qualitative research approach will be used in the collection and analysis of data. The overall intent of qualitative research is to construct insightful understandings of social situations using a variety of non-empirical methods (Locke, Spirduso, & Silverman, 1987). In this study, the investigations will be carried out by myself rather than by the use of numerical or statistical tools.

My role as the researcher means I will be the primary instrument for data collection (Lincoln & Guba, 1985). This is important as it situates me within the context that is being researched. It is this immersion and participation that should allow me to make sense of what is happening within the group being investigated. As Denzin and Lincoln (2000, p.3) maintain, "qualitative research is a situated activity that locates the observer [in this case myself, the researcher] in the world" being studied. I recognise that I will not be "an objective, authoritative, politically neutral observer standing outside and above the text" (Lincoln & Denzin, 2000, p.1049).

However, this should not be seen as a negative, because a qualitative-based study can embrace the personal history and perceptions held by the researcher. In this study, I will be relinquishing what Gergen and Gergen (2000, p.1028) describe as the "God's-eye view", in order to listen to, observe and ultimately have the children involved tell their own stories.

This qualitative study will utilize the ethnographic style of research in order to construct a holistic picture of the participants, with a primary emphasis on understanding the experiences of girls and boys interacting with science curriculum based computer software. Thus, the study will include in-depth interviewing of individual children, focus group discussions, and continued and extensive in-situ observation of the students as they interact with the software and their peers. It also means that I will not be entering the study with fixed theories or hypotheses. Rather, the viability of my initial hypotheses and theories will tested and, as more observation and interviews take place, develop and change as they are further informed by new data gained during the research period. This reflects Flick's stand (in Denzin & Lincoln, 2000, p.9) when s/he states "research is increasingly forced to make use of inductive strategies instead of starting from theories and testing them".

As I will be the main instrument of data generation, it is important that my beliefs, personal values, assumptions and biases are continuously identified and acknowledged. It is important because the lens that I am using to reflect on and interpret the data needs to be made as explicit as possible for the reader. This also assists in dissolving what Lincoln and Denzin (2000, p.1051) describe as the "false division between the personal and the ethnographic self [that] rests on the assumption that it is possible for an author to write a text that does not bear traces of its author". Acknowledging my history also incorporates Gergen and Gergen's (2000, p.1028) idea of "reflexivity". Throughout the investigative process, I will need to be actively aware of how my opinions and ideas are influencing the study, or as Gergen and Gergen put it, how "personal histories saturate [my]…enquiry" (p.1028).

I have completed a number of graduate courses focussing on issues of gender and technology, gender and science and mathematics education, as well as the general role that gender plays within the world of primary education in Australia. I have worked in co-educational primary schools for fourteen years as a teacher-librarian. From my studies and my work experiences, I have come to the conclusion that girls do not have equitable opportunities in many facets of education, particularly in the areas of science, mathematics, and technology. I acknowledge that this is the perspective that I have started with in this research inquiry.

To add "rigor, breadth, complexity, richness, and depth" (Denzin & Lincoln, 2000, p.5) to the inquiry, I shall make use of a variety of ways of generating and verifying the data to be interpreted in the study. Using a variety of research methods allows alternative standards (Flick, 1998, in Denzin & Lincoln, 2000, p.5). Multiple methods of data generation, or triangulation, reflect an attempt to construct an in-depth picture of the circumstances being studied, rather than to gain validity in quantitative terms (Denzin & Norman, 2000). Strategies in the data collection phase will include long-term and repeated observations in-situ, individual interviews, focus group discussions, continual review of observations and commentary by my supervisor. This provision of "rich, thick, detailed description" (Creswell, 1994, p.168) provides a solid framework of transferability for anyone interested in a comparison study (Merriam, 1988). Also, a fuller clarification of the biases and opinions I hold will be articulated within the introductory chapter of the final dissertation that will further allow a reader to understand my position within the findings and conclusions of the study.

Ethical Issues

Because the research will be carried out in two New South Wales public schools, the conduct of the research will conform with the guidelines issued by the Department of Education and Training (Guidelines for approving applications from external agencies to conduct research in NSW government schools, 2000). Written permission to conduct research within the schools will be obtained from the Director of Strategic Research, Department of Education and Training, New South Wales and the Principals of the two schools involved.

Written permission also will be gained from the parents/caregivers of children who volunteer to participate in classroom observations, interviews and focus group activities. Individual children will be interviewed in the presence of another adult. Assurances will be given that the research will not detract from children's normal learning programs.

Individual names will not be recorded in transcripts of interviews or focus group conversations, nor will they appear in reports on the research, including the thesis to be submitted for examination. Pseudonyms will be used.

Facilities and Resources

No special resources or facilities will be required for the study. Interviews will be conducted in the schools' libraries during my release time and software will be used and evaluated within the schools' computer laboratories. Students will be using the software packages as part of their normal science and computer lessons as conducted by classroom teachers.

Software will be purchased before the second phase of the study. As yet an estimated cost has not been made.

Data Storage

Field notes of classroom observations and recordings of all classroom activity, interviews and focus group discussions will be held for a period of five years within (i) the schools' archive collections that are held in the security rooms of the individual schools and (ii) at Curtin University's Science and Mathematics Education Centre. Access will be restricted to staff of the school.

Timeline

Semester 2 – 2001 – Review of literature,
Semesters 1 and 2 – 2002 – Observations, interviews and focus group activities,
Semester 1 2003 – Writing of thesis.

APPENDIX 6

COMPUTER WHIZ/WHIZN'T SURVEY

Girls - Whizn't

	Male	Female	Undetermined
12 years (10 students)	1	9	0
11 years (32 students)	13	19	0
10 years (29 students)	13	15	1
9 years (34 students)	16	17	1
8 years (21 students)	9	12	0
Totals (126 students)	52 (41%)	72 (57%)	2 (2%)

Girls - Whiz

	Male	Female	Undetermined
12 years (10 students)	8	2	0
11 years (32 students)	28	4	0
10 years (29 students)	18	11	0
9 years (34 students)	18	16	0
8 years (21 students)	4	16	1
Totals (126 students)	76 (60%)	49 (39%)	1 (1%)

Boys - Whizn't

	Male	Female	Undetermined
12 years (9 students)	9	0	0
11 years (23 students)	21	1	1
10 years (33 students)	31	2	0
9 years (46 students)	42	2	2
8 years (23 students)	17	3	3
Totals (134 students)	120 (89%)	9 (7%)	5 (4%)

Boys - Whiz

	Male	Female	Undetermined
12 years (9 students)	9	0	0
11 years (23 students)	21	1	1
10 years (33 students)	28	2	3
9 years (46 students)	41	4	1
8 years (23 students)	16	0	7
Totals	115 (86%)	7 (5%)	12 (9%)

All students - Whizn't

	Male	Female	Undetermined
12 years (19 students)	10	9	0
11 years (55 students)	34	21	0
10 years (62 students)	44	17	1
9 years (80 students)	58	19	3
8 years (44 students)	26	15	3
Totals (260 students)	172 (66%)	81 (31%)	7 (3%)

All students - Whiz

	Male	Female	Undetermined
12 years (19 students)	17	2	0
11 years (55 students)	49	5	1
10 years (62 students)	46	13	3
9 years (80 students)	59	20	1
8 years (44 students)	20	16	8
Totals (260 students)	191 (73%)	56 (22%)	13 (5%)

APPENDIX 7

RESULTS OF GAMES LIKED AND DISLIKED SURVEY

(Number after the title refers to times mentioned by individual children.)

All girls - games liked - 135 games
102 Dalmatians
Age of Empires - 11
Aquanoid - 13
Arcade
Army Men - 2
Aussie Maths Invaders - 6
Ball Game
Barbie Doll Hair- 2
Bushrangers database
Car Racing
Cards
Carmageddon
Carmen Sandiego series- 14
Carrot Mania
Chess - 2
Clue Finders
Command & Conquer
Computer Classroom - 2
Cosmopolitan Makeover
Craft Factory
Crash Bandicoot - 3
Crayola - Make a Masterpiece
Creative Writer
Creatures
Croc - 3
Dangerous Creatures
Diablo 2
Diamond Mine - 13
Donkey Kong
Dragon Ball Z
Driver Game
DX 2
Dynomite - 3
Equestrian 2001
Fashion Doll
FIFA 98 Soccer
Freddie Fish - 2
Fury 3
Game of Life
Giants
Girl Talk
Gizmo & Gadgets
Goosebumps - 3
Grand Theft Auto
Greeting Card Workshop
Gumball Game
Harry Potter - 7
Hexen 2
Horse Racing
Hot wheels Racing Track
Hotdog Stand - 5
Hoyle's Games
I Spy Australia - 2
Imagine Express
Jazz Rabbit
Jungle Pinball
Jungle Mania
Kids Pix - 9
Kung Fu Kim - 15
Lego Races - 2
Liro
Machine Guns
Magic School Bus - 3
Mario
Maths Circus - 3
Maths Workshop
Maths Blaster
Mission Think - 2
Monopoly - 3
Mortal Combat Trilogy
Motor Cross Madness
Motor Racer
MSN Internet chat
Nature Encyclopaedia
Ned Kelly - 3
Need for Speed High Stakes
Neopets
Nightingale Games
Nini Car Racing
Pac Man
Pharaoh
Phonics Active 6
Typing
Pin Ball - 3
Pocket Tanks
Quake - 3
Rambo 6
Rayman 2 Great Escape
Reading Blaster
Red Fraction
Renee's Resort
Roller Coaster Tycoon - 3
Sabrina Teen Witch - 5
Saddle Club
Sailor Moon - 2
Sam Adventures
Santa Claus Bowling
Sergeant's Men
Save the Tassie Tiger - 2
Sim Tunes - 2
Sim City - 6
Simpson Bowling
Simpson's Car Racing

Snakes & Ladders
Snowbound Sheree - 3
Solitaire - 3
Spy Fox - 2
Spyro the Dragon - 3
Squat 2
Squirrel Golf
SSX Tricky
Star Trek
Stuart Little
Super Smash Bros.
Tarzan - 2
Tarzan Action Game
Tenchu
Tetris
The Sims - 23
The Great Egyptians
The Game of Life
The Emperors New Groove
Thinking Things - 15
Timon & Pumba Pinball
Tomb Raider - 4
Tony Hawk Pro Skater - 3
Toy Story 2 - 6
Tunnel Man
Vampires Tomb
Warcraft
Weekend Warrior
Wolfenstein
Worms
Wrestling
Zoo Games
Zoombinis - 51

All girls - games disliked - 78 games
African Visits
Age of Mythology
Age of Empires - 3
Arthur series - 7
Aussie Maths Invaders - 8
Aussie Spell
Barbie Fashion Dolls - 7
Battleships - 4
Blinky Bill - 4
Bow & Arrow
Carmen Sandiego - 8
Checkers
Chess Master - 2
Computer Classroom - 2
Diamond Mine - 3
Dynomite - 3
Freddie Fish Games
Gizmos & Gadgets
Goosebumps - 3
Hocus Pocus
Hong Kong Fuey
Hot Wheels
Hot Dog Stand - 3
I Love Science - 2
Jump Start
Kid Pix
Kids Colouring Book Centre
Kung Fu Kim - 13
Land & Sea
Lego Island
Literacy
Little bears/big bears in the Big Blue House
Llama
Lunch Box - 2
Madeline European Adventures
Magic School Bus - 8
Magic Emeralds
Maths Circus - 44
Maths Blaster
Memory
Microsoft Soccer
Minesweeper
Missile Command - 2
Mission Think
Moles - 4
My Lost Dog - 2
My Little Pony - 2
Myst
Peg's Party
Pin Ball
Putt Putt
Puzzle Games
Pyjama Sam
Reader Rabbit
Reading Graduate - 4
Red Alert - 2
Renee's resort
Resident Evil
Rodney's Funscreen
Save the Tassie Tiger - 2
Serious Sam
Sim Tunes
Solitaire - 3
Soul Reaver
Star Trek Captains Chair
Super Mario
The Sims
Thinking Things - 29
Timon & Pumba Jungle Pinball - 2
Tomb Raider
Toy Story 2 - 5
Toy Story 2 Colouring Book
Typing Tutor - 17
Volcano
Warcraft
Warrior of Town
Why Do We Have To? - 3
Zoombinis - 4

All boys - games liked - 167 games
4th Grade Adventures
Admiral Sea Battles
After Dark Games - 2
Age of Empires - 40
Alice in Wonderland
Alpha Centura
American Mac Gee
Aquanoid - 6
Army Men 3D
Aussie Maths Invaders

Balder's Gate - 2
Battle Ships - 2
Battle Zone - 6
Big Game Hunter - 2
Bionical
Bomb Man
Bow & Arrow - 2
Caesar 3
Car Rally - 2
Car Crash
Carmageddon 2
Carmen Sandiego - 3
Cash Team Racing
Civilisation 3
Comanche
Command & Conquer - 11
Conflict Desert Storm
Counter Strike - 2
Courier Chaos
Crash Bandicoot - 3
Cricket 2002 - 4
Croc legend of the Gobbos
Croc Rock
Dangerous Creatures
Dark Reign - 2
Dave Mirre BMX
Diablo - 3 Diamond Mine
Die Hard Trilogy
Digimon Rumble Arena
Dink Smallwood
Dino Crisis 2
Dinosaur Snaps
Donkey Kong
Doom - 2
Driven
Duke Nukem - 4
Dulex
DX Ball - 3
Empire Earth - 2
Fallout
FIFA World Cup 2002 - 8
Final Fantasy - 2
Freestyle Snowboarding
Gizmos and Gadgets
Goose Bumps
Grand Theft Auto - 13
Grand Turismo 2
Half Life - 4
Halo
Harry Potter - 4
Hearts
Hell Bender
Heretic - 2
Heroes of Might & Magic - 2
Hot Dog
Hot Wheels
House of the Dead
Hoyles Kids Game
I Love Science
Ice Age
James Bond - 5
Jazz Jack Rabbit 2
Jazz Ball
Kid Pix - 3
Knights n' Merchants
Kung Fu Kim - 7
Kyodi
Lands of Lore
Lego Island 2 - 7
Leiro - 3
Lemmings
Lord of the Rings - 3
Mad Max - 2
Mafia
Magic School Bus
Majestic
Marathon 00
Max Payne
MDK(murder death kill)
Medal of Honour Underground - 3
Might and Magic VIII
Minesweeper - 2
Missile Command
Mortal Kombat - 2
Moto Cross Madness - 2
Motor Cross Champ
Need for Speed - 4
Neo Pets
Oni - 3
Out Laws - 2
Perfect Dark
Pinball - 6
Pod
Pokemon - 3
Project Gotham
Quake - 3
Ray Man
Reverse
Roller coaster tycoon
Scorch
Setters 4
Shane Warne Cricket
Sim Earth - 2
Sim City - 11
Simpson's Road Rage
Simpson's Doom
Slayer
Smugglers Away
Snakes and Ladders
Soccer
Soldier of Fortune
Solitaire
Soul Reaver
Space Invaders - 2
Spiderman - 6
Sponge Bob Square Pants
Spy Fox Tow
Spyro - 3
Star Wars pod racing - 9
Star Fox Adventures
Star Monkey Starcraft
Super Smash Bros - 2
Super Monkey Ball
Swat team 3
Sython Filter - 3
Tecken - 2
The house of the Dead
The Medieval Times
The Sims - 16
The Land of Um
Thinking Things - 6

Time Crisis - 2
Time Cruisers 3
Timon & Pumba - 2
Tomb Raider
Tony Hawks Skateboarding - 8
Total Annihilation - 2
Toy Story 2 - 3
Train Simulator
Treasure Math's Storm
Trenge Cove
Turok 2 Seeds of Evil - 2
Unreal - 3
V8 Supercar Racing - 2
War Craft - 7
Whack a Mole
Where in time is Carmen Sandiego
Wolfenstein - 5
World Rally Championship
World scariest Police Chases
Worm 3 - 7
Wrestling - 2
Zebra Land 2
Zelda Ocarina of Time
Zoombinis - 9

All boys - games disliked - 88 games
3D Scooter
Age of Empires - 2
Alone in the Dark
Ants extreme racing
Aquanoid
Aussie Maths Invaders - 4
Baddies
Bananas in Pajamas
Barbie Games - 5
Battleship - 2
Blinky Bill - 2
Book Self
Bow & Arrow - 2
Buffy Vampire Slayer
Bull Dogs
Busta-Move
Carmen Sandiego - 2
Chess
Christmas Bowling
Colour Mania
Colouring Books
Crash Bandicoot
Crazy Taxi
Cyber Tiger
Diamond Mine - 3
Dynomite - 2
Ed. Games - 4
Forgotten Boy
Gizmos & Gadgets - 2
Goosebumps - 2
Grand Theft Auto
Gumball
Harry Potter - 5
Hexen II
Jewel Jam
Kid Works Deluxe
Kids Pix
Kill the Dill - 2
Kung Fu Kim - 18
Let's Go Shopping
Lion King
Loderunner
Magic School Bus - 3
Matchbox Racing
Math Circus - 65
McDonald Land - 2
Medal of Honor
Minesweeper - 2
Missile Launch
Mission T.H.I.N.K - 2
Monster Dark
Motor Racer
My Little Pony
Myst
New Kid
Nightingale
Play School
Pokemon - 2
Rainbow Six
Reader Rabbit - 6
Save Tassie Tiger - 3
Serious Sam
Sim City - 2
Simpson Game
Ski Free
Snakes & Ladders - 3
Solitaire - 4
Speed Freaks
Spiderman
Spy Craft
Star Wars - 2
Star Shot
Super Mario Land
Tarzan
The Wiggles - 2
The Dare Game
The Sims - 2
Thinking Things - 53
Tonic Trouble
Toy Story 2 - 3
Toy Story 2 Colouring
Treasure Math Storm
Typing Tutor - 8
Vines
What's in the Box
Where in the world is Carmen Sandiego - 2
Yahtzee
Zoombinis - 7

APPENDIX 8

MY FINDINGS COMPARED AND CONTRASTED WITH THE PUBLISHED LITERATURE

My Findings Compared to the Published Literature

As stated in my research design, one of the main reasons why I chose a qualitative approach to my research was because I believed that a more refined and accurate picture could be drawn. Rather than using statistical generalisations that are often provided by quantitative analysis for my criteria for educational software selection, I felt the more detailed and locally relevant qualitative approach would enable me to find the shades of grey that exist between the black-and-white quantitative picture. In the first two columns of the tables below, I have listed what the literature told me was preferred by girls and boys in relation to computer software games. The third column outlines what my data indicated. It can be seen that many preferences outlined by the literature were found to be not an exact match for the preferences of my children, while some preferences outlined by the literature were directly contradicted by the data. I believe the table certainly demonstrates enough shades of grey to justify my research. If I had simply followed the published literature to select educational computer software I would not have been doing my job of locating and purchasing the most effective educational computer games software resources for the girls in my schools.

Table 41: Summary of findings from data compared to the published literature on girls.

Girls would be turned away by violence and aggression	Brunner et al, 1998; Butler, 2000; Copper et al., 1990; Dempsey et al., 1998; Glaubke et al., 2001; Morse, 1995	Girls did not like violence in computer games involving humans, however, they will accept violence involving cartoon characters. Girls prefer non-violent action as would be found in software with a sports theme.
Girls would not be turned away by violence and aggression (referring to fantasy violence)	Funk & Buchman, 1996b	In relation to cartoon violence, this was found to be consistent with my girls preferences.
Girls prefer fantasy/mystery/adventure setting	Brunner et al., 1998; Cesarone, 1998; Funk & Buchman, 1996b; Gailey, 1992; Martinez, 1992; Neumark, 1991	This was weakly supported by the data. Mystery settings needed to be located in a realistic setting.
Girls prefer realistic settings	Glaubke et al., 2001; Kafai, 1996; Laurel, in Subrahmanyam & Greenfield, 1998	Stronger support for this was indicated by the data as a preference of my girls.
Girls prefer verbal feedback	Cooper, Hall, & Huff, 1990	This was not supported by the data. No mention was made relating to this feature.
Girls prefer non-violent feedback	Kafai 1995; Miller, Chaika, & Groppe, 1996	This was supported by the data.
Girls prefer positive feedback	Glaubke et al., 2001; Hall & Cooper, 1991; Miller, Chaika, & Groppe, 1996; Morse 1995	This preference for either positive or negative feedback was not supported by the data.

Girls prefer large and detailed graphics with shades of colour	Freedman, 1989; Jakobsdottir, Krey, & Sales, 1994; Passig & Levin, 1994	Support for large detailed graphics was not present, however the importance of colour was strongly evident.
Girls prefer a variety of scenes	Dempsey et al., 1996a	This was not supported by the data.
Girls view music as important in a computer game	Cooper, Hall, & Huff, 1990; Malone & Lepper, in Wilder, Mackie, & Cooper, 1985	This was strongly supported by the data.
Girls find music annoying and irritating in computer games	Fiore, 1999; Miller, Chaika, & Groppe, 1996	There was weak support for this from the data - related mainly to music repetition.
Girls prefer a strong narrative	De Jean et al., 1999; Inkpen et al., 1994; Krantz, 1997; Laurel, in Cassell & Jenkins, 1998c; Miller, Chaika, & Groppe, 1996; Murray & Kliman, 1999; Polak, 2001	This was supported by the data. The narrative was an important feature for many of the girls.
Girls prefer female protagonists	De Jean et al., 1999; Glaubke et al., 2001; Jakobsdottir, Krey, & Sales, 1994; Klawe et al, 1996; Littleton et al., 1998	This was not supported by the data. Rather, the girls indicated they preferred a choice of main character often selecting the character they think will give them the best chance to succeed in the game.
Girls do not prefer female protagonists	Chappell, 1997; Fiore, 1999; Joiner et al., 1996	This was not shown. See above.
Girls prefer realistic protagonists with emotional depth	Purple Moon, n.d.	There was slight support for this through the frequent mention of the computer game *The Sims* and its derivatives.

Girls prefer multiple protagonists	Laurel, in Cassell & Jenkins, 1998c	This was not supported by the data.
Girls prefer to collaborate	De Jean et al., 1999; Elliot, 1990; Hawkins, 1987; Henney, 1986; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Murray & Kliman, 1999; Nicholson et al., 1998; Rubin et al., 1997; Shade, 1994	This was not supported by the data. The data showed that, generally, the majority of girls were happy to work on and play with the computer by themselves. They would cooperate and share if required, but it was not a preference for the majority. Weak support was evident from the 8- and 9-year olds.
Girls do not like competition	Arch & Cummins, 1989; Kelly, in Cassell & Jenkins, 1998a; Lockheed, 1985, Serbin, Powlishta, & Gulko, 1993	This was not supported by the data. The older girls, 10-12 years, liked aspects of competition. Indications that girls liked to compete against themselves.
Girls like competition	Caftori, 1994; Chappell, 1997; Malone, 1981; Signer, 1992	There was support for this from 10- and12-year girls, while 8- and 9-year girls indicated a slight preference for cooperation.
Girls prefer a slow paced game	Caftori & Paprzycki, 1997; Inkpen et al., 1994; Kafai, 1996; Laurel, in Cassell & Jenkins, 1998c; Polak, 2001; Rubin et al., 1997; Scott, Cole, & Engel, 1992	The support for simulations, which are generally slower in pace, by many of the girls could lend indirect support for this. However, the liking of arcade games by a significant number of girls would contradict the literature.
Girls preferred a variable or fast paced game	Caftori, 1994; Glaubke et al, 2001	Inferences from the data would support this.

Girls prefer multiple activities that also have a purpose	Cooper, Hall, & Huff, 1990; Kafai, 1995; Klawe et al., 1996; Westrom & Super, 1995	This was not generally supported by the data although the focus groups viewed it as a positive feature desired by other girls.
Girls prefer clear and accessible instructions	Forsyth Jr. & Lancy, 1989; Glaubke et al., 2001; Lancy, Forsyth Jr., & Meeks, 1987; Lancy & Hayes, 1988; Whooley in Scott, Cole, & Engel, 1992	This was supported by the data, albeit weakly.
Girls do not view clear and accessible instructions as important	Carroll, 1997; Gery, 1991; Miller, Chaika, & Groppe, 1996	This was not supported by the data.
Girls prefer problem-solving computer games with multiple solutions	Brunner, Bennett, & Honey, 1998; Bunderson & Christensen, 1995; Caftori & Paprzycki, 1997; Cooper, Hall, & Huff, 1990; Subrahmanyam & Greenfield, 1998; Walker, 1998	This was supported strongly by the data.
Girls prefer to be able to save their progress at any time	Caftori & Paprzycki, 1997; Fiore, 1997	While there was little direct mention of this attribute, indirect evidence was found to support this preference.
Girls enjoyed having humour in a game	Brunner, Bennett, & Honey, 1998; Westrom & Super, 1995	This was weakly supported by the data.

Table 42: Summary of findings from data compared to the published literature on boys.

Boys like violence and aggression in computer games	Caftori & Paprzycki, 1997; Canada & Brusca, 1992; De Jean et al., 1999	This was generally supported by the data, however, it was apparent that many of the boys were quite happy if the aggression was supplied by non-violent action from sports-based games, for example.
Boys enjoy fantasy/space/adventure settings	Caftori & Paprzycki, 1997; Kafai, 1995; Scott, Cole, & Engel, 1992	No evidence was found to support those specific settings. It appeared boys enjoyed any setting that was not overtly feminine.
Boys prefer violent / trial and error feedback	Kafai,1995; Subrahmanyam & Greenfield, 1998	This was not supported by the data. The boys did not like 'dying' if they failed.
Boys prefer sophisticated, highly-detailed graphics	Kafai, 1995	This was supported by the data.
Boys prefer 'noise' made by game, not necessarily music	Henney, 1986	This was not supported by the data. Sound effects were rarely mentioned. The boys indicated they preferred loud and fast music.
Boys prefer 'super-hero' protagonists	Purple Moon, n.d.	This was not supported by the data. There was, however, a strong preference for male protagonists.
Boys prefer to collaborate	Rubin et al., 1997	Older boys, 10-12 years, preferred to cooperate with their friends when playing a game.

Boys prefer competition	Klawe et al., 1996; Yelland & Lloyd, 2001	Younger boys, 8-9 years preferred competition and supported the literature. Older boys, as mentioned above, preferred cooperation. If competition was involved, they preferred to cooperate with their friends to compete against the computer.
Boys prefer a fast paced game	Caftori & Paprzycki, 1997; De Jean et al, 1999; Klawe et al., 1996; Nicholson et al, 1998; Passig & Levin, 1999	Support for this could be found in the boys' liking of arcade-style games, although a significant number of boys, 23%, indicated that arcade games were not preferred.
Boys do not care about instructions	Greenfield, 1996; Revelle, 1984	This could not be supported by the data.
Boys prefer problem solving computer games	Klawe et al., 1996; Sherman, Divine, & Johnson, 1985	This was not strongly supported by the data. A stronger preference was seen for arcade games.

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