A Model for the Professional Development of Teachers in Design and Technology ® (Paper Code: STE99273)

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Abstract

The implementation of the technology key learning area in the primary school sector during the last few years has resulted in issues being raised relating to teachers' knowledge of technology, and their propensities for incorporating it into an already packed curriculum. During the study reported in this paper, three teachers designed and implemented units of work around ideas which they drew from the national statement on technology, *A Statement on Technology for Australian Schools* (Curriculum Corporation, 1994). These teachers were faced with challenges to their various teaching professional knowledges and to their prior and developing understandings of the conceptual and procedural aspects of technology. A theoretical model for professional development is thus presented in the light of these teachers' experiences. The model highlights the need for professional developers to be aware of the impact that teachers' prior knowledge and beliefs about teaching and learning and about technology can have upon the meaning they make of the key learning area. The model also stresses that there is need for a combination of theoretical, practical and reflective experiences to be built into professional development programs on technology to provide teachers with the opportunities they may need to develop their understandings, while at the same time represent and promote technology as a process, as well as a product.

Introduction

In Australia, the national statement on technology, A *Statement on Technology for Australian Schools* (Curriculum Corporation, 1994, p. 3) describes technology as involving "the purposeful application of knowledge, experience and resources to create products and processes that meet human needs." Technology, as a national key learning area, is being implemented currently in both primary and secondary schools across the country. In Queensland, a new syllabus is being written to translate the broad statements of the national document for teacher use in classroom planning (Queensland School Curriculum Council, 1998).

Where technology education has been introduced as a learning area in other parts of the world, primary school teachers have experienced a variety of difficulties. These difficulties have been related to teachers' limited understanding of the phenomenon of technology (Jarvis & Rennie, 1996), their struggles to conceptualise the whole technology learning area in line with national frameworks (Mittell & Penny, 1997), and their limited knowledge of specific tool and practice skills (Anning, 1994). All these struggles point to the challenges that teachers are facing as they endeavour to conceptualise teaching and learning within a new subject area context.

If teachers are to be supported in their efforts to implement technology in ways that are aligned with the national statement on technology, then professional development will need to address the many knowledge and organisational issues that will be faced by teachers as they attempt to make the new learning area part of their everyday curriculum offerings in the primary school context.

Theoretical Underpinning

Shulman (1987) recommends that teacher education, including professional development, should help teachers to think and reason about their teaching role. He points out that it is the subject matter knowledge and the associated pedagogical content knowledge that hold real

challenges for teachers who must learn about an innovation and somehow convert their new knowledge into a pedagogical form. He also identifies the disequilibrium that is caused to all teacher professional knowledges by the introduction of new ideas and changes in beliefs and practices.

A number of descriptions of professional development have emerged during the last decade or so as generic guides for teacher change processes. Some identify the many complexities in the changes that are made during teacher professional development. For example, Hargreaves and Fullan (1992) see teacher development as knowledge and skill development, as development in self-understanding, and also as social change. In this way, they highlight the influential and determining dimensions of the person, the social group and the context in the process of teacher change. Others, such as Joyce and Showers (1988) concur, and suggest that professional development is most effective when it is looked at in terms of individual needs, the needs of schools and systems, the particular learning programs in place, and the students, their needs, abilities and characteristics. Focusing upon specific elements which encourage and support teacher change is Guskey's (1986) model of effective staff development. This model shows that teacher change will occur if, through staff development programs, teachers are encouraged to alter their classroom practice, and see and experience improvement in student learning outcomes. Still others have attempted to isolate key characteristics which together combine to describe quality professional development programs. For example, Loucks-Horsley, Harding, Arbuckle, Murray, Dubea, and Williams (1987) list ten features including collaboration and collegiality, time to work on staff development and assimilate new learnings, and the incorporation of experimentation and risk taking. Approaches to the overall approach or format of professional development experiences have also been highlighted to emphasise and capitalise upon one or more of these key features. Action research, advocated by Carr and Kemmis (1989), for example, promotes the importance of teachers investigating their own practices and beliefs within their own contexts by themselves and with colleagues in response to needs they have identified.

A number of underlying themes are identifiable across all of these models and descriptions. First, it has been recognised that in planning for professional development, teachers' existing beliefs and knowledge need to be taken into account, as these will influence the perspective the teachers take of an innovation and the sense they make of it. Second, non-critical assistance and support can be invaluable for facilitating teachers' review and reflection upon their own practices and beliefs. Third, opportunities to engage in professional dialogue with colleagues in similar situations, facing similar challenges, can provide encouragement, support and critical friendships. Fourth, teachers need to feel a sense of responsibility for their own learning and development. Finally, time, space and opportunity are needed for teachers to experiment with ideas and to reflect upon their experiences.

The descriptions and models cited above refer to teacher change in general. While there is much that can be applied to the technology education implementation situation, it must be acknowledged that the technology key learning area is a new learning area for primary teachers, not just a development of a subject that already exists in the curriculum. In implementing technology for the first time, teachers are having to formulate a conceptualisation of a learning area that is very new for them.

Where professional development in technology education in particular is concerned, some ideas and recommendations are emerging in the literature. Banks (1996) has acknowledged the need for professional developers to take cognisance of Shulman's (1987) alert, mentioned earlier, about the impact of introducing new subject matter and pedagogical content knowledge. Banks' (1996) teacher education experience has led him to note the changes and challenges to some of the teacher professional knowledges. For example, he

has recognised the important place teachers' personal subject construct knowledge has in underpinning the whole range of their professional knowledge about technology. Personal construct knowledge influences, and is influenced by, teachers' school knowledge, or their understanding of how technology as a school subject is different from technology in the outside world; their curricular knowledge, or their awareness of the different types of technology tasks; their subject matter or content knowledge; and their pedagogical content knowledge or, in Shulman's (1986, p. 9) words, "the ways of representing and formulating the subject matter that make it comprehensible to others."

Jones and Compton (1998) and Compton and Jones (1998) take a similar perspective. Their investigation into the beginning experiences of teachers implementing technology education in the New Zealand context, have led them to develop a model for professional development which shows how the various professional knowledges and understandings contribute to teachers' classroom implementation of technology. Jones and Compton (1998) have reasoned that if teachers are to become effective educators of technology, then they must be allowed to develop an understanding of technological practice, an appropriate concept of technology, and an understanding of technology pedagogy. They also say that these developing understandings will be influenced and determined by the teachers' prior experiences and social positionings, and that professional development experiences should include opportunities for teachers to reflect on their own and others' technological practice, upon the concept of technology itself and upon general pedagogical knowledge (Jones & Compton, 1998).

The study reported in this paper investigated the beginning experiences of three teachers as they implemented technology in their primary classrooms for the first time. With a view to considering future professional development in technology education, the study was an attempt to glean from the teachers' beginning experiences, their needs and their concerns and the issues that challenged them.

Thus, a major aim of the study was to document areas of significance that indicated the teachers' needs, concerns and propensities for implementing the new key learning area of technology. In the light of the teachers' experiences, a second aim of the study was to draw implications for the professional development of the teachers involved through the formulation of a theoretical model to guide professional development.

Design and Methods

The study was an interpretive one (Erickson, 1998) in which "the meanings and purposes attached by human actors to their activities" (Guba & Lincoln, 1989, p. 106) were sought. The intention of the study was to acquire an understanding of the way the teachers involved experienced and conceptualised technology and technology education and how those experiences and conceptualisations developed over a period of time. Through hermeneutical and dialectical processes the criteria for evaluating the quality of interpretive inquiry, that is, trustworthiness and authenticity, were applied (Guba & Lincoln, 1994) as a small group of teachers implemented technology ideas in their classrooms, reviewed and reflected upon their experiences and implemented further lessons in response to the review and reflection.

Informants/Participants

The participants involved in the study were three experienced teachers who taught middle and upper primary school classes in a rural school in south-east Queensland, Australia. In collaboration with a university based researcher (SJS), the three teachers, Ann, John and Mary (pseudonyms) implemented ideas based around the national statement on technology, *A Statement on Technology for Australian Schools* (Curriculum Corporation,

1994). The technology key learning area was new to these teachers who volunteered to be part of the twelve month study.

Data Sources

At the start of the study, semi-structured interviews of the three teachers were carried out to gain an insight into their conceptualisations of technology as a phenomenon, their views about teaching and learning in general and their predictions about their role as part of the classroom implementation of the technology key learning area. Stimuli for the interviews included a technology survey (Rennie & Jarvis, 1994) which the teachers completed prior to the interview; written reflections provided by each teacher on his or her beliefs about teaching and learning; and a lesson observed by the researcher which was deemed by each teacher as typifying his or her approach to classroom practice and organisation. The interviews were audio taped and transcribed, and the transcriptions were returned to the interviewees for checking and comments.

The teachers, together with the researcher, met formally on ten occasions during the twelve months to plan, review and reflect upon their technology lessons, discuss issues related to the teaching and learning of technology in primary classrooms and to discuss the meaning of technology as a phenomenon. Each meeting was audio taped and transcribed and used for further reviews, reflections and comparisons of ideas in subsequent meetings and conversations. Each teacher developed and implemented four units of work. Each unit consisted of one or more lessons up to a maximum of seven lessons. The lessons implemented by the teachers were observed and video taped by the researcher. Field notes were also made by the researcher. Sections of the tapes were used in discussion meetings to stimulate comment and further discussion and sharing of ideas and comments. Six students from each of the teachers' classes were also interviewed on at least three occasions during the study. During these interviews the students were asked about their experiences of being involved in the technology lessons and were shown sections of the video taped lessons to elicit their comments and reflections. Artefacts, such as student work and comments and reflections written by the teachers were also collected.

At the end of the study, summarising statements were gathered through written and spoken modes during a group meeting. These statements were made by the teachers about the changes and developments to their beliefs and practices they perceived had occurred during the period of the study in relation to technology as a phenomenon and to technology education. Written descriptions by the researcher of the teachers' approaches to teaching and learning and their conceptualisations of technology and technology education were returned to the teachers for their comments. To describe the teachers' experiences during the twelve months of the study, three case studies were compiled, one for each teacher. Subsequently, a number of assertions about the needs, concerns and propensities of the teachers involved in the study emerged, and implications for the future professional development of these teachers were made.

Findings

To illustrate the findings and provide a basis for the professional development implications of the study, events from the case study of Mary will be described in detail. Findings in relation to the experiences of the other two teachers will be referred to in brief, in the discussion section. Other outcomes of the study have been reported elsewhere (Stein, McRobbie, & Ginns, 1998, 1999).

A Case Study of Mary

> *As far as the actual building or engineering of what they're doing ... I lack the correct terms to be able to really observe and label what they're doing in any depth (Collaborative meetingT13a: 6).*

This comment came from Mary, the Year 4 teacher involved in the study. During her second unit of work she had her students designing and making houses for the Three Little Pigs. These houses, made from cardboard, string, glue, masking tape, ice cream sticks, paper and all sorts of similar materials Mary was able to gather, had to survive the "wolf's blow" (an electric fan) to meet the criteria for success.

It was towards the end of the unit which was comprised of three lessons that Mary made the above comment. What was frustrating her most was that she was not able to identify clearly what her students had learnt, as she was not sure of what she should expect from them, principally because she recognised that she possessed limited knowledge of structures and buildings herself.

While she identified her limited knowledge of the "content" of the technology experience, she believed that she had tried to set up in the lessons, processes that would be open enough to allow the students to tackle the building problems in their own ways. She said the students will "often see possibilities that you won't. I didn't want to have them take on a particular way of doing things" (Video - Pigs' Houses UnitVRC1d). This statement reflected her general approach to teaching other subject areas too. In her 20 years of teaching she had decided that the structures incorporated into classroom experiences should relate to the purpose of any lesson. So, sometimes she would guide the students very closely - "I will give them the information and I will show them how to do it and they will repeat it. And they will do it after me and they will do it exactly" (Interview T01b: 67) - and at other times when creativity was called for she would create an environment to support the generation of ideas and student centredness. In Mary's eyes, it was a question of balance and of being aware of the needs and demands of the students and the curriculum - "There is no one way you should teach. You look at each particular thing that you want to teach and you see the best way to achieve that particular objective" (InterviewT01b: 67).

Mary reasoned that technology lessons had to provide opportunities and support for student-generated possibilities, and so she allowed plenty of freedom for her students. At the same time, through her constant presence amongst the children as they worked, she provided scaffolding to encourage, support and inform the students' exploration and investigation. In the pigs' houses unit the students were provided with time to experiment with materials, to test them for strength and flexibility (though this was not led in a formal way by Mary) and to interact with one another, move around the room and share ideas. The following excerpt from the pigs' houses unit, shows how Mary encouraged students and recognised the thinking in which they were engaging.

> Student: I've just realised it was better making [it] like that because [it] looks better.
>
> Mary: Oh right. So you've overlapped it?
>
> Student: Yeah. That one, I had a lot of problems [with it], but -
>
> Mary: Yeah, that's a very good idea and probably will sit a lot better and be easier to put the string around a lot better, wouldn't it?

Student: Yeah. (Video - Pigs' Houses UnitVR C1c)

The processes incorporated into the lessons were viewed positively by one student who recognised that Mary "let's us think of the way we want to make [the artefact] and let's us do it ... She's trying to let us think and know how to make the things ourselves" (Interview - Year 4 StudentT16b: 55, 57).

By conducting lessons in this manner, Mary was demonstrating the match between her beliefs about teaching and learning in general, and her beliefs about teaching and learning technology education. Simultaneously, she was also demonstrating, perhaps more implicitly, her beliefs about technology as a phenomenon. Earlier in the study, Mary had described technology as "finding ways to do things better" producing a "faster, easier or a more pleasing result" (AFT-C1b Written reflection). She also saw that technological activity was "an innate gift of being [able] to look for a better way, a fast or effective way to do things" (InterviewT01b: 13). The openness with which she ran her technology lessons indicated this belief, because through her approach she attempted to minimise the restrictions placed upon the student activity. Through an open approach she hoped to encourage the students to explore possibilities and share ideas.

Later in the study, following the frustrations she felt during the pigs' houses unit, she also began to include science in her descriptions of technology, describing science and technology as two "sides" of a similar endeavour. So, for example, she talked about theoretical (or scientific) and practical (or technological) perspectives of understanding and describing the natural and artificial world. For Mary, when "the practical and the science" come together "that's when you get the technology and that's when it works!" (Meeting 9T20a/20b: 90). Developments in thinking were encouraged and supported by the researcher, who posed questions and supplied journal articles for reference (e.g., Stables, 1997) and access to teaching resources (e.g., Aitken & Mills, 1989), and the other teachers, who engaged with Mary in discussions, for example, about the roles of people who design, and people who make technological products and processes. During some of these discussions the teachers recognised that many of their everyday experiences were indeed, technological ones, for example, Mary talked of her "onion picking days" (Meeting 7T18a/18b: 260) and her husband's mustering activities (Meeting 9T20a/20b: 208). Thus, Mary (and, indeed, the other teachers, too) was exposed to a variety of ideas and perspectives. Hence, as time went on, Mary continued developing her practical/theoretical ideas by relating them to aspects of technological activity. She thus began to differentiate her ideas about technology and technology education and her thoughts became more refined compared with her earlier notions. She began to describe designing as an essentially theoretical activity, and making, as a practical one. She believed that in technological activity the two had to come together. "Designers are not necessarily practical people. ... Designers and people who actually manufacture things, practical people, need to work very closely together" (Meeting 8 T19a: 92-98).

Mary saw that from this perspective in a classroom, the technology "content" elements that she knew she lacked an understanding of, could be found through science. Science could provide the core concepts for focus, and technology could enhance the teaching of those science concepts, by extending them in a practical way. "Science introduces the concepts, then technology uses those concepts to produce something and test them" (Meeting 8T19a: 66). In this way she began to see technology as being "very scientific, an extension of science" (Meeting 8 T19a: 171).

By the end of the study Mary had overcome the frustrations she had experienced during her pigs' houses unit to a great degree, because she had found a niche to fit technology into her way of understanding teaching and learning and her conceptualisation of technology as it

related to science. While she was still developing her understandings and was conscious that she still had lots to learn, she felt that she had cultivated a basis from which she could feel at least some security, as she looked to continuing her exploration of the technology key learning area. She felt she had "more understanding of the basic everyday nature of technology" (Written reflectionAFT-C1g) and as the study came to a close she saw that her "planning [had] become much tighter, lessons more integrated and time not so much a problem" (AFT-C1g Written reflection).

Discussion and Implications

Some common themes became evident in the case study of Mary that were representative of the experiences of the other teachers. These themes, stated as assertions, are now discussed in the light of Mary's experiences, and with brief reference to the experiences of the other two teachers, John and Mary.

1. The teachers sought to fit their held views of teaching and learning with their implementation of technology education.

A priority for the teachers was to feel that they had some control over the overall progress of events and intentions of the lessons that they implemented. In Mary's case, from the start of the study, she saw a match between the intentions of technology and the way that she saw lessons aiming to encourage and promote inventiveness and creativity. Ann recognised a similar connection. John highlighted the need to know the "content" of what was to be learned as this matched his beliefs about what he saw as important in planning for teaching and learning. These were the first ways in which the teachers felt they had gained some security in their tentative experiments with implementing technology. Later, Mary still felt out of control over her planning, but because she identified a relationship between technology and science, and she felt comfortable with her science knowledge, once again matched the new ideas from the technology key learning area with those that she had established during her past teaching experience. The other teachers also sought to reconcile their beliefs about learning and teaching with the experiences they were gaining in their classrooms. By fitting technology education with held views of teaching and learning, and with their knowledge of other learning areas, the three teachers were able to secure for themselves a base from which new ideas about technology and technology education could emerge and develop.

2. The teachers displayed limited explicit knowledge about technology.

The teachers, as exemplified by Mary, found that there were aspects of technology conceptual knowledge that they did not possess. As a consequence, they looked for aspects of what they did know in other key learning areas that they could relate to technology. Mary tended to see links between technology and science and began, by the end of the study, to see technology as akin to applied science. While this was a view which was not in line with the national statement on technology, it represented Mary's growing ability across the period of study to be able to articulate more and more of her ideas about technology as a phenomenon from her perspective, and the implications of those ideas for teaching and learning of technology. Ann's experience was similar to Mary's in that she, too, looked for similarities between technology and other subject areas. She saw connections with art and craft, and in this way was able to frame her lessons with more confidence as time went on. John sought to link technology with science and English within an integrated unit of work to capture what he believed was the problem-centredness of technology, and create a context for what he saw as nebulous technology "content." John identified links between his existing knowledge and technology too, but he tended to look for differences rather than similarities as he became interested in what made technology unique as a key learning area. For the three teachers, while they did not develop, necessarily, broader conceptual knowledge of

technology, they were able to differentiate between technology and other areas of endeavour in a more explicit way during the course of the study.

3. The teachers had no experience of technology education, but developed understandings through implementation of ideas in their own classrooms and through reflection on those experiences by themselves and with colleagues.

For the three teachers, it was through the opportunity to implement ideas in their own classrooms that they were able to be critical about technology education and its implementation. They were able to listen to and react to each other's perspectives and ideas. The teachers engaged in numerous discussions with the researcher and each other during the many collaborative meetings. They were able to comment on each other's lessons, question actions and share opinions. These exchanges of ideas made in the light of classroom experiences, helped the teachers begin to differentiate their notions of what technology was all about as it related to other learning areas. Even though the teachers did not always develop ideas that were consistent with the ideas of the national statement on technology, it was as a consequence of these interactions and experiences, that they gradually felt more comfortable with the continuing task of learning about technology and preparing for its formal introduction in the future.

4. The teachers needed opportunities to develop and learn strategies appropriate for the design and technology context.

While the participants in the study were experienced teachers, they found that the new context of technology set challenges for them in the selection and creation of teaching strategies that they could draw upon to implement technology ideas. They drew upon past teaching structures and strategies, but these did not always match the new context. So, for example, Mary sought to build a community of learners (Lave & Wenger, 1991; Roth, 1998) within her classroom, as she reasoned that technology would demand a very student-centred approach. However, she found that because of her lack of conceptual knowledge, she was unable to apply the strategies she was familiar with in the same way. It was through creating a design and technology context within her classroom and reflecting upon the experience that she was able to begin to make changes to her approach to satisfy the needs and demands that she saw as being inherent within technology education. For Mary (and for John), this meant seeing connections between technology and the conceptual elements of science. For Ann, it meant recognising links between technology, and art and craft. Exposure to teacher resources, such as those provided by the researcher and to the other teachers' experiences and views, also helped the teachers to develop their ideas in this area.

5. The teachers gained from the support offered by the outside researcher.

While the study was not intended to be a formal professional development experience, the teachers did gain from having an outside presence of the researcher. The researcher was able to provide resources, facilitate meetings and discuss ideas with the teachers. Mary's theoretical/practical ideas were in part stimulated by the discussions facilitated by the researcher, and while it was questionable whether Mary was developing appropriate views of technology by relating it very closely to science in the way she did, it was because of the outside presence that she was stimulated to begin thinking on a deeper level about aspects of her technology understanding and teaching. In the same way, John was encouraged to continue to contemplate the uniqueness of the technology key learning area, and Ann gained information about individual students' performance in technology lessons through having the opportunity to observe the researcher leading a classroom discussion.

In summary, the teachers were influenced by their prior experiences of teaching and learning and their early views of technology as a phenomenon. Through the implementation experiences, the teachers explored their conceptualisations of the nature of technology further as they attempted to reconcile their beliefs and views with the needs of their students and what they saw as the nature of the key learning area itself. Classroom organisation and lesson approaches thus became very important, because it was through these that the teachers attempted to enact their developing and emerging understandings. Finally, it was through the processes which formed part of the methodological approach of this study, that is, through frequent interactions between and amongst the researcher and the teachers, that ideas developed and review and reflection upon beliefs and practices occurred.

A Professional Development Model for Technology Education

Figure 1 presents a framework through which to address the needs and concerns the three teachers in the study experienced and to take advantage of the teachers' propensities for implementing technology education. The framework incorporates the need to address the practicalities of implementation, as well as to support the inclusion of epistemic, conceptual and theoretical dimensions of the key learning area (Mittell & Penny, 1997), and in doing so, respond to the various needs of primary teachers implementing technology in primary school situations for the first time. The model is designed from the perspectives of a professional developer, seeking to plan a program of teacher development in technology education.

The professional development model is divided into three main sections separated by the dotted lines. These sections indicate areas of teacher professional knowledge (i.e., personal construct knowledge, subject matter knowledge, school knowledge, pedagogical content knowledge and curricular knowledge) that will be addressed or developed as attention is paid to the particular focus of each section during any professional development program using this model as a basis. In placing so much emphasis upon the prior knowledge and experiences of the teachers - because, as the study showed, the teachers' actions and thoughts were influenced and determined by their personal constructs - the professional development model complements models presented by Compton and Jones (1998) and Banks (1996). At the same time, the model integrates, extends, and reorders their ideas. The model also matches the more generic bases for professional development identified early in this paper (e.g., Guskey, 1986; Hargreaves & Fullan, 1988), but makes specific reference to the technology education context.

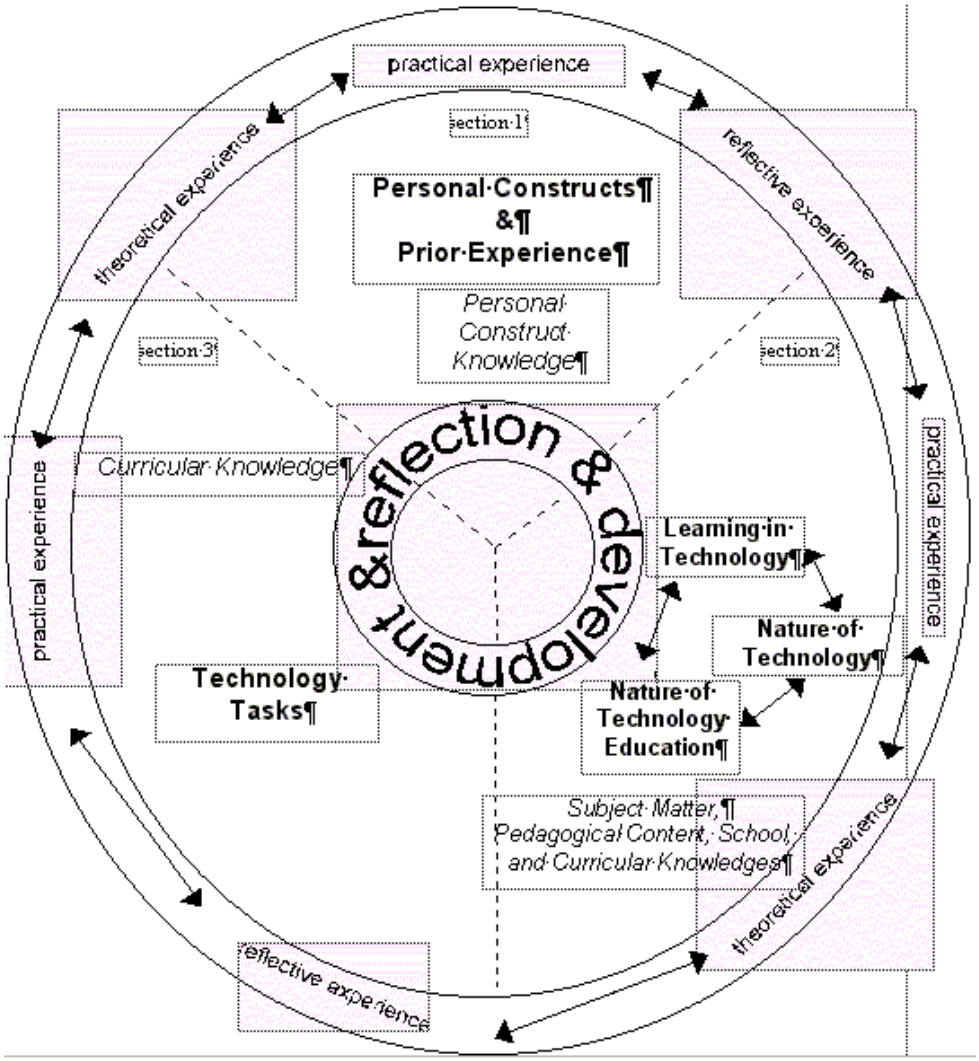

Figure 1. A professional development model for technology education.

Section 1 of the diagram acknowledges the importance of teachers' prior experiences of technology, their personal constructs or beliefs about technology and about teaching and learning in general, and the influences they can have upon the way teachers implement technology and evaluate what happens in their classrooms (Duffee & Aikenhead, 1992). From the case study reported in this paper, this reflects the overriding influence that Mary's views of teaching and learning, her early views of technology and her realisation that many of her everyday experiences were also technological, had upon how she grappled with the implementation of technology in her classroom. It also reflects how she used this prior knowledge and experience upon which to build and extend her ideas and practices. Thus, specific elements included in this aspect of the professional development model comprise: teachers' views of technology and technology education; their views of teaching and learning in general; their background and past experiences of the use and development of technology; their experiences of being taught technology related subjects; their motivation for the implementation of technology; the value they place on the inclusion of technology in the primary curriculum; and other curricular and school demands (Banks, 1996). In this way, the teacher professional knowledge addressed and drawn upon in this part of the professional development model is predominantly personal construct knowledge.

The second section of this model draws upon and addresses mainly subject matter, pedagogical, school, and some curricular knowledge (Banks, 1996). The third section chiefly addresses the development of curricular knowledge (Banks, 1996). Together, these two sections portray the nature of technology and technology education; learners in technology and technological tasks.

The second section of the professional development model in Figure 1 is comprised of three interacting aspects of knowledge about technology and technology education. These three encompass much of the theoretical or background knowledge that teachers new to technology education, such as the three teachers involved in this study, will need to develop. The *nature of technology* part refers to the need for teachers to develop a conceptualisation of technology as a concept and how technology works within different contexts. Mary, for example, began to explain technology as she believed it worked within science contexts, but did not pursue how technology could appear in the more engineering-type context that she developed during her pigs' houses unit. The *nature of technology education* part of the model refers to the need for teachers to develop an understanding of the key learning area as an entity in itself, in other words, to gain a "sense" of technology as a key learning area alongside other more established learning areas. This reflects the three teachers' endeavours to differentiate technology from other fields of study and is also reflected, to some extent, in Mary's attempts to sort out the relationships that she identified between technology and science. Inclusion of this section in the model points to the need to consider the purposes of technology education and the place of technology education within the whole primary curriculum. This part of the model also suggests a need to investigate the conceptual and procedural aspects of the key learning area, so that teachers are assisted to understand what makes technology unique. An exploration of the differences and similarities between technology and other key learning areas will help teachers gain a sense of what technology is and what it is not, and therefore assist them with the practical aspects of planning, teaching and assessing.

The third part of this section, *learning in technology,* indicates the need to develop an awareness and understanding of learners and learning within technology contexts. Mary's views of teaching and learning were premised by the need to acknowledge and recognise her students' needs as well as the demands of the curriculum. She was also concerned about what the students were learning during the technology lessons. For professional development, the study implies a need to help teachers develop a view of learning technology as distinct from, and related to, a view of learning in general, and an awareness of the factors that can influence students' abilities and capabilities in technology, such as their prior knowledge, their learning abilities and strategies, and their cultural and social backgrounds. In this way, the model acknowledges the constitution of learning communities in general (Lave & Wenger, 1991) and more specifically, within technology education contexts (Roth, 1998).

The three parts of section 2 of the model interact with each other and would help teachers form a background picture against which to highlight the many practical implementation strategies and activities in the classroom. In this study, Mary's views about technology and its implementation in the classroom were enacted through her use of certain strategies and organisational approaches. Her planning was assisted by the use of teacher resources. It was then upon reflection of those strategies used and how events unfolded in the classroom that Mary was enabled to reflect on her beliefs about technology and about technology education. Through the development of a combination and integration of understandings related to the three aspects included in section 2 of the professional development model, teachers would be given opportunities to build their technological capability (Kimbell, Stables & Green, 1996) and literacy (Dyrenfurth, 1991), and at the same time consider how to help their students do the same. In other words, it would be upon consideration of the nature of

technology, the nature of technology education and the nature of learners in technology that teachers would develop plans and activities for implementation in their classrooms.

Hence, the *technology tasks* part, which makes up section three of this professional development model, refers to just that: the development of knowledge related to the practical implementation of technology education in the primary classroom. This includes all the strategies and methods used to plan, teach, assess, and evaluate effectively and would necessitate an examination of how the whole curriculum is managed and impacted upon with the introduction of the new key learning area of technology.

This model not only describes the content of professional development in technology and how those aspects of content fit together, it also presents a plan of action for professional development. The action nature of the diagram is indicated by the elements contained within its border, namely, *reflective, practical and theoretical experiences* and the central part labelled *reflection and development*. These elements refer to the evidence gained from the study about the experiences of the teachers involved, which implies a need to include reflection-in-action, reflection-on-action, and technical decision-making aspects (Hatton & Smith, 1995). Changes and developments that occurred for the teachers happened as a result of their practical experiences in their classrooms, their discussions which stimulated and were stimulated by their reflections and their interactions with the outside researcher, and their forays (though limited) into theoretical underpinnings of technology and technology education. Inclusion of the border and central parts of the model acknowledges that teachers develop their beliefs and practices as they reflect explicitly about teaching and learning technology and enact ideas not only by themselves, but also, and perhaps most importantly, in collaboration with others (Briscoe & Peters, 1997). The role of the outside researcher was influential here in facilitating reflection and "creating" opportunities for interactions. The arrows in both the border and the central parts of this professional development model indicate constant flow. A major difference between this model and the one developed by Compton and Jones (1998) is that this model emphasises that learning about technology education, like the process of designing, making and appraising (Curriculum Corporation, 1994), is an iterative and recursive process in itself. Only through constant theoretical, practical and reflective engagement with experiences in the classroom in the light of developing personal constructs and broadening and deepening knowledge does professional development (in technology education) grow (Hargreaves & Fullan, 1992). Thus, this model shows that professional development in technology is a continuing and developing process, that change continues to happen, that it is not static with a definite beginning and end, and that it happens in contexts of which the teachers are part and within which they can find meaning.

In the study reported in this paper, it was the practical occurrences of technology education in the classroom, evident in the case study of Mary, that often were the catalysts for many of the decisions the teachers took as they tried different ideas and attempted to make sense of their experiences. To show this, the model gives prominence to the role played by classroom practice as a key force in the reflection and development of understandings in technology. As practical knowledge is gained, all other aspects of knowledge and understanding across the model will be affected and developed. Because of this, time and professional space (Fullan, 1988) will be needed in professional development in technology for this iterative and recursive process to occur.

In summary, this model provides a constructivist framework (Hauglustaine-Charlier, 1997) to support the teachers in their technology implementation activities. It focuses on questions asked by the teachers in this study emanating from their own practice. It indicates the need for an examination of the complexities involved in combining and translating understandings about technology, technology education, and learning in technology into classroom practice.

There is acknowledgement of the crucial influence that teachers' prior experiences and personal constructs have upon their implementation of technology. At the same time the model allows, and indeed sets the scene, for the teacher to be the researcher into his or her own practices and beliefs in collaboration with other teachers and with supportive colleagues from outside their context.

Conclusion

This paper has reported on an investigation into the beginning experiences of teachers implementing the key learning area of technology in their primary school classrooms for the first time. Using the experiences of one teacher involved in the study, it was demonstrated that there were many influences upon the way the implementation took place. The teacher's prior knowledge and conceptualisation of technology as a phenomenon, and of teaching and learning in general, played a very important role in helping her to establish a secure base from which new learnings and understandings could grow. Needs and concerns identified included her limited conceptual knowledge of the learning area and of technology and her struggles to differentiate technology from other fields of endeavour and other key learning areas. The implications of the study were described through a theoretical model for professional development. This model acknowledged the more generic professional development models already in existence, but highlighted teacher needs, concerns and propensities as they emerged from this study specifically within a technology education context.

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