Technology: changing the way we think and learn or maintaining the status quo?

Introduction

Since the introduction of computers into educational contexts, early childhood educators have been somewhat sceptical about the appropriateness of their use with young children. Such beliefs were predominant in the literature of the 1980’s (Anzelmo & Zinck, 1984; Cuffaro, 1984; Hill, 1985; Elkind, 1985, 1987) and were based on the views that computer use was not only detrimental to the development of social skills in young children but also that, as a two dimensional medium, computer based activities were not as effective as manipulatives in developing understanding and skills in the early childhood years. Even in the early years of the present decade it has been reported (e.g. Bailey and Weippert, 1992; Kaden, 1990) that early childhood teachers still believe that the introduction of computers into their classroom would replace the use of the traditional materials such as blocks, collage, construction and paints and would thus be detrimental to learning in these formative years. Such views are grounded in the developmental approach to learning which suggests that learners need to be able to manipulate materials in order to make sense of ideas and that using a computer without having such experiences would be detrimental to their learning and the development.

However, recent research has revealed that far from being detrimental to learning, the use of technology in early childhood contexts, can have a positive effect (Clements, Nastasi and Swaminathan, 1993). This is not only apparent in terms of the social aspects of learning but also in relation to understandings and children’s motivation to learn. Clements et al (1993) have suggested that we now stand at a crossroads in terms of the use of technology in early childhood education. We can use it to reinforce existing practices or appropriate the technology to develop new curricula that are both more meaningful and stimulating to the learning process. If we choose the former route technology becomes an add on to the current curricula and often will consist of activities that act as a reward for finishing traditional work ahead of schedule, usually with software that reinforces content in a mechanistic way. In this context computers become a control device, rather than a resource that could be appropriated for learning. It is this second route that I would like to explore further in this paper.

It is my belief that until curricula change so that the use of technology becomes embedded, teachers will not use technology as a learning tool for the children in their classes. At the present time we have curriculum documents that ignore the use and power that technology can have for learning. This is most clearly evident in the areas of Mathematics and English. Additionally, we have national profiles that are labelled with the word “Technology” but contain content and processes that are an integral part of the core curriculum subjects. The way in which technology is situated in such documents means, that for early childhood educators, acceptable uses of technology are manifested in creations with LEGO and larger building blocks.

We now have available machines and software that can help us, as learners, to shape our ideas in new and original ways. Unfortunately, we seem ill prepared as a profession to take advantage of such an opportunity. In order for technology to have an impact on existing curricula and pedagogy, such changes will need to be initiated with teachers and policy makers participating in the process. The results will be evident in more meaningful and engaging learning activities for the children in our schools, that incorporate the use of technology.

Over the past 14 years the hardware capabilities and software options have undergone significant changes. However, these changes have not been reflected in classroom applications of technology, over the same period of time. Indeed, computers are being used in many cases as an electronic workbook. What is significant however, is that in the early 1980’s few if any children in our classrooms had computers at home. In contrast, today,
Learning and technology

It is my strong belief that technology should be integrated into early childhood programs, so that its use becomes a natural or seamless aspect of the learning processes that are a daily occurrence in education. If this was achieved, young learners would be empowered and engaged with learning processes, using technology as just another resource, or a tool, that can assist them to think and present their ideas. It is important to emphasise that as early childhood educators, we believe strongly that young children learn best when:

- they are actively involved
- there is an emphasis on experimentation, play, problem-solving, self-directed learning and cooperation
- they are engaged in a rich variety of experiences
- they receive positive responses to their attempts
- perceive some relationship to their real world knowledge and experiences.

With these features in mind it is evident that computers can make a unique contribution to learning in a number of ways. This is because:

- children like them
- you can play and explore (with good software) and get feedback that means if you have to make changes to your plan or idea in such a way that it is not a “big deal”
- they can extend cognition
- they can promote thinking and problem-solving skills
- they can assist in building new understandings via explorations
- they act as effective manipulatives (Clements, 1994) to:
  - offer flexibility
  - facilitate the process of changing representations
  - assist in storing and later retrieving configurations
  - are used to record and recall students' actions
  - they are a context for using and extending language
  - they support the development of projects and/or ideas, since in computer environments children can:
    - communicate easily; with each other, the teacher, and remote sources of information and people
    - share their work and ideas with others easily
- explore, develop ideas and play with them and keep records of what they have done
- computer activity allows children to collaborate on projects that encourage collaborative problem-solving.

Of course all these things are only possible in a learning environment that is stimulating and encourages active exploration of objects and ideas. Not all computer software has the structure or potential to achieve any of these things. Teachers and parents need to be aware that both software and contexts for learning need to be conducive to problem-solving and the creative development of ideas and knowledge.

Problem-solving environments

Effective problem-solving environments are characterised by the use of higher order thinking skills and the use of metastrategic processes (Sternberg, 1985). They involve activity that:

- is authentic and therefore meaningful
- is interesting and engaging
- is sensitive to the need of diverse populations of students
- is able to be achieved at different levels of understanding
- allows for initiative
- can be extended in a variety of ways
- can be discussed and summarised into statements that have meaning for the child
- allows the child to use what knowledge he or she knows and then explore new concepts
- does not have one path to a solution or has a variety of acceptable solutions.

The use of computer based problem-solving learning environments has been an area that I have actively researched over the past 10 years. There are a variety of computer based activities that I would regard as being conducive to the development of problem-solving skills in the early childhood years. My research has shown that the role of the teacher in scaffolding learning in this process is crucial to the development of such skills not only while the children are engaged in the task but also in the creation of a problem-solving environment that encourages young children to actively play...
and explore the objects and ideas that they encounter. This has been the case with software ranging from Logo, a computer language designed specifically for children, to interactive fiction on CD-ROMS, graphics and presentation packages, and more recently the creation and development of online communities of learners.

**Logo**

For the past 3 years my colleagues and I have been working with two versions of Logo called Geo-Logo1 and Turtle Math2. Our research (Yelland, 1994; 1995a; 1995b; 1995c; 1995d; 1995e; Yelland & Masters, 1994; Yelland & Masters, 1995a; Yelland & Masters, 1995b) has been based on two aspects of learning and teaching. Firstly, the versions of Logo that we have used were specifically designed to support children learning within a particular curriculum context; that of mathematics. Secondly, the content of our work has focused on the importance of the role of the teacher in mediating learning, and the ways in which children may collaborate to solve novel problems within the Logo environment. Geo Logo was developed as part of a large curriculum project in mathematics and forms part of a series of modules which contain activities about specific mathematics topics, such as, paths, co-ordinates and grids and two dimensional shapes. Turtle Math is a stand alone product designed for children in Years 3 to 6 of Primary school.

**Logo: Philosophy and Implementation.**

With turtle graphics, the idea of programming is introduced through the metaphor of teaching the turtle a new word. In the process of programming the locus of control is with the child and not the computer. This is as significant now as it was in the 1980's, because there are still a preponderance of applications where the user is required to adopt a distinctly passive role. From its first implementation, it was apparent that young children liked the turtle, and that they engaged in activities with a high level of motivation and a deep level of concentration. Additionally, their interactions with the turtle enabled them to embark on powerful kinds of learning that involved consideration of mathematical content areas such as geometry, applications of number and the operations, algebraic relations and in some cases ventured into physics and explored such things as velocities. As (Papert, 1980) stipulated “They are learning to speak mathematics, and acquiring a new image of themselves learning with Logo and built up a profile of the children’s learning in terms of mathematical understandings, cognitive processes deployed and computer programming abilities. At every stage of the project we scaffolded the children’s learning and engaged in conversations in which they articulated their programming strategies and explained particular mathematical processes.

In contrast the second study involved the observation of young children spontaneous problem-solving in the environment in order to develop a model of performance. We observed 30 pairs of children over a period of a term. We used the same tasks as the first study but only offered technical support to the children as they completed the tasks.

**Learning with Logo: Issues and Outcomes.**

We have noted some interesting observations in terms of the children’s involvement with the Logo environment and the activities that were part of it. There are a number of factors that we feel contributed to the quality of the environment in terms of affect and specific performance outcomes. For example, in the first study we ensured that the environment was collaborative and conducive to problem-solving by:

- encouraging the children to work collaboratively in their pairs and we often reinforced this idea if it was apparent that they were not doing so
- asking them to think and discuss their plans before they started to direct the turtle in order to ensure that they might choose the most efficient route
- supporting their exploration with questions about moves that were designed to enable them to not only reflect on their strategies, but also to help them to modify strategies that were not optimal.

In the second study we gave the children instructions for the task that they were about to embark upon and then left
them to their own devices. We told them that we would help if they needed assistance with using the computer.

Some of the differences in outcomes were clear.

The children in the first study:
• completed the tasks quickly and efficiently because they were highly motivated
• demonstrated high levels of collaboration in order to solve the task
• spent more time on task and levels of concentration were high
• were able to explain their strategies and articulate what they were doing and planning in a very effective manner
• did not become frustrated when things did not go as planned or they made errors. We were able to support them in their thinking so they could extricate the turtle from the problem situation and this gave them increased levels of confidence and experience so that if the same or similar situation emerged later in the task they were able to gradually figure out the solution independently.

In contrast, we noted in the second study, that the children:
• rarely spent time planning and launched into the task immediately without consideration or concern about what might be the best way to complete the task requirements
• spent a great deal of time off task
• would leave a task unfinished rather than work through problems or attempt to rectify errors
• did not demonstrate high levels of collaboration. However, it was evident that the gender composition of the pair was of importance when considering this aspect of performance, with girl pairs showing more collaborative behaviours than boy or boy/girl pairs
• displayed a sense of frustration and loss of confidence and motivation for the task when they did not meet the task requirements

The research then supports the use of scaffolded learning in the technological environment, so that learning experiences are not only more meaningful and engaging for young children, but also so that children may use metacognitive strategies more effectively and consistently. Furthermore, over the past 3 years working with these new versions of Logo, one of the most outstanding observations that we have noted is not only the engagement that the children had with the tasks but their applied use of mathematical concepts well beyond that expected of them in traditional syllabus documents. In the final session of one project the children planned their own designs and in doing so it was apparent that they were:
• analysing geometric figures in order to determine their role/place in the final product
• understanding that shapes can be moved to new locations, and flipped and turned without losing their essential properties, that is, the angles in a square were always 90 even when the square was tilted.
• using their mathematical knowledge, especially related to number and operating on them to produce length and turns for different functions.

At the planning stage, a planning sheet was developed and proved to be particularly useful in assisting the children to organise their ideas in a coherent form. It also served the function of helping the children to decide what constituted a viable project. At first when they made elaborate drawings they did not appear to recognise how difficult they would be to develop as Geo-Logo projects. However, when they came to record their ideas as component parts and procedures it became immediately apparent that the plans would have to be considerably modified in order to enter them as code. The resulting pictures not only indicated a sound understanding of basic mathematical ideas but also a well developed skill in programming involving the development and combination of procedures. One interesting feature that occurred when Ryan and Aaron decided to draw a house (Figure 1). They needed to use a semi circle in order to put some domes on the roof section. After thinking for a while they remembered that Angela and Denielle had incorporated a circle in one of their projects. They asked if they could go into the girls’ file to “have a look at it”. Once the circle was located the procedure was copied, their project re-opened and the “borrowed” procedure was pasted into their own command centre. This concept of stolen knowledge (Seely-Brown, 1993) has been described as a powerful source of learning. When they realised that it was too large they modified it to suit the size of their roof. The incident is interesting not only for the bravado of using the procedure that another pair developed but

Figure 1: Ryan and Aaron - security house
also because the logistics of entering, copying and pasting files was only done as a management aid while the research was being conducted, yet the children had observed it, and then used it when they needed to do so. The house project also reveals the kind of detail that the children were able to develop in their drawings. The security camera was created very carefully by the pair, using a top down approach. Initially, the drawing of the camera was very complex. When we suggested that this would be difficult to draw on the computer the boys made new plans that were much more simple and contained the basic shapes that they knew they could draw. This was a very practical approach and they then considered each shape separately and built up the camera before placing it on the house.

**Graphics packages: Kid Pix Studio**

One of the most versatile pieces of software that is available on the market is Kid Pix Studio. It enables a young child to create pictures with a new media and then extend this work by incorporating it into a slide show presentation that may be heard and seen on screen. In a similar way children can present their stories and, or research using the package and incorporate information that has been scanned in from books or photographs or via a digital camera or video source. The software is particulary relevant for storytelling by young children because it means that they can develop their ideas using oral language and present their story in both pictorial and verbal forms without having to manipulate text which is a very difficult skill for them. An extract from a story book by Karen (5 years) entitled The Toe Monster is shown in Figure 2.

Additionally, the software has features which are unique to creations with technology. These include a digital puppet section in which you can create your own puppet and develop both movements and sounds to accompany it, and an interesting feature of the drawing package is that of Moopies. In the Moopies mode a young child can create a drawing using a multi coloured paintbrush, for example, and then when the creation is finished the painting becomes animated. This can be done with a range of media from trees that when located seem to sway in the breeze to a log fire burning at a camp site.

**Creativity**

As stated at the beginning of this paper, one of the initial reactions to the use of computers with young children was that they would cease to have opportunities to interact with three dimensional materials. Additionally, it was thought that many of the activities associated with computers would not encourage creativity and in fact required only that the child press buttons. However, the potential of computers to enable children to encounter and play with ideas has been increased over the past five years with hardware and software that allow the child not only to manipulate objects and ideas that are available in the real world but also to do things that are not possible. This is especially true of software applications such as Logo and Kid Pix where you can create objects and play with them in a variety of ways using the "tools" available to you in the package. In such environments the children often spontaneously discover
mathematical ideas and engages in interactions with other learners that would not have been possible without the technology.

**Conclusions**

In his book Being Digital, Nicholas Negroponte (1995) wrote:

> In the 1960’s, most pioneers in computers in education advocated a crummy drill-and-practice approach, using computers on a one-to-one basis, in a self-paced fashion, to teach those same God-awful facts more effectively. Now, with the rage of multimedia, we have dozed drill and practice believers who think they can colonise the pizzazz of a Sega game to squirt a bit more information into the heads of children, with more so-called productivity (pp. 198 - 199).

With this in mind it could be construed that much of the software that is available for use in early childhood classrooms can be characterised as “electronic crack for kids” (G. Stager, personal communication, July 22, 1995). Teachers have to be particularly discriminating in their choice, and use of, computer applications and ensure that the primary goal of using the resource is engagement and learning, via active exploration and the deployment of problem-solving processes. This paper has attempted to show how this can be achieved with reference to two specific examples. It has highlighted environments that are conducive to meaningful engagement with ideas, via the use of technology, and provided some ways in which educational contexts can be organised in order to achieve mastery over the machine, while motivated by the task and the magic of the moment. In the immediate future the challenge will be to provide opportunities for children to extend exploration in technological environments in more dynamic ways with the delivery of virtual reality experiences via the Internet.

Negroponte (1995) has suggested:

> While a significant part of learning certainly comes from teaching - but good teaching from good teachers - a major measure comes from exploration, from reinventing the wheel and finding out for oneself. Until the computer, the technology for teaching was limited to audio-visual devices and distance learning by television, which simply amplified the activity of teachers and the passivity of children.

**REFERENCES**


