The Development of Technological Literacy in Young Children [Part II]: Pre-School And New Entrant Children

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Introduction

This paper describes the first year of a longitudinal research project investigating the development of technological literacy in a group of twenty-four children during the first three years of their primary education (age 5-7). The research project seeks to find out if common patterns of development occur, and to identify any significant affects of prior knowledge, gender, home environment, learning styles, teaching approaches or other factors on this development.

An earlier paper in this issue (Mawson, 2001) discussed a number of problematical areas which need to be taken account of when undertaking research in the development of technological literacy in young children. The four main areas considered were the nature of technological literacy, the components of progression, assessment in technology, and the nature of young children's learning in technology. The particular stances of the researcher in these areas with regard to this research project were also identified. This paper describes and discusses the early childhood education, and home, pre-school experiences of the children in the research sample, and also begins to document and evaluate their technology experiences in their first year of formal schooling.

Research Questions

This research project seeks to investigate the development of technological literacy as defined in the New Zealand Technology Curriculum statement (Ministry of Education, 1995) in children during the first three years of their primary education. It seeks to find out if common patterns of development occur, and to identify any significant affects of prior knowledge, gender, home environment, learning styles, teaching approaches or other factors on this development. It is concerned with not only identifying the developing

knowledge and understanding, but also with explaining how and why that development occurs. Although working with a single group limits the generality of any findings it is believed that some grounded theory propositions will emerge that can be further tested and refined by other case studies.

The following questions are being used as a means of focussing the data gathering process.

1. What are the technological knowledges, understandings and capabilities of children
   when they enter school at age 5? How have they reached these understandings?
2. How do these technological knowledges, understandings and capabilities develop during the first three years of schooling? Are they generic or area specific?
3. Is there a common pattern of development of technological literacy among children
   during the first three years of schooling?
4. What factors appear to help develop, or hinder, the development of technological literacy in children during the first three years of schooling?

Research Methodology

Type of design

The study is a qualitative, exploratory case study of one class of children, their parents and teachers, during their first three years of schooling at an inner city Auckland school, and is being undertaken using the Grounded Theory model expounded by Strauss and Corbin (1990).

Selection and description of site participants

The participants in the study are: the New Entrant children who began school at an Auckland inner-city primary school during the period January to June 2000, their parents/caregivers, and the teachers who will have those children during their first three years of schooling. The school has been chosen because of its reasonably representative

socioeconomic and ethnic make-up, its commitment to covering all seven areas of the technology curriculum over a three year cycle, and the close working relation developed between the researcher and the school over the last five years. As the school is of slightly above average socioeconomic rating (decile 6), the children are not typical of those from schools at the extremes (decile 1 & decile 10), nor are they typical of those from rural areas or in provincial towns. The small number of children involved (25) also limits the generality of the findings.

Because the focus is on the group interactions as well as individual learning, children who leave the school during the data gathering period are being omitted from the study. There have been two instances of this in the first year of the study.

Data Collection Strategies

The importance of obtaining multiple sources of evidence is well recognised (eg. Yin, 1989). Data collection in this study must also address two problematic factors, firstly the unresolved question of how to assess technology education, and secondly the identification and documentation of the learning of young children. The initial reports of the Learning in Technology Education –Assessment (Jones, Moreland & Northover, 1999) and Technology Education Assessment: Lower Secondary (Compton & Harwood, 1999) research projects and literature on the assessment of young children (Ministry of Education, 1997, Mindes, Ireton, & Mardell-Czudnowski, 1996, Helm, Beneke, & Steinheimer, 1998) have influenced the choice of the range of data gathering methods that are being used.

Individual interviews, (to explore their initial knowledge and understanding of technology), were held with the children during their first month at school, before they began their first technology unit. The children also undertook some simple exercises designed to indicate their level of technological capability, using a canopener, eggbeater, and simple construction kit. These interviews and tasks were both audio and video taped.

The most intense period of data collection has occurred as the children have undertaken the two technology units within the classroom programme. Data was collected by means of personal observation, video and audio recording, and discussions with the class teacher. Samples and photographic records of children's work were collected. At times the researcher acted as participant observer in the planning and teaching of units.

The children's technological knowledge, understanding and capability have also been explored in small group situations on a regular basis using the same range of data collection methods described above.

Interviews were held with every second parent/caregiver (13) at the same time as their children were interviewed. Discussions were held with the teacher during the planning process for each unit to establish expected learning outcomes and teaching strategies, and at the end of each unit to evaluate the teaching/learning process and to discuss and document individual children's progress

Initial Interviews

The children were interviewed toward the end of their first month at school, the interviews being semi-structured and about 25 minutes long. The questions were designed to identify pre-school and out of school experiences and understanding of some common technologies. The practical activities were intended to provide evidence about mechanical knowledge, physical dexterity and problem solving skills.

The selected parents were also interviewed at this time. Again a semi-structured format was used to explore parents perceptions of their child's early childhood education experience their; cooperative and leadership behaviours, learning styles and problem solving ability; competence and experience with electronic equipment and tools and utensils; level of curiosity and attitude towards technology education and the parents own understanding of technology.

Early Childhood Education

All the children had attended one or more early childhood education centres. For most parents the objective was the socialisation of their child. Three parents had sent their child to a Montesorri early education facility because they wanted a more structured learning environment, however in every case they moved their child to a local kindergarten in the six months prior to their entering school, for socialisation reasons. In keeping with the pedagogy of early childhood education the activities were focused around unstructured play. On the whole all children favoured outside play, this was very social in nature. Most of the play described was hide and seek, or on the climbing bars and slides. More boys' (6) than girl's (2) spoke of using tools such as hammers and saws and working with wood and this level of involvement was consistent with that reported by parents. One boy spoke of playing armies with his friends, using a log as a battleship, and three liked to make cars with Mobilo and smash them. Although there was a computer in the centre only one child, a boy, spoke of using it, although parents reported a much wider use. Only girls spoke of reading, drawing and painting. They also tended to use moulding materials more, to make pies and cakes with mud and playdough.

Transition to School

The patterns established at kindergarten were continued in the first month of schooling. Outside play still focused on chasing, hide and seek and playing on the adventure playground. Some of the bigger, more physical boys were involved in playground games of rugby. All the children, except one boy, had used the class computer at least once and for all it had been a positive experience. The computer, Mobilo and blocks tended to be dominated by the boys at those times when the children were free to choose their activity. The objects made tended to revolve around vehicles of one kind or another, with buildings being constructed as props for the fantasy stories they created round the use of the machines. Again, with one exception, only girls chose to read, draw, and paint when given a free choice.

Home Influences

The children generally came from quite technologically and experientially rich environments. The majority of parents had made deliberate efforts to provide their children with a range of interesting and educative play material such as Lego, K'nex, Mobilo, Duplo, Meccano, blocks, construction sets and a wide range of other educational technologies.

About half of the children came from households that contained a computer. There was no noticeable gender difference in level of use of the computer, or attitudes towards working on the computer. Parents seemed to have made a conscious effort to provide software or CD ROMS appropriate for their children's use. All the children who had access to computers in the home were able to start the computer, load programmes from the hard drive or CD-ROM, work their way through the programme unaided, and save and quit from the programmes they used.

In all the houses where there was television children were able to, and allowed to, switch it on and find the channel they wanted. Most children were allowed and able to use the video. All appeared familiar with, and competent in, use of the telephone. A number of children had their own radio/cassette players and four had Play Stations available to them.

Very little activity was reported by children or their parents with regard to helping their parents in the kitchen or with do-it-yourself type activities. Where this was reported there were clear gender differences between the sex of the parent/caregiver worked with and the nature of the task. Except for one instance, only girls were reported as spending significant amounts of time involved in design/art/craft type activities.

Behavioural Patterns

On the whole the children were not percieved by their parents as being particularly curious, nor were they reported as being very persistent in pursing deeper understanding of things that concerned them. In nearly every case the preferred learning style for boys

was seen as trying it and doing it themselves, and for girls it was being told or shown. The children were not seen as having good problem solving strategies, nor did they persevere when faced with problems. Only three children were not regarded as having good social skills and being able to cooperate with other children, but only four children were regarded as having and using good leadership skills.

Technological knowledge and understanding

All the girls and a majority of the boys could identify the eggbeater, explain its purpose, and demonstrate its use. Slightly more than half the boys and just over a third of the girls could identify the role played by the crown gear in transforming the turning motion of the handle to the beaters. Less than half the boys and about a quarter of the girls recognized that the beaters turned in different directions and rotated at a faster speed than the handle.

With regard to the can opener the level of recognition and knowledge of use was the same for the boys as it had been with the eggbeater. However the girls had significantly less knowledge and understanding of the use of the can opener.

The children were shown a completed model made from a *Gizmos* construction set and given time to look at and manipulate it. They were then given the correct number of pieces and asked to build another model similar to the one they had examined. Three girls and three boys completed the construction task under two and a half minutes and with minimal verbal intervention from the researcher. At the other extreme three boys and two girls did not complete the task even after a number of quite clearly directed verbal interventions. In four of these cases this was a failure to connect the bases together but one boy was unable to mesh the cogs due to an inability to match the correct sized cog to the appropriate base.

Although there was little real difference in the average time taken to complete the task (girls 4 minutes 6 seconds, boys 3 minutes 56 seconds) the girls required slightly more intervention from the researcher in order to successfully work through the task. Boys

were given an average of 2.8 cues and girls 3.1 cues as they worked through the task. Only five of the twenty-four children (three girls, two boys) were able to recognise when their attempted construction methods were wrong and use logic and observation of the model to solve the problem. The majority of the children continued to persevere with the inappropriate approach (e.g. trying to force the bases together) until the researcher was forced to intervene, and some children continued to persist even after intervention. Very few of the children made any serious attempt to examine the model before starting, or to refer to it when experiencing problems. They appeared to have real difficulty in relating the spatial arrangement of the model to their own construction. By far the preferred problem solving strategy for both boys and girls was trial and error, although three times as many girls than boys (6:2) did attempt to use logic to solve some of their problems. The boys had a slightly higher level of manipulative skill with handling the pieces and fitting them together

None of the children were able to describe the process by which supermarket checkout operators identified the cost of groceries. Two boys and one girl believed a computer was involved, but had no inkling of the role of the bar code reader. One boy (Chris) said "The lady scanned it with a scanner", but he didn't know what was scanned. He accurately described the scanning action and the "beeping" noise made as the item was scanned. One boy and one girl spoke of numbers on the groceries but were not aware of what they meant. Most children seemed to believe that the checkout operator had all the prices in her head and made up the final figure.

The children were also asked what they thought happened to the rubbish when it was collected from their gate, and if it was possible to make less rubbish, or to do other things with it. The majority of girls believed the rubbish was put in a big bin of some description, only two girls were aware of the concept and nature of a rubbish dump. Eight of the boys were very clearly aware of the nature and use of rubbish dumps, and three of them had actually been to a dump with a male adult. No child was able to talk about recycling, conservation or means of reducing rubbish.

Technology education in practice

The first formal technology unit was delivered in a four-week period beginning in late May. The unifying curriculum theme for the term was Hobbies, and the technology unit was focussed on creating and making games and puzzles to use in the classroom.

The second technology unit was delivered from late August to mid September. The children had visited the Auckland Zoo two weeks previously as part of their science unit on birds. During the visit their attention had been directed to a range of bird feeders and nesting boxes within the various enclosures. The unit was focussed on designing and making a bird feeder or nesting box to be placed in the school grounds.

Discussion of learning

A number of distinctive learning patterns have emerged as the children have undertaken the two technology units, some of which fit with behaviours identified in the literature, and others which seem to differ from them.

Drawing the design for their games was done enthusiastically but the children did not possess the necessary drawing or writing skills to produce recognisable plans (Anning 1993, Rogers & Wallace, 2000), and needed the help of an adult to articulate the meaning of their plans. However, later in the year they showed a good understanding of the advantages and drawbacks of the various materials available to them to construct their bird feeders/houses. Their designs for their structures were more detailed and more focussed than the design work in unit one. Although one group of girls asked the teacher for their design of the bird house and made an unsuccessful effort to follow it, none of the other children referred to the initial design in either unit (Anning, 1997, Welch, Barlex, & Lim, 2000). During the unit on bird feeder and birdhouses the children were introduced to techniques of drawing in three dimensions. As an introduction some photographs of similar structures taken during the zoo visit were mounted on large sheets of cartridge paper, and drawings of front, side and isometric views were drawn onto the paper around

them. The different methods of drawing were explained, and the children discussed how these types of drawing could help people when designing things. The sheets were then left on the wall for the children to revisit if they wished. At two-week intervals four different ways of drawing isometric figures were modelled for the children and they then drew a three-dimensional cuboid using the same method that had been modelled to them. Although it has been suggested that children this age cannot draw in three dimensions (Stables, 1997) by the end of the sessions the majority of children were well on the way to producing reasonably consistent three-dimensional images. This would appear to support recent suggestions that children's drawing skills may be more fluid and adaptable than had been previously thought and that with the right modelling by teachers and exposure to examples of the various drawing genres used for designing, young children may be very capable of drawing designs and using them as reference points in their making activities (Fleer, 1993, Fleer, 2000, Hope, 2000) .

The children worked in a much more collaborative manner than was expected (Stables,1997). In both units children were given the opportunity to either work by themselves or in groups of their own choice. With regard to designing and making the classroom games there was one group of four, two groups of three, one group of two, and four children who worked as individuals.

The single sex groups worked collaboratively with a good deal of early discussion and common effort. In all of them a leader soon appeared who led the development of the final concept. The groups remained focussed and did not look at what other groups were doing. There was however a greater degree of discussion and shared decision making in the girl groups than in the boy groups.

There were two boy/girl pairings and they worked together quite differently. There was a good discussion and interaction between William and Anna, both taking the leadership role at times. They developed one of the more complex, successful games which had some degree of sophistication to it. Ted and Mary also worked together and Ted took charge right from the start, doing virtually all of the designing and making with Mary

acting as the labour. The key difference was clearly the personality of the girls involved. Anna is a very assertive, physical girl who normally plays with the boys building with the blocks during choosing time and she often assumes the leadership role during these activities.

Apart from one girl, (Jenny) the individuals produced the least complex games. Jenny worked in a much more evaluative manner than any other individual or group. She was very focussed the whole time and stopped to stand back and reflect frequently, looking at other games for ideas and play testing her game as she added each new element to it. She developed the most complex arrangement of tunnels and obstacles.

During the unit to design and make a bird feeder or nesting box, twelve children chose to work in groups of three, and six children in pairs. Only one grouping, a pair had mixed gender. Anna, the dominant girl in the class was again the female involved. Five children, (4 boys, 1 girl) chose to work by themselves. Three of these five finished in the first session and then chose to work cooperatively with other groups in the next session. One pair of girls deliberately chose to split up so that one of them could join two of their friends who needed help with their making. One pair of girls and two individual boys had not produced anything substantial after the first session. This was mainly due to them attempting structures, which were beyond their skill levels, or not feasible given the limitations of the materials and tools they had to work with (Fleer, 2000). All children, including those who achieved little of substance worked solidly and concentratedly on task for the whole hour. The making phase occupied three one-hour sessions and the same patterns as in the first unit emerged. Groups produced more complex products than individuals, girls designed and made in a more cooperative manner than boys.

For the children designing and making was a collaborative, iterative process. For most of the time designing was done orally and mentally with each decision being physically carried out, discussed and evaluated before the next decision in the making process was

made. The product was always a “work in progress”, not a product being made to a pre-conceptualised design (Kimbell, 1996,Welch et.al. 2000).

As the children’s ability to use language to clarify and explain their ideas developed during this first year at school, so did their ability to design and problem solve (Medway, 1994). In both units the children were given the opportunity to talk to the rest of the class after the first ‘making’ session about what they had done and how they were going to proceed to next ‘making’ session. In unit one, after being given an opportunity to play with their games and talk about how well they worked a number of children went back and modified them. In unit two the children talked to the class about what they needed to do, and what had worked and not worked the previous session. All the children were able to clearly explain how they intended finishing their structure and talk with some understanding about the problems they had faced. As a result of what they had seen and heard, four groups changed their design and produced A-framed structures. Once the majority of children had finished their structure they were asked to self evaluate their process and final product. They were able to describe how they had used different materials and joining solutions to overcome problems, identify weaknesses in their final solution. It is clear therefore, that these sessions not only gave the children time to reflect on what they were doing, it also had major impact on the designing process itself.

This developing language capability also had an impact in developing the children’s technological knowledge and understanding, and their understanding of the relationship between technology and society. The following examples illustrate this growth of understanding. At the conclusion of the games unit the children were able to talk quite perceptively about their understanding of games and the reasons why people play them.
At the beginning of the bird feeder/bird-house unit after inspecting the school grounds, the children were able to clearly identify the preferred nesting/feeding situations and discussed with good understanding the need to protect the birds from predators such as cats, dogs, and people. Following a discussion of the social context of birds and the technologies associated with them, they were asked to design a birdcage suitable to keep a

bird in the classroom. In almost every case the cages were designed in appropriate materials, with thought given to the provision of food and water, and secure access to the cage for dealing with the birds needs. The final session of the unit was aimed at getting the children to identify some impacts of technology on bird life. The children were asked to categorise eight pictures into good impacts and bad impacts and explain their choice. In all cases they placed the pictures in the right category and gave valid reasons for their choice.

As might be expected at this age the children's own physical skills constrain their ability to transform their ideas into concrete reality (Fleer, 2000). As the children developed physical maturity during the year they were able to cope with a wider range of tools and materials. This was particularly noticeable with the girls. Prior to the bird house unit the children had done a similar design and make task, building boats earlier in the year (March) for which the same range of materials had been available to them. In that instance all the boys had chosen to use wood, but only one girl chose to work in wood, the other twelve choosing cardboard. When making the bird structures all the children chose to work in wood, and the girls showed a great deal of pleasure and pride in their ability to use the wood working tools competently.

Discussion

These children entered school with quite rich early childhood and home experiences. They had well-developed social skills, and because most had attended the same kindergarten they had developed cooperative work patterns. They were confident in using a wide range of electronic technologies and had highly developed manipulative skills. The boys did have a wider experience with working with wood, and the associated tools, and had a different preferred learning style than the girls. As a group they lacked problem-solving strategies and were not used to persevering in the face of difficulties.

During their first year at school their technological literacy has developed in a number of areas. The girls have shown themselves to be as ready to use wood and as competent in

the use of the tools as boys in situations where they are engaged by the purpose of the task. Almost invariably, more appropriate technological outcomes have been achieved where children have worked collaborative rather than as individuals. Where mixed groups have worked it appears that the girl becomes marginalised unless she has a strong personality and acknowledged leadership roles in the classroom. Design work has become more focussed, with greater awareness of appropriate materials and less irrelevant ornamentation. Awareness of three-dimensional views is developing and some indications of this are appearing in the drawings. However little reference is made to these designs in the making phase.

The children have also been able to recognise the needs of specific 'clients' and to pursue appropriate solutions. They have been able to formulate a range of possible solutions and evaluate and modify these in the light of reflection during the making process. They have also been able to describe their own technological practice and offer justifications for decisions made as part of it. There is less evidence of a development of conceptual knowledge in areas such as understanding of technological principles or the use and operation of everyday technologies. A greater understanding of the children's learning in these areas may emerge with a more intensive examination of the data obtained.

Comments welcome
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