>INTRODUCING TECHNOLOGY EDUCATION: USING TEACHERS' QUESTIONS AS A PLATFORM FOR PROFESSIONAL DEVELOPMENT

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Paper presented at the Annual Conference of the Australian Association for Research in Education

29 November to 3 December 1998

Adelaide, South Australia

Abstract

The recent introduction of technology education in the primary school sector has been a topical one as teachers and school systems wrestle with understanding its practical and theoretical implications for learning and teaching. This paper explores the issues and concerns identified by a small group of teachers implementing technology ideas using the national document, A Statement on Technology for Australian Schools (Curriculum Corporation, 1994a) through four questions they posed as a result of reflection upon their existing ideas and practices. Early in the study, the teachers asked four key questions which they identified as important and which framed their later experiences as the study progressed. The case study of one of the teachers is used to illustrate how the teachers implemented technology education working from their own perspectives and tackling issues that made sense to them. By reviewing the teachers' own questions about technology implementation, it is becoming clear that what may be important for professional development in technology education is related to the questions that the teachers themselves are asking about their own beliefs and practices.

Introduction

The last five to seven years have seen a large increase in the introduction of technology education programmes in the primary schools. An overview of past changes and future plans in this area around the world has been provided by Layton (1994) and Williams (1996). The rationale for the introduction of technology programmes spans the gamut of economic, social and educative reasons (e.g., Stables, 1997). For many primary school teachers these types of reasons may seem sustainable, but rather theoretical and ideal, and not necessarily practical. The difficulties that have been experienced, for example, in England and Wales (Shield 1996a, b) may be due to this lack of acceptance by teachers of the value of technology for primary school students - a predictable occurrence, especially in cases where the introduction has been a "top down" directive. Lack of direction and knowledge about the learning area has resulted in difficulties for teachers expected to enact the new addition to

the curriculum (Anning, 1994; Lindblad, 1990; Stables, 1995). Research into, and reflection upon, the practical experiences of the teachers has been worthwhile, of course, in helping to develop technology curricula that are more suitable for primary school conditions and situations. Perhaps the reasons have been too broad and teachers have had difficulty breaking these down into coherent, practical reasons for themselves.

In countries such as England and Wales, and New Zealand, technology has been introduced on a national scale (Department of Education and Science and the Welsh Office, 1990; Ministry of Education, 1995). In Australia, introduction is happening nationally, too. However, the states and territories of Australia are independent as far as education is concerned. Whilst this independence has led to variations in schooling across the country, there is agreement, or national collaboration, upon the implementation of eight key learning areas, technology being one, in so far as the philosophical framework is concerned. This philosophy is expressed in A Statement on Technology for Australian Schools (Curriculum Corporation, 1994a) which is a broad based document that presents an overall conceptualisation of technology and technology education and a framework for action in the production of syllabi.

The national collaborative approach to curriculum development in Australia is also an outcomes based approach. A companion document entitled Technology - A Curriculum Profile for Australian Schools (Curriculum Corporation, 1994b) listing outcomes considered typical of learners experiencing input based upon the national statement has also been produced. While national collaboration on curriculum means that all states and territories will write documents within the frameworks of the national statements, the profile document is intended only as a starting point. As technology curricula are being implemented in various places across Australia, varying forms of outcome statements are emerging as individual states and territories place their respective emphases on the national document (Francis & Holt, 1997). For one state, Queensland, the formal introduction of technology education as expressed in the national statement is imminent. Government schools in the state have been introducing the learning area in low key and informal ways, but not all teachers have been involved. Non-government schools have not necessarily begun to contemplate the introduction at all.

In recent years, a variety of issues relating to technology education for students in the compulsory years of schooling have been identified and documented. Such issues include those related to: the nature of problem solving in technology, (Hennessy & McCormick, 1994; McCormick, Murphy, Hennessy & Davidson, 1996; Roth, 1995); the role and meaning of design (Chidgey, 1994; Davies, 1996; Johnsey, 1995; Roberts, 1994; Saxton & Miller, 1996); the learning of specific practical and tool skills (Anning, 1994, 1997); planning for appropriate technology learning experiences for students of varying needs and levels (Fritz, 1994; Kimbell, 1994; Stables, 1995); teachers' and students' understanding of the concepts of technology and technology education (Aubusson & Webb, 1992; de Klerk Wolters, 1989; Hall, 1996; Hendley & Lyle, 1996; Jones & Carr, 1992a, b; Mittell & Penny, 1997; Rennie & Jarvis, 1995; Rennie & Treagust, 1989); the meaning of technological capability (Jones, 1997; Kimbell, Stables & Green, 1996; Sage, 1996); the place and meaning of technological literacy/critique (Barnett, 1995; Bensen, 1991; Dyrenfurth, 1991; Lewis & Gagel, 1992; Prime, 1993); exploration of the nature of classroom activities, student interaction and learning (Fleer, 1992; Jane, 1996; Ritchie & Hampson, 1996); and state and country-wide innovations and local implementation projects (Black & Atkin, 1996; Williamson & Cowley, 1995). These and other documented experiences will be a valuable guide to technology curriculum development in Queensland. The general situation remains, however, that there are many primary school teachers in Queensland who have had little opportunity to think about the new key learning area, and yet, they will be expected to begin working with a new syllabus on technology when it becomes available in one or two years' time. Teacher change

and subject change will feature in this development, meaning that it will be important to consider teachers' own perspectives in such a move (Black & Atkin, 1996; Shield, 1996a). Thus, the nature of the profession development to be provided will be crucial.

This paper reports on the findings of a study that aimed to examine the developing understandings of technology and technology education experienced by three teachers of primary level classes as they introduced technology, deriving their ideas from the broad framework presented in A Statement on Technology for Australian Schools (Curriculum Corporation, 1994a). From the outset the teachers had to grapple, not only with understanding technology as an entity in itself, but also with what that meant in terms of the strands of the national statement, namely, "designing, making and appraising" (the "process" strand), and "materials," "information," and "systems" (the "content" strands).

Working from this broad framework document, which is not very specific in terms of giving direction for classroom practice (it was designed for curriculum developers), caused difficulties for the teachers, but only in so far as it did not give a strict, orderly direction that more teacher-oriented documents usually provide. This is because the document is not a syllabus, but a comprehensive statement or framework for the key learning area. Yet, because of this feature, the teachers were free to conceptualise technology education within the breadth of the framework and allowed, therefore, to tackle problems as they arose in the light of their own needs, and classroom contexts and events.

An overall outcome of the study was to identify, in the light of documented research experience elsewhere, possible issues in relation to professional development for the Queensland situation. The specific questions addressed in this paper, however, are:

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What were the teachers' prior understandings of teaching and learning, technology, and technology education?

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What were the concerns about technology and technology education expressed by the teachers and demonstrated in their classroom practice during the study?

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How did the teachers attempt to address their concerns in their classrooms?

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What implications can be made about the professional development of primary teachers in the learning area of technology?

Research Methods and Data Sources

The study took place over a twelve month period beginning in July 1997 and ending in June 1998. It was set in a Catholic co-educational primary school in an agricultural, rural community, approximately 100 kilometres from Brisbane in southeast Queensland, Australia. The school had an enrolment of approximately 180 students in Years 1 (5 year olds) to 7 (12 year olds).

The overall study employed an interpretive design (Erickson, 1986) in which a hermeneutic dialectic process (Guba & Lincoln, 1989) framed the learning and interpretation of the interactions and experiences of those involved. In such a study, as data is gathered, what is learned about the context and the participants, is informed by what is already known about them. In this way, theories about the participants' experiences develop and build throughout the period of interaction. The study was informed also by collaborative action research methodology (Grundy, 1995; Oja & Smulyan, 1989) in that a high priority was placed upon the four teachers pursuing answers to their own questions, in collaboration with an outside researcher. As a consequence, the structure of interactions with the teachers was such that in cycles, they asked questions about their practice and knowledge of technology education, made plans for action in the light of those questions, carried out their plans and reviewed outcomes, and then, to begin a new cycle, asked further questions.

Data sources were:

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interviews with teachers and students. These interviews were audio taped and transcribed.

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teacher responses to the Writing/drawing Activity, Picture Quiz and Technology Questionnaire developed by Rennie and Jarvis (1994) to elicit some notion of the their conceptions of technology.

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field notes and video recordings of technology lessons.

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field notes and audio recordings of planning meetings held with the teachers during which lessons were reviewed and plans for future technology sessions were made.

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field notes of significant conversations and experiences.

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artefacts including student writing, models made in technology lessons and teacher writing and lesson plans.

Participants

The participants, who volunteered to be part of the project, were three upper primary school teachers: (pseudonyms) Mary (Year 4), John (Year 5 in 1997 and Year 7 in 1998) and Ann (Year 6). The researcher (the first author), who initiated the project, visited the teachers and their classes weekly throughout the period of the study ensuring that contact was consistent and continual (Guba & Lincoln, 1989). The chief role of the outside researcher was to work as part of this team of teachers at the school to "walk with them" as they introduced technology ideas in their classrooms and to document the developments and understandings of the teachers along the way. According to Jones, Mather, and Carr (1995),

professional development in the area of technology should include reflection on one's own and others' conceptions of technology, on pedagogical knowledge and upon technological practices. In order to include opportunities for these experiences to happen, teachers participated in discussions and planning of technology lessons, and reflected on their developing thoughts about technology and technology education. The outside researcher, taking the roles of interpreter and facilitator as well as participant, involved herself in these discussions, provided information of her reading of current literature in the area when requested and at appropriate times within discussions, and also provided resources for the teachers to use for their lessons. She observed the technology lessons implemented by the teachers, making field notes, and videotapes along the way. In addition, the outside researcher interviewed the teachers on at least two occasions, as well as a small group of students from each year level.

Analysis

Analysis of the video taped and audio taped data was undertaken principally by the researcher as soon as possible after each interaction. The teachers were involved in the analysis in terms of reviewing their own actions and thoughts and sharing these within discussions (Guba & Lincoln, 1989). The analysis was ongoing, therefore interpretations about changes and developments about the teachers' thinking and practices occurred continually, one interpretation building upon the next, one answer leading to another, one question leading to a further one. This approach, which is similar to the approach described by Muralidhar (1993), facilitated the ongoing development of theories about the beliefs and practices of the teachers as they worked with and experienced technology education. Member checks and peer debriefing occurred continually and as a matter of course (Guba & Lincoln, 1989), enabling the action research format - of asking a question, planning for it, enacting the plans, reviewing the actions and planning for further action - to take place. This continual analysis meant that all participants, including the outside researcher, were able to contribute to the ongoing movement of plans and actions, together.

Findings

This section consists of two parts. The first part presents the four questions identified by the teachers in the study. The questions represent a summary of the teachers' concerns and needs in the light of their experiences of having implemented technology during the twelve month period. To illustrate the origins of the questions, one teacher's views and experiences will be examined closely in a case study. This will form the second part of this section. The case study is a synthesis of evidence drawn from the various data sources and provides a background against which the developments in the thinking and action of the teacher, Ann, can be set. This background is also a prelude to a discussion of how the questions played a role in Ann's implementation of technology and to a consideration of implications of her experience for professional development.

The Teachers' Questions

Early in the study important issues for the teachers began to emerge. The issues and concerns were summarised into four key questions, which became the foci for thought and discussion as the study continued.

1.

What are the children learning?

This concern was expressed in terms of a need to be able to label specific skills and content that children had learned during a technology experience, in order to be able to make assessments of the children's performance and to be able to set new objectives for further interactions. The teachers placed importance upon wanting to know that their pupils left their classrooms with enhanced technology knowledge. The teachers wanted to be able to plan for the teaching and assessment of that learning.

2.

Is technology a unique learning area?

The teachers' discussions repeatedly led to asking how technology is different from other learning areas. As they thought about it, there seemed to be many recognisable elements, but plenty that was different to anything they had done before. Thus they faced a dilemma in identifying what was technology and what was not technology, in particular as they attempted to integrate technology with other learning areas.

3.

How do you plan for and structure technology activities?

This question's focus was upon the practical and technical aspects of implementation including planning for and teaching technology lessons in classrooms. In order to provide answers, the teachers attempted a number of strategies throughout the period of the study. These strategies related to the overall structuring of activities, the grouping of students, the establishment of authentic technology contexts, and the support for both design processes and appraisement of technological products and processes.

4.

How can technology fit into an already packed primary curriculum?

This was of particular concern for the teachers at the start of the project. As they experienced technology education in their classrooms they began to work out ways for themselves that technology could be included in their programmes. To do this the teachers had to wrestle with their personal understandings of teaching and learning as well as with their developing understandings of what technology education was all about and its value as part of the primary curriculum. An early dilemma was "What will have to go in order to fit technology in?"

The Case Study of Ann

This case study of Ann (Year 6 teacher) serves to illustrate the role played by these four questions in the way the teachers thought about and enacted technology education during the twelve months of the study. The prominence the questions played varied and changed as the time progressed, in response to discoveries the teachers made, and the meanings they placed upon their experiences.

This case study includes some background information, a description of Ann's approach to teaching and learning and an overview of her understanding of technology and technology education at the start of the study. The case study also includes a description of the technology education lessons she implemented during the study. Links between her actions and thoughts and the teachers' questions above are indicated in parentheses by reference

to the relevant questions. Codes used throughout the rest of the paper, such as (T10a: 23-25) and (Vid Seq An) are data storage references.

Personal description, experience, background

Ann taught Year 6 for the whole of this study. During her 33 years of teaching, she had also taught Years 1, 2, 3, 4, and 5. Apart from her first teaching qualification, Ann had also gained a Bachelor of Education Studies and Advanced Skills Teacher 1 status.

Her 1997 Year 6 class was made up 27 students (15 girls and 12 boys) and her 1998 class, 19 (5 girls and 14 boys).

Views about teaching and learning - a teacher for the whole child

At the beginning of the study, Ann described herself as having a strong belief that her task as teacher was to help children build and develop Christian values, the core of which she said was respect for self and for others (TPS; T07a: 52). In order to achieve this, Ann believed that children needed to have the opportunity to develop themselves as total human beings and educationally speaking, that meant that both character training and basic skills were necessary (T07a: 52). In Ann's view children should be encouraged to know their world's opportunities through a broad education so that they can develop a critical eye and come to know, appreciate and understand the breadth and variety of human capabilities and achievements (T07a: 54). While academic skills are vital, so too are experiences in the arts, music, theatre, and sports (TPS; T07a: 52).

Ann thus described herself as "a teacher for the whole child" (T07a:58), her role being to help each child to be grow academically, but also to be open and responsive to society and world needs by developing skills that will contribute to the good of themselves and others.

I would like to think I was a teacher for the whole child. I do tend to stress academic because I think that's our product and our industry ... I wouldn't be doing what I said for them if I didn't. ...we have to recognise that they won't all be academic, but they still must feel they themselves as a person is worthwhile. So I would try - and I say the word try - to be a teacher for the whole of the child. ... And you must have, to be whole person, to be a person of spirit and you must have art and music and theatre in your life and reading, literature. All that. The arts. Otherwise you can be a very wonderful caring person, but you yourself have missed something in life. (T07a: 52, 58)

Thus Ann saw her role as a vital one in the lives of her students and a complementary one to their lives at home. She believed that "subconsciously you are a collection of the people who trained you" (T07a: 83), and that "values and attitudes to life will come from the family and the school." (T07a: 52). "I've read where the second most forming part of your life is at school." (T07a: 83)

To demonstrate and simulate, to a certain extent, these beliefs she had about life and school experiences, Ann ensured that the dynamics of the groupings in her class varied. Variations included teacher led and controlled activities during, for example, mathematics lessons (VR M1a), as well as flexible group work sessions aimed at stimulating thinking and the sharing of ideas (VR M1a). This provided ongoing opportunities for students to interact with each other and to experience time by themselves. In this way she aimed to help students to come to know and appreciate their own and others' perspectives.

Ann felt to some degree that the current education system constrained her efforts to develop these ideals within her students and would have preferred arrangements to be different.

I believe they [students] should work at their own rate. I think that they shouldn't all be in a room because of their age. (T07a: 65)

However, she accepted the less than ideal system and worked to the best of her ability within it.

Views about technology - related to all aspects of life

Ann's understanding of technology was broad. Her emphasis was on the integral part technology plays in all aspects of human life and upon the kind of thinking that supports, promotes, and influences technological activity.

Ann described technology as being part of all aspects of life. From her perspective, technology or links to technology are identifiable in everything in the environment, natural, and made.

Well it includes all parts of our lives. So from the moment we get up in the morning until we go to bed at night and even while we are sleeping technology has been part of our lives. (T07a: 3)

She described processes involved in technological activity such as designing, packaging, and inventing and pointed out that everybody is a user of technology (T07a: 23, 32). She believed that technological knowledge was built up gradually and developmentally over time (T07a: 25) and made use of a variety of materials (T07a: 36). Ann saw computers as only a small part of what is involved in technology, even though she recognised their heavy involvement in many technological processes and developments (T07a: 32).

If we didn't have these things in the past we wouldn't have what we have now because you know, you take your old computers. They've only been built on and everything else that we have has been built on, what inventions we use. It's all about design and packaging and inventing; and computers are only a tiny part, even though they make a lot of uses of other technology. (T07a: 25, 32)

For Ann, an overriding factor which identified technology as something unique from other aspects of human existence was the creative thinking that she saw as being integral to it (T07a: 40).

We have inventions because somebody saw wheels and then we had the progression of transport and now it will go further but if we didn't have that person, who thought, "why walk." So we need that kind of thinking ... to go further. (T07a: 50)

Ann's early ideas about technology education - limited exposure, but some ideas related to other views of learning and teaching and technology itself

The emphasis Ann placed upon the creative thinking involved in technological activity formed the core of her predictions about what would be involved in technology education at the start of this study (questions 1, 2). She saw technology education as providing another facet through which the development of the whole child could be understood and therefore promoted, and another means to broaden a child's learning about the world. Thus technology education could provide the basis for the development of creative thinking to help students to understand how the world has and can be moved forward. (T07a: 50).

Well I think as I said with practical work, it would sometimes be an individual would be working totally alone and learning the basic skills and then you would combine that into your the group activities. Or where they perhaps themselves might do some sort of just creative activity by themselves, but without it being a structured activity. (T15a: 117)

Ann believed that while any of the subject areas in primary school could provide a context for technology activities (T07a: 44), technology in primary school should take the students beyond the "craft" of making something. The orientation should be upon the processes involved in its being made (T07a: 42) (question 1).

Well most importantly of all it needs to be the thinking skills. It's not important what particular practical thing for doing it. And it need not even be a hands-on. It could be designing on paper, but it will be thinking outside the norm that this is what we've got. ... So when they're doing craft, rather than give them the design of making an aeroplane which is, one of the things that we've been doing, you would give them perhaps the material and see what they invented. Or you might even leave it to them to collect their own material. So it would be that kind of program. It would be the thinking part that will encourage the creativity. (T07a: 40, 46)

Ann was not concerned about the difficulty of conceptualising the new key learning area. At the start of this project, although she was concerned about how to fit the new key learning area into her programmes timewise, she had conceived of technology education as already in existence in the curriculum (T07a: 69, 71) (question 4). The implementation of the new key learning area, technology, would mean making the processes of technological activity, particularly the thinking, explicit.

Views about involvement in the study - positive, but time an issue

Ann was concerned about the time involved for teachers participating in studies introducing technology (question 4). Even so, Ann was positive about her involvement and saw it as a new opportunity to help students to develop skills of analysis and problem solving (T07a: 71).

A summary of the key features of Ann's beliefs about teaching and learning, and about technology and technology education

Ann's view of technology and her views about education formed the framework around which she approached the implementation of technology education ideas. Her beliefs about education being for the development of the whole child and then what that belief implied for the classroom was a particular determinant of Ann's practice and thought during this study.

Like her understanding about education, her view of technology was overarching and broad. While she was able to talk about the elements that contributed to her beliefs about education, related to such aspects as what needs to be taught, why, how and the nature of involvement of participants in the teaching/learning process, she was not able to verbalise to a great extent, elements which contributed to her understanding of technology, beyond the type of thinking involved. In identifying thinking as a key to understanding the uniqueness of technology, however, Ann was attempting to "fit" technology into the curriculum (question 4) and pinpoint for herself the detail of what technology was all about (question 2).

Description of Events throughout the Year

Ann's approach to the implementation of technology education: The whole is greater than the sum of the parts

Ann's beliefs about technology as being related to everything in life, together with her view of education as being the development of the whole child, influenced the way she planned and implemented technology ideas. She worked from a holistic view of the learner and learning and of the place of technology in life and drew from those "wholes" elements that could be described as technological. The following four technology sessions describe the lessons implemented by Ann during the course of the study. Each session is made up of one or more lessons that cluster around a key idea or central theme. Once again, links with the teachers' questions are provided in parentheses to show where the questions originated for Ann and how she tried to address them in her practice.

Technology session 1 - bridges (VR M1b; Vid Seq An 16.10.97)

Background

The motivation for this first technology session was for the teachers (all the teachers implemented this session) and the children to gain a first experience of technology in the classroom upon which later learning experiences could be based (question 3). After searching through a number of books of activities and lessons on technology, the idea that the students could be asked to build a bridge arose. After consideration of the resources available, it was decided that the students would be asked to build a bridge out of 50 matchsticks (toothpicks) and craft glue. The bridge was to be made as strong as possible. A comparison of how much weight each bridge could hold would be the test for strength, and an examination of the structures used for assembly would provide clues to students about how constructions using wooden matchsticks can be strengthened (question 1). It must be pointed out that at this early stage of the study the teachers had very limited knowledge and understanding about technology education. They relied heavily upon their own ideas developed from resource books, the outside researcher and the general direction provided by the national statement on technology.

Goals

A major intention for Ann in this session was to experience a first technology activity with her class. The goal she set for the students was to make a strong bridge from the 50 matchsticks provided. She was particularly interested in the thinking in which the students would have to engage, and in deciding upon how long they were to make their bridges (question 1). Ann was very interested in seeing whether the students could work out for themselves that they would have to make the bridge a little longer than the prescribed 20 cm (FN Vid Seq An 16.10.97). Unlike the other teachers, Ann left that detail for her students to discover for themselves.

Classroom Organisation and Approach

In introducing the activity and outlining what the children had to do Ann pointed out that their aim was to attempt to make the strongest bridge. She had the students make drawings of their plans, discuss them with a partner, and draw more designs that they thought would help them in their task.

During the building which the children did in pairs, Ann reminded the class of the aim of the task and alerted them to the fact that the paper they were using to protect their desks from glue should not be allowed to stick to the constructions. This unfortunately had the effect of disheartening some students who, when lifting their bridges from the paper, broke their constructions and had to begin again. At the end of the session Ann led the testing of the bridges for strength. The focus was mostly on the testing with only an occasional reference

being made to the relationship between the structure and the strength or the amount of weight the bridges could support.

Reflections

Ann noted that the session created sustained interest amongst the children. They were enthused not only by the building task, but by the testing for strength as well.

It caused a lot of interest with the children. Well, what I found was they were very interested to see it through to the end. They're still even this week wanting to measure [the amount of weight their bridges could hold]. (T10a: 4, 34)

She recognised the problem that the students experienced with the matchsticks sticking to the paper could have been overcome by using aluminium foil or plastic instead (T10a: 23). She also added that writers of resources for technology in classrooms should highlight such potential problems and provide hints to help teachers beginning technology to deal with them before they arise (T10a: 27,30) (question 3).

Ann identified that some students did not think through the task sufficiently to realise that they had to make their bridge slightly longer than the specified 20 cm to enable it to span a gap of that width (T10a: 36). However, there were students who did build their bridges longer than 20 cm and Ann attributed this to their utilisation of "extra thinking skills" (T10a: 53) (questions 1, 3).

Ann recognised that the students learned about how to increase the strength of their bridges by gluing their matches closely together, but by doing this, the limited number of matchsticks available for use meant that width had to be sacrificed (T10a: 64). Another learning was that the bridges could hold more weight if the masses used for testing were placed across the length of the bridge, rather than arranged one on top of the other in the middle (T10a: 70) (question 1).

Finally, Ann believed that in her class, organising pairs of students to work together was a worthwhile arrangement, as there were enough tasks to engage each of the two students (question 3). Larger groups would not have been successful as

There weren't enough separate tasks. Like if it had been something where we need[ed] wheels and we need[ed] these and perhaps they could have split up and said I'll make the wheels and you [make some other part]. (T10a: 101)

Technology session 2 - planet settlement (VR M1c; FN Vid Seq An - 13.11.97)

Background

At this stage, all the teachers decided to try technology activities that suited their own programmes and classes. For Ann, this series of lessons integrated ideas from technology, English, and science (questions 2, 3, 4), and formed part of a larger unit of work on settlement. One of the tasks the children were to engage in was the building of a settlement on a planet, reflecting research they had undertaken into space travel, space exploration, and planets in the solar system. In tackling the task the children were to imagine they were members of an expedition charged with establishing a colony on an uninhabited planet. The students had to imagine and plan for survival. They were then to design the buildings they would erect on the planet and eventually construct models of their settlement.

Goals

Ann's (technology) aim for this series of lessons was to highlight the technology aspects of similar activities that she had implemented with classes in other years (questions 4). She wanted to represent to the children through her organisation of the activity, ways that people work together in contexts outside school. Thus her aim was to show to them that individual ideas could be broadened and enriched through interaction with others, and that working in groups could greatly enhance and improve task and outcome quality and effectiveness (question 1, 3). In essence, she intended to spend a great amount of time developing and establishing a context for learning (question 3).

Classroom organisation and approach

Many sessions were spent during which groups of children discussed their imaginary journey, the features of their chosen planet and what they would need in order to survive there. They made plans, drew diagrams, and undertook research. There were groups of students that remained stable for the whole of the project, but Ann organised different groups and individual work throughout the lessons to spread ideas, give time for contemplation and to stimulate creativity through the wider interactions. Besides the plans and ultimately the construction, tasks also involved exploration of such topics as qualities of leaders, use and selection of materials, the variety of jobs to be carried out by members of the expedition, designs for settlement buildings and supplies needed for the journey there. Thus the dynamics of the class groupings varied constantly and Ann facilitated the action. The emphasis upon the importance of the context is illustrated in the following excerpt of Ann's talk to the class during an early lesson in the series.

We're going to pretend that you have left school, Year 12, you went on to university, you took up different kinds of jobs. Some people went into management, some people were architects, other people were engineers, some people were astronomers, some people went to the space station are astronauts. Now there are going to be teams of four who have been picked. And you are being picked by the government. So we now have a ministry of space and you, because of your ability, you yourself have been chosen to lead the first exploration of this planet. Now you are allowed three other people to be in the team. It doesn't mean that you will do everything, all the work. You will get contractors, you will have people coming in to help you with things, but you are to be the organising group from the beginning and you will be the group that eventually goes to the planet, who take part in the exploring and the colonising or the settling whether for a short time or for a long time. Now I want you to think about who in this class you would choose to be part of this thing with you, so your name goes down first, presuming that you are the leader. And now you're going to pick three other people. I want you to put their names down and the write a short sentence or some words or phrases to say why you're picking that person. So you're going to - if it was a sports team, you'd write down I want so and so because they're every good at fielding. I want someone because they're excellent at batting. I want someone because they cooperate. Write down and it's from this class of people who -. (VRM1c)

Reflections

Ann felt that she had adequately achieved what she set out to do in terms of her exploring with the children the notion of collaboration within a project. She explained that through the way she organised the planet settlement sessions she felt she had simulated that groups of people with their individual approaches, perspectives, skills and abilities all contribute "something" to a (technology) project, which together enhance and enrich the outcome and the process of achieving that outcome (question 3, 1). The instructions Ann gave to her students for one of the discussion tasks, following, show this.

When I tell you to get into a group, it will only be a group for brainstorming for about two minutes. What you're going to discuss [in] the group [is] what sort of people do you need to have in the team. What are the kinds of qualities, personalities, abilities that you think is needed and then I want you to come back as the whole class we'll put up on the board different ideas you got from your group and then you're going to rethink. Now we'll just see the people [who] can think of ah, what is it we're planning. Remember, you're going to be like Captain Cook and all those explorers and you have the choice to have these people you want in your crew. You think about it's not just for a few minutes you're gong to be with them or a day, and all the jobs that perhaps you can think are going to be done, what sort of people are needed. (VRM1c)

Furthermore, she expressed a belief that in the world beyond the classroom, varieties of people working in teams are needed, because one person cannot possess all the skills and knowledge necessary to achieve the best outcome (question 2).

Even the person who had the idea, probably when the practical comes might not have had that idea in mind. Theirs was, say Boeing, you know, - we can get a machine that will be able to fly, as simple as that. While the person who may have studied, you know, how things move through the air would, then have said well you can't have one that looks like this, or you need -. I think perhaps, most of your technical things would have been a combination of teams. (T15a: 33)

She noted that during the sessions she altered her approach to the groupings of the students to promote individual input. For example, during the second lesson in the unit with a technology emphasis, rather than having the students move directly into groups to begin to discuss the task at hand, she asked them to think quietly by themselves for a few minutes. She then asked them to write down any ideas that came to mind. In this way she created the opportunity for individuals to make their own thoughts explicit beforehand, thereby supporting and encouraging those who were reticent in groups to have something to say when the groups were formed and under way (FN Vid Seq An 13.11.98). Thus she made her thoughts about the value of individual contributions to group investigations explicit (questions 1, 3).

Technology session 3 - joins (VR M2a, b; VR M3a, b; VR M4a, b, c, d)

Background

Session 3 consisted of a series of four lessons about joining various materials. This differed from Technology Session 2, because it was the specific joining skills that were focussed upon, rather than the development and exploration of a broad context within which technology plays a part (question 3). In thinking about the session before planning and implementing it Ann noted that:

I don't think [I] could always have every unit like that [referring to the planet settlement unit]. I think there would be the practical side as I see I would like to have a look at joining and I think that you need a practical 'one off.' It might be, just a straight, we'll call it technology, I guess in the past we've called it craft activities. So you could have, well, now that you're going to use something in the kitchen and it could be that you start with the idea, but it need not necessarily extend further than just that. (T15a: 53)

During the four lessons the students explored joining paper, clay, wooden pegs and plastic straws (question 1).

Goals

Ann aimed to focus upon specific skill development rather than holistic or contextual understanding of a technology context in this series of lessons (question 1). She saw knowledge about joining as fundamental to understanding the nature of materials and the importance of developing specific skills as a relevant and contributing factor towards the development of bigger things in technology (question 2).

Classroom Organisation and Approach

The general structure of the lessons involved open exploration of the material, and group and individual brainstorming of the variety of joins possible. In some instances the students named the joins and investigated the use of the joins by constructing something. In some of the sessions Ann interspersed the discussion, quiet individual work, experimenting and constructing, with drawing of plans and ideas for building. The drawings were used as a way of making ideas concrete, as a sort of translation process for ideas. After construction the children were not asked to present their drawings. The drawings remained as a record of thought development (M-AF2b).

Another feature of these lessons was the mix of teacher directed and more open activities presented by Ann. For example, during the lesson on joining wooden pegs, one activity involved the children constructing a space vehicle using their own ideas and another incorporated building a space vehicle following a set of written directions. This had the effect of allowing Ann and the children to observe their different responses to the different degrees of direction.

Figure 1 (M-AF2b-17) illustrates the variety of approaches and tasks Ann integrated within her lessons on joining. Specifically, it shows the ideas, plans, and reflections made by one child in response to the activities presented during the lesson on joining wooden pegs. Part A of Figure 1 is the child's individual brainstorm of materials that can be joined. Part B is the child's individual and group brainstorm of ways to join various materials with some sorting into material "types" - here wood and cloth. Part C is the child's sketch of an idea for her space vehicle using her own ideas. The diagram is rough and unlabelled - a record of the child's thoughts. Part D is the child's answer to the question: Which construction was easier - the first one you made by yourself or the second one you made with your partner? The answer provided by this child indicates a sense that although working by oneself is easier, the outcome of collaborative interaction means the possibility of the sharing of more ideas. Part E is a record of what the child did during each construction time, by herself and with her partner. It is the sequence of major tasks undertaken during each construction. Finally, Part F is a reflection upon what the child learnt about materials during the different construction tasks undertaken.

Reflections

Ann's reflections upon Technology Session 3 highlighted the various ways one can understand technology and the technological process. She suggested that there were different levels of thinking and action that could all legitimately be called technological (question 2).

Probably the different levels too, would be that you apply and make something that you've already got directions for and then the next level would be that you make and design something that works, but is not, you know, something of your own creation. (T19a:80)

She made the link here to the structure that she used within her lessons which comprised the mix of closed teacher directed activities and more open and less defined ones (question 3).

Further to this, Ann expressed the notion that the focus of technological activity is problem solving (question 2). Problem solving for Ann involved creativity. Problem solving begins with the idea, even one that has been thought of before.

But even if it is to move this piece and put it on top, that's being creative. In being able to see the workings that's going on and what the result will be from making that move. Well, I would call that being creative. (T20a/20b: 122)

I'd say that the problem solving starts as soon as the idea starts. I'd say that no matter what you do even if it's taking an old idea, you're solving a part of that. I would say that it's very much the essence of it. (T19a: 104)

Thus even if a student is given the directions on how to make something, injecting ideas, slight changes, and adaptations to the instructions would constitute problem solving for Ann. Within an open-ended task, problems are created for students to solve and the opportunity to promote creative thinking is provided (T20a/20b: 111) (question 3).

She noted also that the students were very enthused by the making part of the activities during the session. She had observed that once they had spent a short time thinking of ideas, perhaps sharing them and refining them with other students, they were eager to involve themselves in making.

And I was also looking for working by yourself [themselves] and working in a group and trying to analyse and watch the ones that performed better in either way. And on the whole most of them seemed to like to work by themselves. They enjoyed the social part of the group, but having to wait and having to talk about it with others, it didn't really appeal to them, most of them. (T19a: 6)

Ann's observation of the students' preference for working by themselves was borne out by statements by some students while others said they preferred working with a partner to be able to create a more complex product and to share ideas. To a question asked during the lesson on joining wooden pegs to make space vehicles - "Which was easier, the first vehicle you built by yourself or the second built with a partner?" - responses included:

Second, because I had someone to help me and to compare things with. (M-AF2a-3)

The first design because you thought your own idea. The second is more complicated because your ideas come together and make a completely different idea. (M-AF2a-17)

First one, because in the second one we had a good idea, then we had a better one, then another one. (M-AF2a-12)

Second one, because we had more ideas to put together. (M-AF2a-8)

However, she did think there was value in having the students write about their thoughts or draw ideas for making.

And also by the paperwork that they're allowed to think before they did it in a concrete way. That would be encouraging them to see, to be able to put down what they were visualising upon paper. (T20a/20b: 127)

Thus she noted the eagerness the children displayed in wanting to work with the materials. Ann, however, saw the value of interspersing the making parts of her lessons with structures to frame opportunities for thinking and sharing of ideas (questions 1, 3).

Overall, Ann was satisfied that she had achieved her aims. However, because she had tried to fit so much into the sessions, she felt that the amount of time she took to cover the four lessons could have been reduced. She suggested that if she were to implement the unit again she would shorten the discussions and review sessions with the children - even though she saw them as worthwhile - include exploration of the same number of materials and allocate plenty of time for the making activities (questions 3, 4).

The first part [discussion, brainstorming etc] would only, only be a small element of it, within the lesson. But the practical part would take as long .... Well if it was going to be a unit on joining, I think you would need to look at all of the, you know, at least that many materials. (T19a: 168, 170)

Technology session 4 - castles (VR M5a)

Background

Like the series of lessons planned around the settlement of a planet, Ann organised the building of castles as part of a unit integrating technology with social studies and English on life in medieval times (questions 3, 4). She saw that through the unit there would be plenty of opportunity to develop the students' understanding of the context out of which the technological aspects would arise.

Goals

Thus Ann's technology aims for this session focussed mainly on developing the students' understanding of the context within which they were to construct castles. Attention to tool skills and selection and use of materials were to occur incidentally as the need arose during the construction time (questions 1, 3).

Classroom Organisation and Approach

During the lessons leading up to the actual construction, the students had engaged in research about castles and had gained a rudimentary knowledge of main structures. They had also worked in groups to design their constructions after considering the available resources. Resources available included large cardboard boxes, cardboard tubes, polystyrene foam packaging, masking tape, glue and various other similar items brought by students from home. The actual construction took place on one day rather than during a series of short lessons spread out over a number of weeks. In this way Ann thought she was able to use time effectively and allowed the students extended and focussed time to concentrate on the one task (question 4). During the construction time the students worked as pairs, selecting and using materials as they needed. Planning, constructing, testing and appraising happened in no particular order, but in response to student needs and progress in the building of their castles. Ann wandered from group to group, talking in general terms about what the children were doing. She made suggestions about the use and selection of materials at times and when requested, and provided assistance with the cutting of thick cardboard. In this way learning episodes were incidental and occurred as a response to immediate action.

Reflections

Ann was positive in her review of the castles activities, believing that in accentuating the technology aspects of the building - the design and the selection of materials, in particular - the activity was taken beyond a craft activity (questions 1, 2, 3). Rather than focusing only on the end product, she had aimed to have the children pay attention to their ideas for building, the design of their castle and the consideration of, experimentation with and use of materials available. She provided support for these tasks as she moved around the room during construction time. This example is of Ann providing some ideas about using different thickness of card for the construction of battlements.

This sort of card... and then you can tape it on. Look you'd never be able to - that's thick card and you're going to have your - what do they call them - the indentations in each one. It was for the arrows, so that .they had somewhere to hide - a shield. So don't try it on these thick ones. You could take some thinner card, see something like that. Cut it then you'll have to stick it on, either with our glue, we've got it out here the thick glue... (VRM5)

However, her main thrust ultimately was to support children in what they were doing and provide an opportunity for them to display their problem solving skills.

I didn't think technology was about the end product. I was sort of trying to get them to be problem solvers and be designers. ... you achieve something by them experimenting. (T20a/20b: 275, 277)

Ann was also satisfied that the time was well spent in this session. She found that limiting the construction aspects of the technology activities to one day proved to be a worthwhile way to culminate the integrated unit on medieval times and an efficient approach to attend to the long and involved task of building (question 3). The advantages of integrating technology with other subject areas were again identified as a means to reconciling limited time and the broad curriculum (question 4).

I found that by using it [technology] in an integrated way, that it could easily be fitted into whatever areas you were working on. (T21a/21b: 11)

Discussion

Ann's beliefs about technology as being related to everything in life, together with her view of education as being the development of the whole child, influenced the way she planned and implemented technology ideas and the way she tackled the teachers' four questions. She worked from a holistic view of the learner and learning and of the place of technology in life and drew from those "wholes" elements that could be described as technological.

Ann's early concern with time was similar to those of the other teachers. She wondered how room could be made for the inclusion of another key learning area in the curriculum (question 4). Like the other teachers, she found that integration of learning was the key.

[I wanted] to find out whether the time element involved would be a burden in the classroom. And I found that by using it [technology] in an integrated way, that it could easily be fitted into whatever areas you were working on. (T21a/21b: 11)

This ability to find meaningful links between technology and other key learning areas stemmed from her view that technology is one of many aspects that together make up the world. In implementing technology in the classroom the establishment of a context thus was important for Ann, because the context represented the broad picture and within it then, from

an educational perspective, the elements of the various key learning areas could be identified. This conception of the overall purpose of a specific task was important for Ann and was illustrated in a discussion with the other teachers about whether painting artefacts could be regarded as art or as technology, when Ann stated that

Well it depends on the area, then. If you're going to go into a mill and work some machine, it doesn't really matter whether it's coloured or not. But if it's going to be selling to the general public, that would be part of its completed state. (T21a/21b: 65)

Viewing technology education from a wholistic perspective assisted Ann as she attempted to place a framework for action upon her planning (question 3) and identify what was important for her students to learn (question 1).

Her propensity for seeing technology in everything in life seemed to have influenced her "natural" tendency to integrate it with other areas. Rather than force technology into an integrated relationship with other key learning areas, Ann tended to draw technology possibilities from the other learning areas. The process involved imagining the "wholes" (learning areas) and identifying the technological parts, rather than identifying aspects of technology (thinking, content, process) and in piecemeal fashion slotting them into links with other key learning areas. In lessons Ann would have previously classified as art and craft, she tried to inject technological aspects into them by making the processes of thinking and designing explicit. Similarly, where the development of thinking was concerned, rather than plan for particular modes of thinking at the outset, Ann considered how, and when children think technologically first. Then she drew from those situations possibilities and opportunities to focus on and tried to make explicit that which she believed was already existent in some way. These notions are evidenced in Technology Session 2 - Planet Settlement. With the addition of specific questions and tasks, Ann led students to consider not just the needs of the settlers on the planet but how those needs could be satisfied in the design of the buildings and other constructions in the new colony. Without the technology aspect, Ann would have seen the construction of the colony buildings as an art activity either to complement the science and social studies that were addressed during the unit or to be just an interesting way to conclude the unit. Emphasis would have been upon the aesthetics and the art techniques - use of paint, shaping of cardboard, and so on - rather than on the functionality, purpose and structures of the buildings. This example not only illustrates how Ann wrestled with fitting technology into her curriculum offerings (question 4), but also how she considered the complexities of incorporating interesting learning activities within a context (question 3).

While Ann did not describe the nature of technology in great detail, she did label the kind of thinking involved in technological action, that is, creative and inventive thinking, framed within problem solving and designing. The development of this thinking became a particular feature with which she worked in her technology lessons. This view helped her to identify the uniqueness of technology education (question 2) and also to frame the planning and structuring of activities (question 3). Her lessons, particularly as evidenced in Technology Session 3, were made up of a mixture of both open tasks and closed instruction-based ones. For Ann, open tasks by their very nature compelled students to think, problem solve, plan, design, make, and so on, and thus could be easily called technological. Closed activities, for example, ones that involve following instructions on how to make an item could also be called technological, as they showed children how others had created a particular artefact. Thereby, they extended children's knowledge, provided some basis upon which new ideas could grow and provided opportunities to appraise the work of another and to develop a critical stance. Thus Ann rationalised that different activities can be used to generate different levels of technological thinking and action. It is up to the teacher to draw from those activities the technology possibilities.

Another illustration of the way she addressed question 3 came in her view of how technological processes involved in designing, making and appraising could be incorporated into lessons. Because of Ann's belief about the importance of creativity in design, and providing freedom to the children to experiment and imagine, she put few, if any, limitations on the process through which the students progressed during any technology design, make and appraise cycle. While she asked them to draw, write down ideas and share them or refer back to drawn ideas and alter them if appropriate, she did not insist that any particular problem solving cycle or design cycle was followed. She allowed and encouraged the natural inquisitiveness the students had for the task and the materials with which they were working to "take them forward" from the general directions and knowledge of the purpose of the task through its undertaking and to its achievement. Reflection upon the sequence of steps taken by children during tasks revealed in their "natural" approach a step-like procedure (see Figure 1, Part E). For Ann incorporating (reflection-type) activities which help children to become conscious of the progression they make as they process an idea through to its final outcome, may be a good way to improve designing and problem solving skills without expecting adherence to rigid design sequences.

While she could see how from simple ideas complex thinking could arise, she also noted that the provision of rich experiences for students was dependent upon the extent of teachers' personal technology knowledge. Ann could see that to answer question 1 adequately, it would be necessary for her to gain relevant background knowledge, so that she would be able to identify what is important about aspects of technology and thus be able to plan, teach and assess more successfully. Thus the introduction of the key learning area into primary schools meant to Ann that teacher learning about technology and technological processes would have to happen.

Now if you've got a science background or you know you're very aware of craft or art and other different areas that you can bring into it, that's a help. But that background knowledge is such a difference, makes such a difference to your actual teaching of it. (T21a/21b: 130)

During the study Ann's lessons focussed upon the materials strand of the national statement and did not move into the strands of information or systems in any explicit way. Furthermore, it became evident that Ann's knowledge of what comprised the materials strand was also limited. While she felt comfortable drawing possibilities for technology from a typical art activity, there were times when there seemed to be little that could be identifiable as technology. For example, while Ann intended all of the Technology Session 3 lessons to be ones that focussed on specific joining skills and features of different materials, and the clay lesson did achieve that, overall the lesson tended to be more reminiscent of an art experience, rather then a technology one. The following quick interchange between Ann and various students in her class provides an illustration of the focus of Ann's questions and instructions for activities during this lesson.

(A = Ann; S = various students)

A: Starting with you [one student], we just want you to name a one shape. Now if you [the class] haven't got what she says then you are free then to make one of them. What's the shape that you made? What do you call it?

S: Cone.

A: A cone shape.

S: Circle.

A: You made a circle. James?

S: Um, sort of a tower thing.

A: Right. Ok.

S: Triangle.

A: Triangle shape. Now if you had a -. Now try to think of birds. See if you can make a shape - now we don't want a bird, but when you think of the parts of a bird -. You're not making a bird. You're not joining anything at all. It's just is there any shape now that, is a part of a bird shape -.

S: Egg?

A: No. We need the bird's body.

S: The head.

A: The head shape? It's showing what it's really like.

S: The beak. The beak is like a cone.

A: You've got the beak that's like a cone. Well, what else?

S: Legs - a cylinder.

A: The legs you could have as small cylinders.

A: What do you have under the ground? And -?

S: Roots.

(VRM4c)

The children spent time shaping the clay and making items and in doing so "experiencing" the nature of the clay. However, the language used by Ann remained within the arena of describing and talking about shape in non specific terms (from a technology perspective), and the product outcomes were not a result of any purpose other than to indicate that the students were able to shape the material. In other words, it became evident that it was a lack of knowledge about what constitutes the "content" of technology that limited Ann in her implementation.

Implications for Professional Development

Investigations into the implementation of technology education in the New Zealand context led Compton, Jones, and McGregor (1997) to argue that professional development should aim to develop teachers' technological practice, their concept of technology and their technology pedagogical knowledge. The study presented here supports these conclusions from the teachers' perspectives. The questions the teachers in this study asked related not only to practical classroom implementation, but also to wider concerns regarding the uniqueness of the key learning area technology, and its place in the overall education of children. All of the questions asked by the teachers were in the light of their experiences of

their own school and classroom contexts. It was within these contexts that they were able to make sense of and draw meaning from their experiences.

For learning experiences to have lasting effect, contextually based activities are very worthwhile (Thiessen, 1992). Teachers are the primary agents of their own development and this development builds as they experience relationships with their students and with the curriculum innovation within their own classrooms. In other words, it is ultimately the teachers who are the makers of the curriculum (Clandinin & Connelly, 1986). Thus this study indicates that when considering professional development needs of teachers implementing technology education, thought has to be given not only to teachers' understanding of technology, but also to their understanding of teaching and learning within the technology context. The teachers need to see the reasons for making changes in their beliefs and practices and they have to experience the value of those changes. This is a particular concern when introducing innovations from "above," (as is the case with the introduction of the key learning area, technology) because the challenges that come with didactical and pedagogical change can also impinge on teacher professionalism (Olson, James & Lang, 1998).

Time and its management was seen as a particularly important concern by the teachers involved in the study presented in this paper. Integrating technology with other key learning areas seemed to be the most feasible way to organise time. In order for teachers to be able to incorporate technology into their overall programmes they have to recognise where it is going to fit. They have to be able to distinguish not only similarities between technology and other key learning areas, but to discriminate between what is technology and what is not technology as well, so that the integrity of the key learning area within integrated programmes is retained. Furthermore, these distinctions are necessary to assist teachers to see, understand, and name the aspects of technology and other key learning areas they are trying to teach their students and what they are ultimately going to identify in terms of learnings. While technology is a new key learning area, and the study showed there is much that is new, it also showed that there is a lot about it that is very familiar to primary teachers. The prospect of them ultimately making no change to their programmes and naming what they are doing "technology" is a likely outcome - even though it may be more like art or science - if they cannot understand how technology is different from other key learning areas.

Similarly, teachers will need to develop their personal knowledge of aspects of technology - their understanding of materials, information and systems - and of technological processes - designing, making and appraising - so that they can make explicit in their teaching those natural designing and making tendencies children tend to demonstrate. Technology is a broad learning area and can incorporate a vast variety of contexts, situations, and tasks. If teachers' knowledge is limited they will find difficulty in identifying what they should plan for, how to support their students through learning processes and what to look for when they are assessing outcomes. Lack of personal knowledge and experiences of teaching contexts will limit what they can do in the classroom. One way of helping teachers gain understanding of technology content and processes is to provide them with an opportunity to engage in a technology project themselves (Stein, McRobbie & Ginns, 1998).

This study has shown that teachers' current beliefs and practices and their expectations about technology education have a strong influence on implementation. In secondary school situations these held beliefs and practices have been seen to relate to cultures of different subject areas (Goodson, 1985; Jones & Carr, 1992a, b). As a reflection of constructivist ways of understanding learning, teachers will base new experiences and attempts upon what they already understand and feel comfortable with. New meanings will come through as a development of, or with support from, old understandings. In this way, different teachers

will construct meanings about technology education differently (Clark, 1996). Thus professional development programmes should acknowledge, appreciate and indeed value what teachers already know and what they bring to the curriculum innovation.

Finally, this study has also indicated that as a means to planning more specifically for professional development, using questions asked by the teachers themselves, derived from their own thoughts and experiences may help ensure that programmes are more meaningful. Asking teachers what is important for them will highlight their differences in views and as a consequence their needs and concerns. As occurred in this study, the depth and complexity of teachers' questions change over a period of time as teachers attempt to sort out meanings for themselves. Professional development adhering to well researched attributes of quality (Loucks-Horsley et al., 1987) that extends over a period of time and that is flexible enough to respond to the changes in teacher needs will be warranted.

Conclusion

This study aimed to describe the efforts of teachers as they implemented technology education ideas in their primary classrooms. The teachers identified four questions early in the study and these formed the framework around which their further experiences were structured and reflected upon. The case study of one of the teachers involved was used as an illustration of how these questions remained pertinent throughout the course of the study, and how she made meaning of them in the light of her own beliefs about teaching and learning, about the nature of technology and about what she felt comfortable, secure and knowledgeable. As technology education is a new key learning area for Queensland schools, professional development of teachers is going to be critical for its successful implementation. Professional development will need to help teachers to comprehend the integrity of the key learning area itself and at the same time, assist them to see how technology "fits" both practically, in the everyday life of the classroom, and conceptually, as a meaningful inclusion in a broad and balanced curriculum.

Figure 1: One child's ideas, plans, and reflections on joining wooden pegs (M-AF2b-17).

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