Where do I start? Technology in early childhood.

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Introduction

This paper begins by briefly considering the place of teacher domain knowledge in early childhood education. It then examines current views on the nature of technological knowledge and goes on to explore the implications of this for early childhood educators. The technological knowledge and understanding needed by early childhood teachers if they are to effectively support learning in technology is discussed, and some foundational areas of knowledge are identified. Finally some possible teaching approaches are examined, using examples from New Zealand early childhood settings.

The importance of early childhood teachers having domain knowledge is now well established. It was identified as one of the seven pedagogical principles of quality teaching in early childhood settings (Farquhar, 20003) and is one of the four specific areas of focus in Round Two of the Ministry of Education's ECE Centres of Innovation strategy (Ministry of Education, 2004). There has been an increasing call for early childhood educators to increase their subject content knowledge and to move to a constructivist pedagogy (Backshall, 2000; Cullen, 2003; Fleer, 1993; Garbett, 2003; Garbett & Yourn, 2002; Hedges, 2000, 2003; Rodd & Savage, 1997). Hedges (2004) suggests that a lack of emphasis on subject knowledge can no longer be justified in early childhood education in New Zealand.

There is a fear that focus on subject knowledge will undermine the approach of early childhood education. Traditionally the knowledge base of early childhood teachers was focused on material from the child study movement and developmental psychology, and content knowledge was not valued. Experiences in mathematics, science, and technology have been regarded as less critical to children's development than play based experiences. This has been related to prior negative experiences and a lack of confidence in their own knowledge in these areas by many early childhood teachers (New, 1998). Certainly teachers have an important role in influencing children's dispositions toward learning in these areas.

Technological knowledge

Currently, there is debate among technology educators in New Zealand as to the nature of technological knowledge. The New Zealand Technology statement (Ministry of Education, 1995) saw technological literacy as being composed of three strands, technological knowledge and understanding, technological capability and the relationship of technology and society. The team involved in the Learning in Technology Education – Assessment (LITE) project commissioned by the Ministry of Education (1999-2002) saw technological literacy as having four components, conceptual knowledge, procedural knowledge, technical knowledge, and societal knowledge (Moreland, Jones & Chambers, 2001). This knowledge was seen as existing in two spheres, either as generic across most contexts, or context specific. The LITE team has not produced a list of generic knowledge at this point in time. Compton (2004) has challenged these previous views of the nature of technological knowledge. She questioned the Technology Curriculum's categories of technological knowledge, pointing out much of the defined knowledge was not specifically technological, and was equally applicable to other domains such as science. Compton makes a distinction between knowledge of the natural world (Science) and knowledge of the material world (Technology). Compton's views of the nature of technological knowledge are reflected in the Draft Essence Statement for Technology (Ministry of Education, 15/4/05). In this draft document, technological knowledge is identified as one of the three organizing strands of the Technology Curriculum. Device knowledge is seen as focusing on knowledge about technological artifacts, models and abstract concepts. System/process knowledge focuses on understanding the way things work together as part of an overall outcome and an understanding of how things function. Other forms of technological knowledge identified in the Essence Statement are resource knowledge and understanding the social and physical environment of any technological development or site. Also in line with Compton's paper, a new component of technological literacy, the nature of technology, is given as another organizing strand in the essence statement. While Compton has identified these categories of technological literacy, the specific knowledge and age appropriate level of understanding for progression in technological literacy has yet to be addressed.

The lack of consensus and clarity among technology educators makes the identification of appropriate domain knowledge for early childhood teachers somewhat problematic. However, using the broad definitions in the draft essence statement, and focusing on the activities that currently occur in early childhood settings, some fairly essential teacher technological knowledge can be identified. One question that needs to be addressed is the tension between breadth of knowledge and depth of knowledge. How much subject knowledge is enough? Technology is such a vast subject, covering practically every aspect of everyday life that no person can be expected to know all, or in fact, very much of the knowledge available. For much specialized knowledge early childhood educators will do the same as their colleagues in the primary, secondary, and tertiary sectors, which is to go and ask the experts. In this article I will focus on the foundational technological and procedural knowledge relevant to the early childhood settings.

Technological practice may be considered as unique in its dependence on the combination of both conceptual and procedural knowledge for success. Therefore early childhood teachers need some knowledge of the particular way in which we go about technological solution finding as well as the conceptual knowledge outlined in the draft essence statement.

Function is the key idea relating to knowledge of devices, systems and processes. Technological practice is focused on achieving the most appropriate functional solution to the particular task in hand. Teacher knowledge of devices would support the tasks and activities that children and teachers undertake in early childhood settings. The devices it would be relevant to have knowledge of are those that are a central part of a child's daily life and about which they may be curious, or those that children may use in an early childhood setting.

Devices that fall in the first category include electronic media, motor vehicles, sewing machines, microwaves, refrigerators, bridges, cranes, and the supermarket checkout.

Knowledge of the basic operating systems of these elements would allow teachers to both answer children’s questions and ask children the provocative questions that will engage children in learning.

A second area of essential knowledge involves understanding of how elements of a system connect and work together to achieve the desired outcome. The three most important aspects are the development of mechanical systems (using gears, levers, pulleys, cams, and linkages), hydraulic systems, and simple electrical circuits. Allied to this is knowledge of the various structural elements used in buildings, and an understanding of the forces that act on them.

Resource knowledge also has some obvious areas of importance to early childhood educators. Knowing which is the most appropriate material (wood, metal, fabric, cardboard, etc.), joining and fixing methods (nails, screws, glue, needle and thread, sellotape, etc.), tools to use, and knowing the techniques appropriate for the use of the particular resource is important.

There is also some knowledge pertaining to the social and physical environment that is important domain technological knowledge. This includes knowledge of health regulations, hygiene and safe food handling and storage procedures and basic good nutritional practices. The practices associated with environmental protection and sustainability of resources is also of significance.

Developing critical thinking about technology

Technology is not value free, and every technological development has both positive and negative impacts on people. An essential element of technology education is to allow children to critically examine the place of technology in their own lives. The opportunity for early childhood educators to talk about the values underpinning the modern technological world is present whenever children play, or undertake more structured teacher-initiated activities. There are two distinct types of technological values, which early childhood educators should be aware of and discuss as opportunities emerge in children’s play. The first of these relate mainly to the capability side of technological practice and are the values, which underpin the concept of a quality product. Among those, which could be introduced to children in early childhood settings in a meaningful way at the appropriate time, are efficiency, usefulness, stability, user friendliness, reliability, dependability, consistency, and fitness of use or purpose. These 'functional' values naturally emerge within children's play, but it needs teacher technological awareness in order for these to be made explicit to the children. A particularly good way to do this is to look at items the children use in the centre and discuss what they are made of, how they are made, how well they work, how easy they are to use, and how they might be improved.

The second set of values is related to 'critical' technological literacy and their introduction might need to be planned for. However, I believe the ubiquitousness of technology in modern life and the impact it has on children's experiences of the world make this an appropriate teaching and learning activity in early childhood. These values are more general and more open to question than those associated with function. At the early childhood level I would see the concepts of social responsibility, sustainability, environmental protection and eco-design, consumer protection and consumer education as being appropriate for discussion.

The first three of these values have clear links with Goal Four in the Exploration strand in Te Whaariki, and the last can be linked to Communication. They are an integral part of developing a relationship with the environment, of developing respect and a sense of responsibility to the environment and learning how to care for it. There are a number of very important concepts in these areas, which can be treated in terms relevant to the lives, and experiences of young children. Basic ideas about recycling can be addressed at mealtime or during cleaning up. The worm farms and composting systems, which are such a feature of early childhood centres, provide concrete examples that can be used to start these discussions. Sustainability can be dealt with when talking about the materials on the carpentry table or when looking at other artefacts in the centre. Getting children to think about what happens to the waste materials they create on a daily basis can lead to discussions about reusing some materials and using materials in ways which produce less waste. Discussions about how to look after and improve their own centre environment can begin the process of developing awareness of the need to protect the environment. Such discussion can also give children a sense of ownership and control of their environment. This sense of control is an essential component of developing a generation who are able to make reasoned choices about the society they wish to live in and the technologies they will use to achieve this.

These values, which are inherent within all technological development, can also be introduced through the choice of stories to read to children, discussion of children's television programmes and popular culture, and teacher comment on current environmental issues events. The key once again is the teacher's own awareness of the issues and a commitment to allowing young children the opportunity to grapple with these ideas.

The conceptual knowledge outlined above represents only one aspect of the domain knowledge associated with technology. Technology is not only a way of knowing, it is also a way of doing, and hands-on practical procedural knowledge is an essential element of technological literacy. An understanding of the basic components of technological practice enables early childhood educators to enhance the learning experiences of the children in their centre.

Enhancing children's technological practice

Technological activities provide a particularly fertile area for children to develop their metacognitive strategies. Metacognition develops when children are encouraged to reflect, predict, question, and hypothesize. Epstein (2003) believes that we can promote this by providing children with the opportunity to plan and reflect. Planning is choice with intention, the chooser begins with a specific goal or purpose in mind that results in the choice. Planning goes further than selecting from open-ended choices, it involves children identifying their goals and considering the options for achieving them. For example, they might consider what they will do, where they will do it, what materials they will use, who they will do it with, how long it will take, and whether they will need help. Planning thus involves deciding on actions and predicting interactions, recognizing problems and proposing solutions, and anticipating consequences and reactions.

Reflection is remembering with analysis. We encourage children to go beyond merely reporting what they have done. We also help them be aware of what they have learned in the process, what was interesting, how they feel about it, and what they can do to build on or extend the experience. In this way their tacit knowledge, the “know how” of experts is developed. Reflection consolidates knowledge so it can be generalized to other situations, thereby leading to further prediction and evaluation.

Technology is always a planned purposeful activity, and a key element for early childhood educators is to assist children to make explicit their own planning process in the activities they are developing. An understanding of the technological process allows early childhood educators to achieve this goal. Compton and Harwood (2004) have identified three components of technological practice that they see as being common to all school technological activities, and these provide a useful starting point for early childhood educators also.

The first of these components is brief development. This is the progressive development of the description of a desired outcome and its desired attributes or specifications. This description is refined as the nature of the need or opportunity becomes more clearly understood. In the early childhood context this is represented by children communicating what they are developing and what they hope to achieve. The role of the early childhood educator is to provide an environment that encourages and supports children’s exploration and to assist the children to articulate their aims and intentions. This may be achieved by asking pertinent questions, listening attentively to children’s plans and encouraging children to elaborate on them. To assist children to reflect on their practice it is useful to work with the children to document their plans. An important part of the planning process at this level is to make sure children can see the areas and the materials in the room when they are planning, as this helps both to make them aware of the resources and materials that are available to them, and keep their planning to what is feasible and practical.

The second component is planning for practice. In early childhood settings children should be encouraged to talk about what they have done, about what they might do next, and what resources they will need to achieve their goal. Early childhood teachers can encourage and support this process by commenting on what you see the children doing, by recording what children say, by referring back to their plans and encouraging them to explain how and why they have changed as they worked to achieve their goal.

The final component of practice identified by Compton and Harwood is outcome development and evaluation. In the early childhood setting children will achieve some outcome, and the important aspect of this is to give children the opportunity and time to discuss their own and other children's outcomes.

Planning to encourage technological activities in early childhood settings

In situations where children's technological activity is arising from spontaneous play activities the key educator's role is to ask open-ended questions that encourage children to talk about their plans and to listen attentively through a technology lens to what the children are saying. A key task is to provide resources that will encourage technological activity. There are a number of ways to start this process. For instance;

- Have a good look at your current resources. Are the tools sharp? Is there a wide range of tools? Are the materials appropriate and manageable? What other materials could you add? Are there a range of easily moveable objects in the outside area? What methods are available for children to fix, join, combine and reshape materials?
- Put paper and drawing materials in the block corner, next to the carpentry table, by the sandpit and encourage children to draw their ideas before and after making them. Put blocks and other construction materials in the book corner and encourage children to build structures they see in the books.
- Set up a worm farm, hydroponic, or composting system for the children to look after.

In more teacher-directed child-centred situations, more formal planning can take place. These situations may develop from a number of starting points. There are a number of documented examples of children's technological practice in early childhood settings that provide an insight into both content and pedagogy. The videotape *Exploring technology with children* (Video Campus, 2001) provides two examples. In the first, a child had become absorbed in the renovation work being carried out in his home and this became a central theme of his talk at Kindergarten. The teachers seized the opportunity given by his desire to build his own house and provided the tools, materials and 'professional advice' that allowed him to begin the project. Very soon a number of other children became involved and the complexity of the design escalated as windows, 'wiring', an electric doorbell, insulation, furniture and a garage were added. The making of a pressure operated electric doorbell for the house provides a good example of how taking advantage of a child's interest can lead to longer, more intense learning experiences. In the initial discussion with the girl who wanted to make the doorbell the teacher brought the discussion around to the various ways that doorbells can be operated. From that discussion came the decision to include, as part of the circuit, a switch that turned on when someone stood on it. A joint exploration of appropriate books produced a plan to make a pressure switch. With help the child was able to follow the plan and construct a working switch and circuit.

The second example from the video documents how an initial activity of sewing buttons onto cloth was developed into a project making skirts and tops which culminated in a fashion show for the parents.

Carr (2000) has described the way in which young children acted as technologists in a hat-making activity. There were six children who spent significant periods of time on the activity. The shape of the cardboard and the means available to make strong joins largely determined the design of the hats, and these artifacts posed several technical challenges that the children needed to overcome with regard to measurement, alignment, fitting and joining. The children tended to work alone, using trial and error to solve technical problems and persisting in their efforts to achieve success. Help was asked from adults when needed, particularly with measuring and fitting difficulties. Very rarely did adults take the initiative in the process.

The early childhood exemplars (Ministry of Education, 2005) contain a number of examples of children working technologically. Most of the activities are child-initiated. *Aminiasi sets himself a goal* (Ministry of Education, 2005, Book 2, p.8-11) shows the child setting his own task of making a kite, asking for help when he needed it, reading books for information, discussing his process and persisting when faced with setbacks, and making choices about shapes and materials. The teacher's role was to provide the materials, support him by perceptive questioning when he faced setbacks, and reassuring him of his ability to complete the task.

Vini similarly set the task with his wish to make new slippers for his mother (Ministry of Education, 2005, Book 5, p.8-9). He makes choices of materials and shapes, and overcomes problems with cutting and joining, again looking for teacher assistance which is given only when asked for.

The Mosaic Project (Ministry of Education, 2005, Book 2, p.22-23) documents the process of a group of children working together on mosaicking concrete pavers for the outdoor environment in their centre, and then moving on to mosaic a pot, a tile, or a picture frame. The activity was teacher-initiated based on observation of children's interest, and had a high parent involvement. Another example of a teacher-initiated activity based on children's observed interest and using parents concerns the making of pizza's (Ministry of Education, 2005, Book 7, p.30-31).

There are a number of planning activities that help to initiate long-term projects and to maintain the impetus over time, once the initial children's interest has been recognized. The first step is to be familiar with a range of potential learning experiences that naturally relate to the focus of interest. For each of these potential learning experiences a number of steps can then be taken. These are to document:

- The resources (people, materials, tools, teacher knowledge etc) that would be required to support the children's learning;

- Teacher questions which would scaffold/enhance children's learning/understanding;
- The potential technological learning (knowledge/capability/understanding) inherent in the experience;
- Potential learning in other curriculum areas; and
- The appropriate assessment strategy/method to recognize the learning occurring.

Not all the potential learning experiences will necessarily take place, as children's interests may take the project in unexpected directions, or the teacher-originated activity may not capture the children's interest. It is difficult to develop longer-term, in-depth learning however, if the groundwork planning has not been done.

Conclusion

Early educators have a responsibility to teach (Cullen, 2003). The basis of this is close observation of children and the recognition of the learning that is occurring and of the potential learning that will occur with support from the teacher. This recognition of potential learning is dependent on teacher knowledge, and an important element of this is domain knowledge in areas such as technology, science and mathematics. Technology is a slightly problematic area for early childhood educators, firstly because the domain knowledge is both wide and not well-defined, and secondly, because it also includes knowledge of process as well as content. This article has addressed the foundational knowledge that would allow early childhood educators to recognize the technological learning that is occurring in their centres and has offered some suggestions as to how this could be enhanced through thoughtful resourcing and longer term planning. Technological activities provide the perfect vehicle to achieve the important longer term, sustained projects that are seen as necessary for children in *Te Whaariki* (Ministry of Education, 1996, p.26). This requirement for children to experience long-term projects is reinforced throughout the curriculum document, for example that the "programme provides opportunities and encouragement for children to develop their own interests and curiosity by embarking on long-term projects that require perseverance and commitment (P.69). The challenge for us as early childhood educators is to develop our own knowledge so that we can provide these opportunities to our children.

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