Toys and Technology

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Abstract

This paper is a description of an integrated unit of study where Grade 7 and 8 students designed, manufactured, and produced marketing materials for toys of their own creation, culminating in a ÒToy FairÓ where the toys were displayed and described to other members of the school and neighbourhood community. The toys were designed and created using a wide range of technology, including tools for carpentry and sewing, as well as computers. The role of the computers was of interest for two principal reasons: (1) students were not required to use the computer except for one aspect of their marketing materials and as a result, a wide range of ways of using computer tools was evident, and (2) the toy production time was the only time during the course of the school year when the computers were not being used during "free" time. The range of computer use and students' view of this integrated study unit are explored through the detailed description of four children's experiences. Implications for designing project-based units with a technology focus are described.

Toys and Technology

> This was the best unit we did all year. I loved it when the little kids came to the Toy Fair and played with my puzzle. I couldn't believe how much they liked it.

The project-based toys unit described in the present paper was a school highlight for many of the Grade 7/8 students involved. Susanne Ellis, the classroom teacher, guided students as

they designed, created, and marketed toys of their own creation. The use of several forms of technology -- including sewing machines, carpentry tools, video cameras, and computers -- was artfully woven into the projects as students used tools of their choice to make their designs come alive. .

The combination of toys and technology is not new. There have been countless attempts to bring childrenÕs love of toys and games into the classroom, and over the past decade many of these attempts have been coupled with computer technology. The study I describe here is part of an ongoing series of explorations to combine children's love of games with math and science teaching undertaken by the *Electronic Games In the Education of Math and Science* (E-GEMS) research group (c.f., Klawe & Phillips, 1995). E-GEMS is a long-term project involving both the study and design of electronic games for home and classroom use.

Perhaps the most notable past work in the area of toys and technology is the series of explorations with LEGO/Logo. The LEGO/Logo environment involves creating structures with LEGO building materials, which are then interfaced with the Logo programming language and specialised LEGO pieces such as motors, lights, and sensors. Using LEGO/Logo, a child might build a merry-go-round, and write a program that stops and starts the merry-go-round, timing the rides, and giving the ride operator time to load and unload passengers for the trip.

Various successful attempts have been made to bring LEGO/Logo to the classroom, and researchers have identified classroom environments conducive to learning with LEGO/Logo, including the importance of involving parents and other members of the community as projects are undertaken (Cesar, 1992; Crawford, 1992; Hall & Hooper, 1993). Researchers and teachers have paid particular attention to the role of LEGO/Logo and gender (Cutler-Landsman, 1993). In one study, LEGO/Logo projects were undertaken with female students, Grades 3 through 8, to examine the impact of same-sex, small group work on students' attitudes and abilities in the areas of mathematics and science (Hutchinson & Whalen, 1995). In the study reported by Hutchinson & Whalen, students claimed that working with LEGO/Logo not only helped them learn to solve some challenging math and science problems, but also helped them feel greater

confidence in their problem solving abilities. By designing and creating such items as washing machines, conveyer belts, helicopters, and an elf cookie factory, the girls were able to pursue their own ideas with the guidance of teachers and input from community members. Further, they learned that math and science problems were embedded in what might be stereotypically thought of as female items and pursuits, such as the washing machines and cookie factories. Like McDonnell (1994), I hold the view that it is important that girls find expression for their own "kid cultureÓ and that we honour the LEGO/Logo cookie factory and explore the math and science that lies within.

The toys unit described in the present paper allowed both males and females to create toys that reflected the traditions of their respective genders. There is, of course, considerable research indicating that girls and boys develop strong stereotypic knowledge about "girl toys" and "boy toys," knowledge which begins to form in preschool years, and is firmly established by the age of 7 (Perry & Sung, 1993). Studies also indicate that boys and girls view such toys as trucks and guns as Òboy toysÓ and dolls and colouring books as "girl toys." This gender identification extends to colours, roles, television and movie preferences, and activities as well, and persists throughout adolescence (McDonnell, 1994). Further, it would appear that male gender roles are viewed as more proscribed than those of females (Henshaw, Kelly, & Gratton, 1992). That is, it is easier for children to imagine a female truck driver than a male nurse. In a study by Martin, Wood, and Little (1990) with children from 4 to 10 years of age, researchers found that the older children made more rigid judgments than the younger children in the areas of role behaviours, occupations, traits, and physical appearance.

The fact that males and females have different views of gender roles, toys, and the like, is not necessarily something over which to despair. Referring again to McDonnell (1994), I would argue that while children are socialised to accept different roles, this socialisation comes not only from the adults around them, but from the children themselves. McDonnell claims that "boys and girls continue to live in largely separate worlds through most of childhood" and that this segregation by sex comes in large part from the pressure exerted by the children themselves (p.

45). Thus, from preschool through to early adolescence at least, girls tend to be focussed on the development of relationships, while boys often focus on objects, including machines and vehicles (McDonnell, 1994). These differences have been observed in play, in social interaction, in children's self-descriptions, in adults descriptions of children, and in narratives produced by children (Libby & Aries, 1989; McDonnell, 1994; Nicolopoulou, Scales, & Weintraub, 1994). However, as McDonnell (1994) argues, these differences or the segregation between "boy culture" and "girl culture," make it possible for male and female children to learn about themselves. She claims that experimentation with gender specific boundaries is a natural and necessary stage of growth and development. The harm of stereotypic segregation, she claims, comes when others, mostly adults, do not value the interests and activities of both genders equally. If boys are praised for building tall structures from blocks, girls should be praised for the complex relationships they create amongst the dolls in their collections. The extension of this argument in the present context is that units of study should allow males and females to express elements of their own cultures, and that different types of expression should be equally valued. As will become apparent, the Grade 7/8 students in the present study did indeed make toys specific to their gender. For example, many girls made stuffed animals, while a number of boys made airplanes and other vehicles. Both males and females made what might be viewed as "gender-neutral" toys, including puzzles and piggy-banks. All forms of toys that were created were valued by the classroom teacher, by the researchers, by other members of the community, and by the students themselves, as evidenced most noticeably in the Toy Fair when all of the toys were displayed to the school and outside communities.

One of the reasons that both males and females were able to create expressions reflecting both their gender culture and individual tastes was that the toys unit was a project-based form of learning. As early as the turn of the 20th century, educators have recognised the value of project-based purposeful classroom activity involving a large degree of social interaction and a natural integration of subject areas (Dewey, 1902, 1938; Kilpatrick, 1918). The importance of social interaction in cognitive development has also been recognised throughout this century (c.f.

Cole & Scribner, 1974; Vygotsky, 1978) as students construct knowledge through their interactions with peers, ideas, problems, and materials (von Glaserfield, 1990; Papert, 1993). Project-based learning makes for a rich classroom environment for constructing knowledge through social interaction, whether those projects are entirely student initiated or students make choices within a unit set by the classroom teacher, as was the case in the present study (Wolk, 1994). Some of the other common features of project-based learning, such as planning and design, record keeping, interdisciplinary or integrated studies, teacher guidance, and self-assessment (Wolk, 1994) were also incorporated in the toys unit.

Finally, a word about computer technology in the context of problem-based learning -- a form of technology that all students used in their projects in the present study. The use of computers as tools for thinking, creating, and learning, has been heralded for nearly three decades (c.f., Papert & Solomon, 1971). The National Council of Teachers of Mathematics has clearly endorsed the use of computers in mathematics education, and numerous references indicate that computers should be used as tools rather than as drill and practice machines (NCTM News Bulletin, 1987; NCTM, 1989). Sherry Turkle, author of the 1984 book *The Second Self: Computers and the Human Spirit*, relayed the importance of students having access to computers as tools in the classroom as they engaged in pursuits that would allow them to make personal expressions (Rhodes, 1986). She also stressed the importance of the teacher being both familiar and comfortable with computer use in order for computers to be used as vehicles of personal and cognitive expression for students in the classroom (Rhodes, 1986; Turkle, 1984). Messages like TurkleÕs have been appearing in the literature for years (c.f., Papert, 1993). It is abundantly clear that teacher support and knowledge is necessary to create exciting and inclusive classroom environments where computers are integrated in a meaningful or authentic fashion (Lebow & Wager, 1994). In a series of articles written by teachers and researchers in Connecticut in 1994, one author, Kinnaman, titled his essay, ÒThe leadership role: Best of all...it isnÕt teacher-proof!Ó I share this view; the most well-conceived project-based units incorporating technology will fail without appropriate guidance and intervention on

the part of the teacher. Having a knowledgeable teacher in a classroom with networked computers is also acknowledged as a better way to use computer technology in the elementary school than the computer lab option, allowing for more integrated use of technology (Whitehead, 1993).

The review of the literature indicates that project-based learning that allows for individual and gender-based preferences to be expressed, that involves learning through social interaction with classroom members as well as members from the community, and that is guided by a teacher knowledgeable in the use of computer technology, is likely to give rise to student engagement and learning. The toys unit incorporated all of the features listed above, and I now turn to a description of the engagement and experiences of the students involved.

Classroom Setting

The class involved in the present study, located in a mid-sized Ontario city, was one of several classes involved in E-GEMS projects during the 1994-95 school year. The other three schools in which research projects were taking place during the same period were located in Vancouver, British Columbia (Klawe & Phillips, 1995).

Twenty-nine students in a combined Grade 7 and 8 class took part in the research. Of these 29 students, 12 were female. Four Macintosh LC III computers with CD-ROM drives and two printers were made available to the classroom teacher, Susanne Ellis, in April of 1994. Thus, Susanne, along with eight Grade 7 students who would remain with her during the 1994-95 year (as Grade 8 students), was able to become familiar with both the technology and some of the available software. There was also an additional Macintosh Plus with a harddrive available in the classroom. Susanne had no experience with Macintosh computers before April of 1994, although she was familiar with IBM computers and used one regularly. By the end of the 1994 school year, and well prior to the commencement of the study described here, she was a skilled Macintosh user.

The classroom was a busy one. The walls were covered with students' work, usually

reflecting the current units of study. In the 1994-95 year, these units included such topics as advertising, poetry, heroes, mysteries, illusions, and, of course, toys -- the unit described in the present paper. Much of the teaching and learning revolved around such units, where students were expected to complete a project or series of projects, and where two or three curriculum areas were often integrated through the unit. For example, the advertising unit included such issues as misleading advertising, gender stereotyping, and the use and reporting of statistics, integrating mathematics and social issues in an authentic way. Thus, project-based learning was a common occurrence in this classroom.

In addition to the units, Susanne also conducted a number of teacher-directed lessons. These lessons would be followed by individual hands-on experimentation, group work, or by individual pencil-and-paper Òseat work.Ó There was also ÒfreeÓ time at various points in the day, when students could engage in a number of activities, including working on the computer, working on homework or other projects, reading a book of their choice, or pursuing some art work. Free time included recess and lunch, as well as variable portions of class periods throughout the week.

The interactions between Susanne and her students were characterised by humour and gentle firmness. There was an unmistakable sense of caring for the students' intellectual, emotional, and personal growth and well-being. This sense of caring was observed not only by the four researchers, but by any number of visitors to the classroom throughout the year.

We had a closely negotiated relationship with Susanne, in terms of our presence in the classroom and the nature of the research that took place. We had regular classroom and out of school meetings to determine how the computers might best be integrated into the existing program, while, at the same time, stretching the boundaries of the curriculum through the introduction of the technology. It was during one of these meetings that Susanne described the toys unit she was planning. It became apparent that this was a unit worthy of close observation. Thus, unlike some of the other studies where we designed an intervention and examined particular pieces of commercial software or E-GEMS prototypes (see, for example, De Jean &

Upitis (in progress), where a paperback version and a CD-ROM book version of poetry are compared), the findings described in the present paper began with a direction taken by Susanne.

All of the computers had word processors, paint programs, and *HyperCard*, and these three forms of software were used extensively during the toys unit. In addition, there were specialised pieces of software and E-GEMS prototypes used in other contexts throughout the school year, some of which were chosen by Susanne, with others being provided by the E-GEMS researchers.

Toys! Toys! Toys!

Toys! Toys! Toys! was one of several integrated units of study, incorporating project-based learning, planned by Susanne for the Grade 7 and 8 students. I have chosen to describe this unit in detail for three reasons: (1) without exception, the students liked this unit -- even Grade 7/8 students found toys appealing, especially if they chose to make a toy for a younger sibling, (2) the computer was integrated in ÒnaturalÓ and diverse ways by students, and (3) this unit provided an opportunity to compare computer technology with other forms of technology such as carpentry and sewing tools.

Susanne outlined the expectations for the unit by providing each of the students with a one page description of the outcomes that would result from their explorations. Students were expected to design and construct a toy, using a wide variety of material and human resources in the process. There were a number of products produced by the students, along with the toy itself, including design plans, promotional displays, logos, advertisements, business cards, and the like. Of these various products, Susanne required students to produce two of them using a computer -- the toy company logo and an advertising flyer. Students could produce these two items during class time or using home computers. If they chose, however, students could fulfil most of the requirements of the project using computer technology, including designing a toy or game for computer use. The other computer requirement, which was fulfilled in a computer lab located elsewhere in the school, involved learning to use a spreadsheet, and ordering toys worth $2,000,000 (!) according to certain criteria. For example, all of the money within $10 had to be

spent, and students could buy no more than 200 items of one toy. Catalogues and magazines were available to the students for this activity to help them price the items.

In general, students were free to work their way through the unit as they pleased, within the structure provided. Susanne monitored their progress through the daily journals completed by the students and through regular discussions with individuals and small groups.

During the five week unit, students worked individually, in small groups, and at times, full class discussions took place. All students, through a process of brainstorming, discussion, and negotiation, agreed on criteria for a Ògood toyÓ including such factors as safety for young children and durability of materials. Small groups sprung up spontaneously when students were working on a similar problem or using common tools. For example, four or five students needed to saw various pieces of wood, and they worked together, helping one another with each of their toys. Some of the work was done individually, both in the classroom and at home. This was often the case when students were designing advertising slogans and materials or writing their daily work journals. The unit culminated in a Toy Fair, where toys were displayed, demonstrated, and described to other members of the school and neighbourhood communities.

Susanne orchestrated and facilitated the unit in a number of ways. She helped students network with other teachers in the local high school when tools were required that were unavailable in the elementary school. She led a number of the discussions, including one on how to effectively display the toys at the Toy Fair. Also, during the course of this unit of study, a student teacher was working in the classroom, and much of the work was taken on by the student teacher, under SusanneÕs supervision and guidance. The researchers, in this case, were primarily observers; we did not influence the unit in any way other than by our presence and by taking a keen interest in the emerging creations.

Documenting the Experience

Students' experiences were observed and documented in a number of ways during the five week period. All four researchers observed the work of the students, asked questions about

individual projects, took part in class discussions, and took notes based on observations and questions asked of Susanne and her students. We all took part in the Toy Fair, visiting each of the exhibits, trying all of the toys, and asking students to tell us about their creations. We took photographs at the fair, gathered business cards, and critiqued and celebrated the various toys and displays.

In addition, several of the students were interviewed individually two months after the unit was completed, in order to get some sense of their reactions to the unit once they had been somewhat distanced from it. The students who were interviewed were asked to complete context webs (White & Gunstone, 1992). Students were instructed to put the name of their toy in the middle of a blank sheet of paper, and then were asked to indicate all of the associations they could remember about the toy, including materials used, feelings about the project, difficulties they encountered, experiences at the Toy Fair, and things they learned as a result of their undertaking. These context webs were then used as a starting point for individual interviews, which included questions on the topics listed above.

We often engaged Susanne in discussion about the toy unit while it was in progress, raising questions as the context dictated. Upon completion of the first draft of the present paper, Susanne was interviewed and asked to critique the paper in its early form, adding observations of her own.

In the description that follows, the experiences of four students are related in some depth. The four students, two boys and two girls, were selected for the diversity of viewpoints and approaches they represented. Desiree and Matt both designed games for the computer. In one case, the game was of the “choose your own adventure” variety, and was entirely text based. In the other case, the game involved solving a series of riddles and puzzles to reach the goal, and the student created black and white perspective line drawings for the graphic component of the game. Jane was selected because she only used the computer insofar as it was required in terms of the project expectations, and had been identified, both in this context and in other classroom situations, as one of the students who did not find the computer technology appealing. Derek

was selected because he used the computer extensively for advertising, but chose to create his toy using woodworking tools. A composite description for each of these four students was compiled using (1) the observations of the researchers, (2) the context webs produced by these children, (3) interviews, and (4) additional comments and observations made by Susanne upon reading the first draft of the composite descriptions.

The Experiences of Four Students: Desiree, Derek, Jane, and Matt

Desiree

Desiree takes learning and schooling seriously. Unlike some of her adolescent female peers, Desiree is keenly involved in intellectual pursuits of her own initiative. She reads avidly, and likes to write poetry in her spare time. She is a resourceful and persistent young woman, so it came as no surprise that Desiree would attempt making a computer game for the toy project. In so doing, she learned to use *HyperCard* through the help of her peers and by using the manuals that were available to her -- there was no classroom instruction on the use of *HyperCard*. Most of her efforts during this unit were spent on the game itself -- partly because it was time consuming to learn how to use *HyperCard*, then design and debug the game, and partly because she was more interested in producing a good game than in spending time on what she viewed as peripheral activities, namely creating business cards or posters to help market her game -- the *Titanic*.

When asked to describe her game, Desiree replied, “It’s a choose your own adventure game, where you’re trying to relive being on the Titanic. There are many paths through the game. I didnÕt count them. Some of them crossed each other, too.Ó

The *Titanic* was an unusual game in that there were no graphics; the game was entirely text-based. Desiree had read a number of accounts of the sinking of the Titanic, and from these accounts, had compiled details about life aboard the Titanic before disaster struck. She also knew, from her reading, that a few people survived the disaster, and so, the game player who makes the right choices survives as well. At each new screen, the player is asked to make a

choice. For example, at one point the player is asked if he or she would like to dine with the guests in the main dining room or stay in his or her own room because of seasickness. The next screen would be contingent on the choice made on the previous screen, and the right combinations of choices, fortuitously leading the player to the right place on the ship when the fateful crash with the iceberg occurred, would result in surviving the disaster and winning the game.

The game and the text were highly engaging, at least for the researchers -- DesireeÕs game was the only computer game we played through to completion during the course of the school year. At one point, Desiree explained that she chose not to use graphics because she wanted players to concentrate on the story -- “I tried to put in enough detail so you could make up your own pictures, in your mind.” A few months later, she conceded that at one point she had planned to use minimal graphics -- “little pictures on the bottom that would move when you clicked on a wordÓ but that she was unable to get the help she needed to create such graphics.

Although Desiree noted that “Scott got me started and showed me how to make fields for writing and how to link cards,” she was often observed working alone on her game. She chose to use an old Macintosh Plus computer (with a harddrive), that was tucked away in a corner of the classroom. The four other computers were networked in a cluster, and were always in a location where there was much activity, talk, and laughter. Desiree picked the old computer deliberately: she knew it was not as popular as the other computers, since it was slow and did not have a colour display, and she expected she would therefore have more time to work on her game. Also, she picked “Ned” (the name the students in the class gave the old computer) because she “wasn’t sure if my game would work out at the end. I wanted mine away from theirs [i.e., the other students, such as Matt, who were also creating computer games] so people [at the Toy Fair] would look at it. And pay attention to mine.Ó Despite the fact that ÒNed kept on breaking down and I had to keep rebooting it,” Desiree was glad to have used a less powerful computer to ensure that she could work at long stretches without interruption and then, ultimately, have her work displayed away from that of others who had created games.

Desiree was justifiably proud of her end result. She glowed as she told us, “Using the computer makes me feel professional. Everyone walks by you and says ÒWow!, You must really know computers.ÓÓ She enjoyed showing her game during the Toy Fair, despite finding a bug “right when people came in.” For Desiree, the game spoke for itself. She spent little time on the advertising aspect of the unit; almost all of her business cards and other paraphernalia, such as a doorknob hanger and buttons, were created by hand. She claimed that she found the advertising “boring” and that she “could never think up good slogans or pictures or anything.Ó In fact, we found her advertising quite amusing -- for example, she made a bookmark with the saying ÒSink into a good book” inscribed across a line drawing of the Titanic, and a doorknob hanger with the phrase _____’s room: Board at your own risk! But for Desiree, the heart of the unit was in making the game; one suspects that she would not have bothered with the posters and buttons had they not been a required component.

Derek

Derek is a kind, enthusiastic, and reflective young man. He is clever, and he is a hard worker, especially when he is enthused about projects he is required to complete. He became visibly excited when he was asked to be interviewed about his toy. Derek created the *Dino-Bank,* a dinosaur with a slit in its back for saving change (we used to call such items “piggy-banks!”). He told us that he wanted to create a “fun way for little kids to save money,” and that by making the belly of the dinosaur clear, “kids could see how much money they were saving.” The *Dino-Bank* was an extremely attractive toy. Derek painted it purple, with large yellow polka dots all over the body and neck, and drew and painted engaging facial features -- the *Dino-Bank* almost looks as if it is smiling and winking. All of Derek’s advertising materials were also yellow and purple, with the exception of the interactive advertisement he created using *HyperCard*.

The *Dino-Bank* posed many challenges for Derek in terms of design and construction. When asked what tools and materials he used to construct his toy he readily recited a list of some

length, including Òa scroll saw, a router, screwdrivers, computers, scissors, pencil and grid paper, wood, Lex-an, paint, screw, beady eyes, and glue." When asked about Lex-an, Derek described it as "unbreakable plexiglass," something he had learned about from his father who "works in a glass company and knows about this kind of stuff." It was important to Derek to use something clear for the body of the Dino-Bank, even when it became obvious that it would have been easier to make the entire dinosaur out of wood. Derek tenaciously held on to the notion that Òkids would like it more if they could see inside."

With the support of his classroom teacher, Derek was able to make use of people outside the immediate classroom community as he was constructing the *Dino-Bank.* Besides involving his father, Derek had a teacher from the local high school help him "router out the middle strip," a groove where the Lex-an could rest in the purple and yellow wood frame. Derek was able to make use of a wide variety of resources, in terms of tools and human resources, to create the toy he had envisaged, all the while retaining a sense of ownership of the toy -- he was proud of what he made, and felt that others had "helped, but it was really my idea and my toy." Derek worked diligently on his toy -- at home, at school, and at the high school.

Derek spent almost as much time working on the advertising of his toy as he did on the design and manufacturing aspects. He created a calendar (complete with an ÒAnnual Dino-DayÓ), doorknob hangers, bookmarks, business cards, a computer-generated pie graph indicated projected sales, buttons, a Dino-Pencil, posters, and an interactive computer advertisement. He chose to create the computer ad since "[he] figured if it was on a computer and people could click on it, it would be more effective." The computer ad, constructed with *HyperCard* on one of the four networked computers, took some time to complete. Derek created the advertisement over many short sessions, and seemed undisturbed by the lack of availability of large blocks of time for computer use and the resultant break in continuity. As he put it, "I worked on it in bits and pieces, in spare time or toy time, until it was done."

Of all of the aspects of the unit, including designing the toy, manufacturing the toy, creating advertising, keeping journals and production records, and displaying the product in the Toy Fair,

Derek found the journal keeping the least absorbing part of the process. He described the journals as “kind of boring,” and, recognising that the journals and production records were designed to keep the toy production on track, he stated, “I didn’t need to do the journals to keep planning and going and on track.” One suspects that Derek was right in his self-assessment here -- his dedication to the Dino-Bank was clear from the beginning idea through to the culmination of the Toy Fair. Derek described the toy unit, in comparison to other units as “a really good one”

Showing the *Dino-Bank* to friends, young children, parents, and members of the community during the Toy Fair was a highlight for Derek. Although he found the Toy Fair long (there were few people in attendance during the last half hour), we noted that each time he described his toy to a new group of people, his eyes sparkled with enthusiasm.

When asked if he had anything else he wanted to share that might help us understand his views on the toy unit and the creation of the *Dino-Bank* , Derek smiled and offered the following comment, ÒI was happy with my toy. I liked when I was all done and I could just sit back and watch people look at my toy. I thought my toy was pretty creative.Ó Indeed, it was.

Jane

Jane’s energy is focused on friends and relationships -- she is eager to move on to high school and explore all of the intricacies of the social fabric in the high school setting. Jane completes school activities and projects with diligence but often with little enthusiasm; at this point in her development, her interests lie elsewhere.

It was not surprising to find that Jane was not terribly enthusiastic about her toy -- an endearing stuffed animal called *Cuddles*. During our final interview, which took place some two months after the Toy Fair, Jane indicated that her toy was still in her locker because she “hasn’t bothered to take it home.”

Jane spent relatively little time designing her toy, and most of her time on the hand sewing. In contrast to Derek, who drew the *Dino-Bank* on grid paper several times before deciding on

the final contours, Jane drew a pattern for *Cuddles* on a piece of plain paper, and proceeded from there. In the end, she seemed to regret her lack of attentiveness at the design phase, commenting that "one part of the head was longer than the other, and one of the arms was longer, and one leg was thicker." If she were to do the project again, she said she would "use a pattern from a book next time," rather than taking the extra time to design her own pattern more to her liking.

Although Jane found the hand sewing difficult, stating that "it was hard to sew, I kept poking my finger," she nevertheless persisted until *Cuddles* was completed, with eyes and nose attached and stuffing snugly in place.

Jane only used the computer when required. Almost all of her advertising was done by hand, including drawings on her display board, a *Cuddles* lunch bag, a door knob hanger, and a graph indicating projected sales as compared to other stuffed animals. The only two items she created on the computer were a business card and a flyer. Her father helped her with the design of these items. Jane also submitted her computer printed journal entries, after transcribing her hand written notes on the home computer. She found the journal aspect of the unit "not too bad" although she doesn't feel it helped her "stay on track." When asked why she didn't simply submit the hand-written form of her journal entries, Jane indicated that she liked to hand in computer printouts rather than hand-written notes. She further stated that she didnÕt mind using the computer when she thought she could do a better job with the computer, she "just [didn't] want to use the computer just because I have to." It is important to note that Jane did not lack computer skills: her decision to use the computer, like the decisions of the other three students described herein, was based on her self-defined interests and needs.

Despite her subdued remarks regarding the toy unit, Jane described it as "a pretty good" unit, one that she liked as much as the units on advertising and heroes. Jane quickly added that there were no units that she ÒdidnÕt really likeÓ -- in a way that might make one think that Jane was telling us what she thought we wanted to hear.

Matt

Matt is a quiet young man, well-liked by his classmates and his teachers, and capable of dedicating large chunks of time and attention to things that interest him. Working on the toy was of great interest to Matt. Like Desiree and one or two others in the class, Matt created a computer game for his toy.

Matt's game, *Puzzle Castle,* was a major undertaking. It was a complicated game, with graphics, and constructed using *HyperCard*. He described spending "*hours* on the game -- lots. Every period at school, I would work on the game. And then I worked on the advertising at home." Matt chose to construct his graphics in black and white, realising that even simple drawings would be time consuming, in addition to working out the design, puzzles, and riddles associated with the game. Like Desiree, Matt enlisted the help of Scott from time to time, but quickly pointed out to us that ÒScott was the *only* one who helped [him]."

When asked to describe his game, Matt replied, "It's about a knight who has to save a princess. He has to solve problems to free the princess, basically. Math problems and riddles." When asked where he got the idea from the game, Matt told us, "I was thinking of non-violent games, because we're not allowed to have violence. So I thought maybe riddles. I was thinking about a robot who would have to save a city. But I kinda thought mine was a better idea.Ó

Matt's game, of course, is not unlike many popular video and computer games where the player's mission is to save the helpless damsel in distress. When we saw Matt's game at the Toy Fair, one of us, a female researcher, asked Matt if it were possible for her -- a woman -- to be the hero. Matt replied that he had never thought of that, but eagerly responded with a suggestion: "At the start, I could ask, please enter your gender. They could have the same story and riddles, but wherever it said ÒprincessÓ it would say "prince."" When asked if he had ever seen a game like that, he replied that he hadn't. He then was asked to think about whether a game like his, with a gender option, would sell. He seemed to think it would, responding, "Yeah, unless it was a really boring game. It would probably sell better. If some people felt stereotyped about games, like heroes as men and distressed damsels and stuff, then more girls would buy it, maybe.Ó

Matt didn't like two aspects of the unit: the scale drawings and the journals. Clearly, the scale drawings didn't make sense for his toy (Desiree, it appears, simply chose not to do them). He suggested that making a story line would have made sense in his case; we can't help but agree. He also disliked the journals, stating that they "got on [his] nerves" and played no role in keeping him on track.

Like Derek, Matt enjoyed displaying his game and spent a good deal of time on the advertising aspects of the project. He created flyers and a banner on the computer, and other pieces, such as a poster, by hand. Matt thoroughly enjoyed putting the display for *Puzzle Castle* together, stating that it was "fun organising the stuff for the Toy Fair. It makes you feel like a big business man!" Paradoxically, Matt claims he didn't like the unit on advertising, calling "Heroes" and "Toys" two of the better units and advertising "one of the boring ones.Ó For Matt, it seems that embedding the advertising in a project of his own made the advertising aspect relevant and engaging.

The Role of the Computers

The role of the computers in this unit was of interest for two principal reasons, each of which is discussed below. They include (1) appropriation of computer tools, and (2) the computer as compared to other forms of tools/technology.

In contrast to other units where the computer was used extensively for text and graphics (e.g., for the "heroes" unit, students created stories, newspaper reports, and comic strips on the computers), for the toys unit students were only required to use the computer in the regular classroom and at home for two rather non-central aspects of the unit -- namely to design the toy company logo and to create an advertising flyer. However, there was the *possibility* of extensive computer use, including, as demonstrated by Desiree and Matt, designing the entire toy or game on the computer. There was, therefore, an opportunity to observe how this class of students would ÒnaturallyÓ appropriate the computer tools (this was not possible to observe during the spreadsheet portion of the unit, as all students were working with the spreadsheet at the same

time in the computer lab).

As one would expect, there was a wide range of computer use as illustrated by the four composite profiles. Students were free to make choices regarding computer use based on their preferences, abilities, and interests. For some students, like Desiree, this gave them the opportunity to learn to use a new kind of program (*HyperCard*) and build a game based on that newly acquired ability. For other students, like Jane, the relative freedom in terms of computer use meant that she could complete the project without being "forced" to use a tool that she found neither appealing nor particularly useful. Others, like Derek, used the computer for more than the required tasks, but constructed a toy with other tools. For students like Derek, who used the computer for more than the minimum requirements but not for the toy itself, there were a number of ways the computer was incorporated, from the design and printing of the business cards, to writing up marketing reports, to creating interactive advertising for the toy fair, to creating signs for the toy displays, to using the computer for the daily work journals. This wide variety of use did not appear to fall into any predictable gendered patterns; we were equally likely to observe girls using the computer for creating marketing reports as boys. During the entire school year, this was the unit where the use of the computer seemed the most fluid; students used computers (at home and at school) when they chose to, and moved easily from using a computer tool to using a saw or a sewing machine. The only difference in terms of computer use by gender was the time of day when the computers were used. Girls and boys both used computers during free time and technology time (the allotted class periods for the toy unit), but the girls were more likely to use the computer during ÒfreeÓ time when Susanne "created a space" for them, that is, when she explicitly made a computer available for a female student (see Koch, in progress). A similar phenomenon was reported by Hutchinson & Whalen (1995); girls were more likely and more comfortable in using LEGO/Logo facilities in same-sex rather than mixed gender situations.

The second point of note regarding the use of computers in the context of the toy unit was that this was one of the only times during the entire school year that the computers were not in

constant use during Òfree time.Ó (The other time that computers were not in constant use during free time was when the students were creating video clips for an advertising unit.)

Susanne and the researchers observed, over an extended period, that students seemed to be attracted to the use of the hand tools, and would choose them over the computers when given free choice. At first, we speculated they were spending free time using the hand tools simply because they were under time pressure to complete their toys -- the date of the Toy Fair had been set well in advance, and students were aware that their toys not only had to be constructed, but displayed as well. However, as we continued to watch and to interact with the students over the course of the year, we became convinced that, indeed, for some students the saw had greater appeal than the computer. There were other times during the year when there were also time pressures to complete projects, yet at those times, Òfree timeÓ would not be devoted on the projects with the impending due dates, but on exploration of computer software.

Designing Classroom Projects With a Technology Focus

By most accounts the toys unit was a successful undertaking. It allowed for appropriate and meaningful use of technology. Both the process of making the toys and the sharing of the products extended beyond the confines of the classroom walls. Students were, for the most part, absorbed in the work, and much learning was evidenced. Some of the learning, like DesireeÕs newly acquired ability to program with *HyperCard*, was computer based. Other learning, of a similar nature, was evidenced in the use of hand tools. The unit also made it possible for students to think critically about advertising and about design. Progress through the unit and assessment was comprehensive, based on Susanne's use of daily journals and work plans. Perhaps most important of all, students enjoyed this activity, and many indicated they would like to do the unit again. In this section, I explore some of the features that we feel contributed to the success of the unit, features that, arguably, should be incorporated in designing other project-based learning with a technology focus. These features are not unlike those reported in the literature that was reviewed earlier in the present paper.

Potential to Create Something Unique and Lasting

One of the undeniably important outcomes of this unit was that, at the end of the five week period, students would have created something with their hands, something original and unique that they could share with others. There was a decided sense of pride for the students at the Toy Fair, as they stated, sometimes shyly and sometimes forthrightly, "I made it myself." For a good number of the students, the unit lived on long after the Toy Fair was over -- some gave their toys to younger siblings and observed with pleasure as their siblings played with their creations, others displayed their toys in their own rooms or played with the toys themselves, and others (especially the creators of computer games) left their toys in the classroom and enjoyed continued interactions with their peers.

Potential for Wide Variety of Technology Use

Undoubtedly, part of the success of this unit was due to the large number of ways that students could use computers and other technology, and use these technologies in combination to create something original and unique. Although none of the students in this year's class chose to create video commercials as a means of marketing their toy, this possibility was made available to them. Students seemed able to use computer technology for a variety of purposes, as described previously, and they were able to use computer technology as well as the tools and technologies associated with woodworking and sewing. While it was important for Susanne to include computers for some aspect of the unit, she left most of the choice in the hands of the students; computer use was not prescribed in a limiting way.

Potential for Community Involvement

One of the ways that this project seemed to come to life was that in the process of creating their toys, students were encouraged to tap into a number of community resources, both at the high school and in the larger community. The Toy Fair itself involved the entire school

community as well as parents (as observers and eager volunteers) and the general public. Three reporters from different local newspapers came to take photographs and write stories. For some students, this community involvement made the project “real” -- something outside the limited realm of the classroom.

Monitoring the Projects

The daily plans and journals made it possible for Susanne to assess the work on an ongoing basis and to help students plan for human and material resources they would require for their projects. Despite the fact that the journals made sense for these two purposes, they were perceived as irrelevant by some of the students. This was the only part of the unit that seemed Òschool-likeÓ to some. The challenge is to make the journalling aspect relevant to the students as well -- perhaps by using journal excerpts as part of the newspaper account, students would have seen the journal as having value as well.

Appeal of Toys and Games

Another feature which bears mentioning is that toys and games appeal to most children, even Grade 7 and 8 students who have other things on their mind as they begin the difficult period of adolescence. Since the unit was designed so that the toys could be created for themselves and their peers or for younger children, the unit did not seem “babyish” even though the subject was toys. A number of students made toys they thought would appeal to their younger siblings or to the younger students in the school (such as Derek’s *Dino-Bank).* Others designed games for themselves and their peers (one person made a chess game). The other important feature of toys and games is that they are, in one sense, gender *neutral*, that is, both boys and girls like toys. On the other hand, they are not gender *neutered* -- it is possible to make both “boy toys” and “girl toys.” As I mentioned earlier, many of the girls made stuffed animals and many of the boys made wooden constructions. Others made what might be viewed as cross-gendered toys -- one boy constructed a wooden dollhouse, making a toy that he thought would

appeal to both boys and girls, but using the woodworking tools he associated with his gender. This unit made it possible for boys and girls to acknowledge their separate cultures, as defined by McDonnell (1994), and for the artifacts created in the context of both of those cultures to be valued.

Likelihood of Success

Perhaps the most important feature of this unit was that each child was capable of designing and building some kind of appealing toy, according to their interests and abilities. Although the class included a wide range of ability on the part of the students, it was not possible to tell, from the products themselves, which students normally had difficulty with school tasks. For some kids, this was one of the few units where they were pleased with their work, and displayed their work with pride next to the work of their peers.

Concluding Comment

As a result of the research reported here, my belief in the value of integrated units of study involving project-based learning has been strengthened. While there is no "fool-proof recipe" for designing classroom projects that would appeal to most children in most circumstances, it is arguable that units of study that incorporate the features of the toys unit would be likely to succeed as learning environments. In short, when (1) students can make an original artifact, (2) when a wide variety of technology use is both possible and necessitated by the nature of the creative undertaking, (3) when people outside the classroom setting are involved, (4) when some sort of monitoring or tracking procedures are devised, (5) when the idea allows both boys and girls to include elements of their own cultures, and (6) when students with a wide range of academic (or school) ability can take part, the project has a good chance of transcending the boundaries of "school work" and allowing the imaginations of the students to make it both relevant and real.

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