Critical Issues to Consider When Introducing Technology Education into the Curriculum of Young Learners

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As the importance of a sound technological education for learners in their teenage years of schooling becomes accepted at a global level, there is increasing interest and belief in the need to start this education at an earlier age, possibly as soon as children begin formal schooling or even nursery school or kindergarten. Some teachers have warmly welcomed the challenge of introducing technology education to children at an early age. They have found that it has allowed them to develop new dimensions to work already underway. For others the idea has been received with more caution, for a variety of reasons. Some are confused by what technology education would mean for young children. Others are concerned that limited resources would be stretched too thinly if the younger age group were included and that the primary curriculum is already overloaded. There are also those who believe that technology education is simply inappropriate with a younger age group.

Expanding the technology curriculum to primary schools raises a number of important issues. Any developments should be based on sound educational principles and thinking. This paper will explore key considerations in this area, including: 1) the value of including technology in the curriculum for young children; 2) critical dimensions to nurturing technological capability; 3) appropriate models of teaching, learning and assessing; 4) addressing the needs of the teacher; and 5) the importance of providing coherent, progressive and continuous technological experiences.

The Value of Including Technology in the Curriculum of Young Children

Human beings are born with the potential to develop as technologists. This is, in part, dependent on an amazing capacity of creating in our "mind's eye" (Archer, 1980) new ideas and new configurations in order to make our world in the way we choose it to be. This capacity is something that sets us apart from other species in much the same way that our ability to develop and utilize complex linguistic systems does. Observing babies and toddlers as they busy about their world confirms the imaginative, inventive and determined way that, right from the start of life, we begin to utilize this creative capacity and to develop technological capability.

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However, as with all aspects of development, creating the right conditions in which the potential can flourish is not necessarily straightforward. Technological capability is dependent on the ability to take action, to intervene in the made world, and to create new or improved products or systems. The children who are given more support to find out how things work, to make things work, and to create and to express themselves, the better chance there is for their technological capability to prosper. Children in the first years of life will encounter a wide variety of experiences. For some there will be an abundance of opportunities to develop confidence and skill in those aspects that support technological capability. For others the opportunities will be limited. The range of experiences will be affected by a number of economic, social, cultural and philosophical influences and these in turn will impact on the way in which capability develops. There are, for example, indications of the effect that gender based expectations have on the early technological experiences of girls and boys and the consequences this has for children's development. (Browne & Ross, 1991; 1993)

A main function of formal schooling is to take control over the experiences children have and to attempt to provide some equity in opportunities. If we accept that technology is an inherently important dimension of a child's curriculum (Kimbell, R. A., Stables, K., Green, R., 1996; Jones & Carr, 1993), there is a logic to proposing that the earlier we, as educationalists, involve ourselves in this aspect of development, the better. Leaving this to chance, or at least until children enter secondary schooling seems a little haphazardous if not dangerous.

But introducing technology into the curriculum of young children is also important because of the propensity of this age group to engage in technological activity with an enthusiasm, curiosity and lack of inhibition that creates an optimum opportunity for development. Children's sheer excitement, wonder and enthusiasm for the world around them makes for an era of rapid development. In the pre-school years, the child's lack of concern for external constraints allows for a free exploration of both their material and conceptual world. Curiosity as to how things work leads to a determination to make things work. Consequently, opportunities to develop problem solving skills are provided.

The more young children engage in technological activity, the more their confidence in their technological abilities may be established. Primary school teachers who have introduced technology into their curriculum often comment that technology activities are a valuable vehicle for all types of learning. This can include developing generic skills such as collaborative group working or problem solving, or more specific development of math or science concepts. The technology activity often promotes a rich learning environment for a whole range of learning opportunities, thus providing an added value.

Giving children a broad based experience of technology at a young age through which the foundations of technological capability can be consolidated and enhanced provides a basis from which to develop in a coherent and continuous way. But in planning technological experiences, teachers need to be aware of a range of factors that will have a bearing on development.

Critical Dimensions to Nurturing Technological Capability

Ron Ritchie (1995) highlighted three critical features of learning situations that are significant for nurturing technological capability: 1) learning through practical experience; 2) an active learning process that allows children to construct their understanding of the world, and 3) learning within a social context. A discussion of these follows.

The Importance of a Holistic View

Technology appears in several guises within curriculum documentation and taken, as a whole, three different formulations are clearly identifiable: courses that focus on developing *awareness* of technology (e.g., exploring it's impact on society), courses that focus on developing *competence* in technology (e.g., learning about electronics, learning how to shape a particular material) and courses that focus on developing *capability* in technology (Kimbell, Stables & Green, 1996). These latter courses develop a pupil's holistic capability to put ideas into action to develop the made world. Put simply, these courses develop a child's ability to design what they make and to make what they design.

There is an important place for the development of awareness and competence (and indeed the three focuses are not necessarily mutually exclusive). But, it is the inclusive, holistic approach to developing capability that is the important focus with children in primary schools. Some might find this wrong faced. It could be argued that it is better to start with developing an awareness in young children and then building from this. But this would deny the important features highlighted by Ron Ritchie (1995), and in particular the priority of learning through practical activity, so vital when considering the learning needs of young children.

Integrating Thought and Action

In the second half of the 1980's in the United Kingdom a major research project was commissioned by the Assessment of Performance Unit (APU) of the Government Department for Education and Science that aimed to assess design & technological capability. The research focused on the nation's fifteen year olds and was conducted at Goldsmiths University of London under the direction of Richard Kimbell (Kimbell et al, 1991). One of the most significant outcomes from this project was an understanding of the iterative nature of the process that people engage in when designing and making and the importance of balancing the need to think about the task that has been undertaken (both reflectively and projectively) with the need to take action to turn ideas into working realities. This work identified that both aspects are important (and their integration even more important) when considering the development of capability in fifteen year olds. Since then we have had the opportunity to consider this model of activity in relation to younger children (Stables, 1992a; Kimbell, Stables & Green, 1996) and have found that it is equally applicable. This model has received corroboration from elsewhere (Anning, 1993) and the importance of developing 'thought' skills and 'action' skills in primary age children is increasingly recognized as critical in technology (Benson & Raat, 1995).

The Importance of Play

Play has been seen by many educationalists as a critical factor in a child's development and this is particularly so of the development of technological capability. In particular "making and playing" (Coghill, 1989) can be seen as the early manifestation of capability, and the very act of being involved in play is crucial to the nurturing of this capability. This is largely due to the fact that play allows a child to enter into an imaginary world, through which they can gain firsthand experience in an unconstrained way. While not dealing directly with technological capability, Bruce (1991) sums up neatly the dimensions of play that provide the conditions through which technological capability can flourish, starting with the importance of firsthand experience.

> ...as we experience, so we struggle, manipulate, explore, discover and practice in order to wallow fully and become proficient....If we can use first hand experience as a means towards wallowing in experiences, and being proficient we have a sense of control over our lives....This sense of control impinges on self-esteem, self confidence, autonomy, intrinsic motivation, the desire to have a go, to take risks and to solve problems, and the ability to make decisions and to choose. (pp 82-83)

Through play children develop mastery, confidence and control. Encouraging them to utilize such skills within technological activity allows for further consolidation.

Building Positive Attitudes

Developing children's skills assists in the creation of positive attitudes such as self esteem and motivation and these attitudes in their turn help establish the conditions in which technological capability can thrive. However, such attitudes can be both built and destroyed through engagement in technological tasks and so it is important that children work in an environment that is at the same time supportive and challenging. They need opportunities to work on tasks that are within their capability, but that still have the potential to stretch them, where risk taking and failure are not seen as negative or handled destructively. The need to develop just such a learning environment has been highlighted by teachers working on a primary technology initiative in the United States—"Project Update" (TIES, 1994). The teachers, who have by and large come afresh to technology activities have developed insights both by working through challenging tasks for themselves and by involving pupils in such activities. The resulting view is that the children should be involved in risk taking situations, where failure is seen as a positive learning experience and that this approach can prevent the children from placing "false ceilings on what they can learn and accomplish" ("Project UPDATE," 1994, pp. 21-24).

Being Aware of Value Positions

Technology is intrinsically a value laden phenomenon as developments are always driven by the needs, wants and aspirations of individuals or groups of people. Diverse needs mean that individuals will often perceive the impact of any technological solution differently - some may see a solution as good, while for others it is an unmitigating disaster (for example, automobiles are good for getting places, but bad for the environment). Because this value laden position is a reality, it is important that children are encouraged to see the issues surrounding any technological decision, and to be involved in the decision making in a meaningful way. For this reason, primary teachers are increasingly involving children in technological tasks where the value positions are clear to the children and are presented in a way to which they can relate, such as the ways in which choice and use of materials impacts the environment.

Access for All

Developing positive attitudes towards their peers and understanding the value of working with others is an important aim of technology education. Within this, the importance of children developing respect for each other, and in particular accepting the rights of all to engage in technological activities is vital in creating a nurturing learning environment. This means that it is critical that technological activities take place in an atmosphere where stereotypes are countered and differentiation strategies are utilized to allow all children to realize their potential. This is particularly so in primary schools as value positions can be adopted at a very young age, and if not challenged by real and positive examples can become intransigent. Technology activities are particularly rich in potential for allowing all children to succeed, thus providing living proof to challenge negative assumptions. However, in order to support the development of all children, particular consideration needs to be given to the ways in which young children learn and consequently the range of experiences that teachers need to structure for them.

Appropriate Models of Teaching, Learning and Assessing

In order to operate effectively, children must develop a range of contributory skills - procedural, manipulative and communicative. This must occur alongside conceptual understandings, both of how to make things work and how to meet people's needs and wants. Few people would disagree with this standpoint, but the way in which such contributory skills are best developed often is the cause for disagreement. This section raises some of the issues surrounding this debate and also offers some examples to illustrate approaches drawn directly from the classroom.

Children as as Active Learners

The ways in which primary education has developed in different parts of the globe will relate very much to the traditions and ethos of the culture in which it has developed. In the United Kingdom, while there are differences between one school and the next, the overarching model of learning in primary schools is one which is seen as "child centered" and in which children are viewed as active learners. This means that, for many young children in the UK, their school (and hence their technology) experience will be managed in a classroom environment which lacks the formality of the secondary school, where much work will be handled in an integrated way, initiated by topics or themes. Moreover, children will be familiar with working both collaboratively and individually. Similar models will be found elsewhere in the world, but some cultures will have a different tradition. It is important to identify these differences here, in order to put what follows in context, as many of the examples used are drawn either from the UK or from school systems that have elements in common with this approach. It will therefore be important that readers evaluate each model, strategy and example that is given in terms of the value it holds for developments within their own school setting.

Educational or Vocational/Instrumental Needs

Any debate about approaches to teaching and learning technology in education must consider the often conflicting claims for priority in addressing educational or vocational needs. For very young children, the focus and priority must be on their educational development. Indeed it's important that educators protect their rights to remain children. The issues of the development of their technological capability should not be clouded by introducing such issues as the economic well being of a nation or how a work force is going to be trained for the next generation. This is not to say that we shouldn't be concerned for the future of the children and do our best to ensure that they develop their potential to lead happy and satisfying lives as adults. It is more to suggest that the specifics of the technological experience of six year olds should not be planned by looking at the skills required for them to pass examinations at the end of compulsory schooling, or those that will allow them to become the mechanical engineers, architects or food technologists of the future.

However it's important to consider two further dimensions within this. First there is increasing acceptance that general technological competencies are more appropriate for young children in a rapidly changing technological society than are specific skills (Jessop, 1991; SCANS report, 1991). By developing a more generic potential from a young age, this next generation may be more comfortable, confident, and secure in their own capability. As a result, they may be in a better position to utilize it flexibly across a wide range of settings. Where these skills are developed through an integrative, holistic approach, there may be greater propensity for them to be utilized in a broad range of settings, hence furthering the potential of technology education.

Activity Driven by a Need to Know

It is also important that knowledge and skill are not seen only in terms of vocational development. The introduction and development of knowledge and skill on “need-to-know” basis can serve to enhance the developing capability as young children resolve tasks in a satisfying rather than frustrating way. Readiness for learning is an important concept - trying to introduce a new skill or concept to a learner too early can at best be wasteful of time and at worst damaging to their confidence if they perceive themselves as a failure. The concept of teaching knowledge and skills in technology on a need-to-know basis, introducing new material to children at the point they need it to further pursue their designing and making, (Kelly et al, 1987) pays attention to the notion of readiness, but goes further to highlight the importance of teaching something new in context.

In recent classroom research conducted at Goldsmiths (the UTA Project[1]) this approach was very effective. In one instance, a 5 year old was designing and making a house for a toy spider. He had made a slide for the spider to play on, but was concerned that the spider couldn't get to the top of the slide. He thought a ladder would be the answer, but needed to know how to make one. The teacher intervened at this point, first to support him to visualize and then draw a ladder, and then to introduce new skills of measuring, marking and cutting wooden dowel and using a low melt glue gun to join the ladder together. The timing was just right, and having developed and consolidated his new skills, the child went on to use them in further work. An older child, age 10, was making a model fairground carousel. She had an idea that it was possible to power the carousel using weights and pulleys, but had no understanding of how this could be done. The teacher stepped in and worked with the child to introduce new understandings about pulleys and then supported the child to utilize this new knowledge to make her roundabout work. In a third incident a whole group was working on making model houses and supermarkets for an exhibition. At the point at which they needed to make stable models of their structures, the teacher demonstrated a range of ways of doing this. Introducing new knowledge when the need is triggered by the project allows a teacher to identify opportunities for progression and critical windows for supporting this. We concluded that it is vital that pupils are engaged in designing and making that is just within or just beyond their reach. This challenges them constantly to extend into new understandings in order to achieve success (Kimbell et al., 1996, p 76).

Problem Solving

A complementary approach, particularly in relation to developing new conceptual understandings, is the use of problem solving. As mentioned earlier, finding out by solving problems is a strategy used by very young children long before they engage in formal schooling. The UTA Project (Kimbell et al., 1996) was particularly conscious of the effective use of this approach with older primary children (8-11 year olds). We the researchers witnessed a range of new understandings being developed in this way: a child working out how to make a slipper that would fit his foot by experimenting with scissors, paper and pins to make a working model; a pair of children working out how to make a tiller for a galleon that could genuinely be used to steer it; a child working out how to make a Venetian blind for a model house she was making; and so forth. In all cases, the solving of the problem became a motivational hook and the sense of

[1] The UTA (Understanding Technological Approaches) Project, sponsored by the Economic and Social Research Council (Research Award R-000-23-3643) was conducted at Goldsmiths University of London between 1992 and 1994. It used close observation techniques to build case studies of technological project work from children from age 5 to age 16. For a full description of the project see Kimbell et al 1996.

challenge and achievement was tangible. Problem solving inevitably involves children in risk taking situations and it is important that it is conducted in a supportive atmosphere. It is equally important that the teacher is on hand to either provide prompts if a child meets a challenge that is too demanding to be achieved independently, or to provide answers that counter any misconceptions a child might develop.

Hands on Exploration

Again linked closely to the previous approach is a belief in learning through hands on exploration in the context of problem solving research. In their collection of activities from across Europe, Benson & Raat (1995) include a valuable example of young children researching material properties through hands on exploration. Six and seven year old children were provided with a collection of different types of wire and gauze and simple tools that could be used to cut and bend them. They were introduced to an activity aimed at finding out as much as possible. They did this first by observing and then by manipulating about the way the wires could be bent, cut and twisted. Initially they explored possibilities in a free way and then explored ways of using their experience to identify technical and decorative uses. This kind of activity builds on the approach very young children adopt to find out about their world. While it is in many ways quite structured, its antecedents can be seen in the free flow play (Bruce, 1991) of the toddler, as can it's value in developing both understanding and mastery.

The UTA Project (Kimbell et al, 1996), found that hands on exploration was a useful way for children to model design ideas. Working directly with materials appeared to free children to think in 3 dimensions, to work kinesthetically with materials and create their designs by trial and error. But, they did this with a growing understanding of the working properties of the material. This was particularly evident with one ten year old child who used this approach to build a complete model staircase, including a landing that turned the staircase through 90 degrees.

Modeling Ideas

The above examples illustrate appropriate ways of encouraging children to develop understanding and also to model their design ideas. They demonstrate how children’s ideas move from hazy ideas in their heads towards working, tangible realities. The approaches all have a firm foundation in models of learning utilized in many primary schools. However, a great deal of concern has been expressed in the UK that the development of technology in the curriculum of young children should not be dominated by paradigms developed in secondary schools, or seen as a mere watering down of work done with older pupils. These concerns have related as much to the approach to work as to the content of lessons. Some of these concerns have been confirmed by situations where a primary teacher has, for want of any other example, employed secondary school approaches, only to find them ill suited to supporting the needs of the children. An illustration of this has been seen in approaches to getting children to generate ideas where the perceived approach has been to ask the children to design what they want to make, in advance, by drawing on paper. This has led to frustration for teachers because they have been uneasy with the relationship between what the children drew, what they eventually went on to make (often bearing little resemblance to the initial drawing) and a growing sense that the act of making the drawing was not supporting the child's process or development. It has also led at times to frustration on the part of the children. The act of trying to express a 3D artifact through 2D on paper (an act that Angela Anning (1993) so aptly points out "would tax many adults") provides confusion and complexity rather than clarity - a clarity that perhaps would have been more attainable by modeling the idea directly in 3 dimensions using construction kits, modeling clay, paper or cardboard.[1]

This concern, particularly in relation to the procedures children use in technology tasks has prompted recent research in the UK focusing specifically on the early years (Johnsey, 1995; Roden, 1995). Cy Roden's work with 5 year olds has raised issues about whether the strategies commonly used by young children are replaced by others as they get older, and suggests that there may be an optimal time for the development of any strategy. This raises the need for further consideration being given to indiscriminately introducing a strategy to one age group that is utilized with older learners. Findings of the UTA Project clearly indicate that children of the same age utilize different working styles, and given the freedom to do so, adopt procedures that best suit their own style. Perhaps the key message here is that, whatever their age, a range of different and appropriate strategies should be accepted and encouraged. What is most important is that children express and develop ideas. The ways in which they do this should be seen as a means to an end and not an end in themselves.

The Importance of Context and the Use of Fantasy

Teaching within meaningful contexts is important in bringing relevance to an activity and to help children take ownership of tasks they undertake. Within technology education the context serves a further purpose. The context becomes a vehicle to bring the design issues into the open. Children designing homes for toy spiders have to think about a range of criteria that relate to creating successful homes—keeping dry and warm, creating a stimulating environment and so on. By addressing such considerations, the task the children are engaged in becomes richer and the children's decision making more thoughtful. One very important strategy that helps a child engage with a context is to use fantasy or role play (Stables, 1992b). This was the case with a group of six year old children whose teacher had taken the topic of explorers for the focus of their work. Through role play and imagination, the class had gone on a sea voyage, been chased by pirates, shipwrecked and subsequently washed up on a deserted island. The children enacted the experience of spending their first night on the island - with nowhere to sleep, nothing to keep them warm and dry, and nothing to protect themselves from wild animals and the pirates. As a result, the children

[1] For a more detailed debate on the use of drawing as a designing tool with young children see, for example, Samuel 1991, Anning 1993, Constable 1994, Egan 1995.

identified the need to build shelters and set about designing and making model shelters that would provide warmth and protection, that would allow rain to run off, that were camouflaged from the pirates, and that had secure entrances, some protected by booby traps, should the pirates track them down. Each decision that was made was governed by the fantasy situation but was made in a critical and thoughtful way. In order to realize their designs, children needed to develop new skills and understandings such as how to make a pointed roof, how to make a house on stilts that didn't wobble, and how to make a fence that contained a hinged gate. The level of learning was made possible by the willingness of the children to engage in the fantasy world.

The Importance of Reflection

The model of technology being promoted here is one in which children are thinkers as well as doers. Consequently the teaching and learning approach needs to be structured to develop children's ability to reflect on their work. Young children develop many skills initially at a tacit level. They may, for example, have developed skills in cutting cardboard shapes accurately without being conscious of how they do it. As educationalists, it is important that we help children turn their tacit understandings into explicit ones - to be 'metacognitive' about their experience. Providing opportunities for reflection and resourcing these with appropriate prompts is critical in achieving this. There are good examples of teachers facilitating this by encouraging children to use devices such as logs and process diaries (Rogers & Clare, 1994). Putting children in a position where they take responsibility for their actions was seen as one way of achieving this in Project Update (TIES, 1994). The author gives the example of children asking the teacher when their project would be finished. The question was turned back on the children - when did they think it would be over? The children discussed this and then replied, "It will be over when it does what we said it would do." The Project reporters point out that this statement showed that the children "had to re-examine their thinking to determine what constituted an adequate purpose," a process which required them to bring their thinking out into the open, thus making it explicit and available for reflecting upon.

Models for Monitoring and Assessing Work

Supporting the children to develop reflective skills will also facilitate the way in which they can evaluate both the outcomes of their task and the progress they have made. This self assessment has often been a feature of the logs and process diary approach and can contribute to the overall assessment by the teacher. By involving the child in the process, they are empowered to take control over their own learning. This approach has been piloted across the primary age range, starting with 5 year olds (Rogers & Clare, 1994).

If such assessment relates directly to project work, then the assessment process can be integrated into the learning process. Children can assess themselves and be assessed by their teacher while working on task thereby allowing for "authentic assessment." However, it is important to distinguish between monitoring a child's experience (in order that the teacher can keep track of the experience and use this to help plan a broad and balanced curriculum) and assessing the capability they display (in order to keep track of the child's progress and, within this, strengths to be built on and weaknesses to be addressed).

It is also important to consider what is the most appropriate model of assessment to be utilized. As has been discussed earlier, technological capability is an integrative capability that draws on and draws together a person's knowledge, skill and understandings. Because of it's integrative nature, the capability is best developed in an holistic way, and hence assessed in a holistic way (Kimbell et al, 1991). This approach allows teachers to build an overall picture of a child's capability, within which they can look to diagnose specific strengths and weaknesses. Once identified, action for development can be taken within the context of the child's overall capability, identifying strategies (that can perhaps be shared with the child) to develop specific areas, such as a child's ability to plan, to reflect, to make and so on.

"Taught not Caught"

Developing technological capability requires teachers to structure activities and inputs in such a way that what children learn, in terms of procedures, concepts and skills, is "taught not caught" (Anning, 1993). Moreover, the children should be active participants in this process. This is not to marginalize experiential learning or to discount the potential of serendipity, but rather to identify the importance of teachers taking an active role in determining both the what and the how of the learning. This means that teachers need to have the personal knowledge, skill and confidence to resource this, which, because of a lack of training provision, is not often possible. It is therefore important to now turn to those issues that relate to meeting the needs of the teachers involved in the enterprise.

Addressing the Needs of the Teacher

Earlier the importance of the'readiness' of children to learn was emphasized. This concept is equally important when considering how teachers can be supported to engage successfully in technology education.

Very few primary teachers have received formal training in the teaching of technology education. Even those countries that have decided to introduce compulsory technology education into their primary curriculum, and who have set up training programs to facilitate this, have a back log of unprepared technology educators teaching in primary schools. The task of providing professional development for them all is massive. Our experience in the UK (where by some standards there has been a considerable input of resources, although nowhere near enough to meet teachers' needs), suggests key areas to be addressed in helping teachers move forward include:

- developing teacher's understanding of what technology education is;
- helping them see how the work they currently do, and the experience they already have, can be adapted to allow technology activities to grow from the work already undertaken with the children;
- developing their confidence in their ability to build on and utilize their previous experience;
- identifying a broad but manageable range of activities for teachers to start from, and providing them with personal, hands on experience with the activities before they embark on them with children;
- providing opportunities (through dialogue and printed materials) for teachers to share good ideas and good practice and build a repertoire of successful activities.

Pilot projects that have been structured to address the above areas have provided good models to build on and have illustrated both issues to be dealt with and strategies that contribute to success. Taking each of the key areas above and illustrating them from some of the work that has taken place in recent years will perhaps help clarify some ways forward.

Developing Teachers' Understanding of Technology Education

From 1990-1992, we at Goldsmiths developed a set of National optional assessment tasks to help primary teachers assess technology capability. This project was linked to the introduction of the National Curriculum in Technology and the tasks were designed not only to help teachers make assessments, but also to help them structure and manage technology activities (sometimes for the first time). Teachers were very confused about technology - was it computers, applied science, or craftwork? We wanted them to understand the simple message that technology was about designing and making products that would meet peoples needs and desires and that the children needed to 'design what they made and make what they designed'. We started by providing activity guidelines and involving teachers in group discussions and 'hands on' activity to see how the guidelines could be used. They then worked through the activities with the children, providing concrete examples to evaluate. For many teachers this was a daunting and sometimes painful task, but, in terms of developing their understanding, the comments made on evaluation questionnaires speak for themselves:

> "Excellent illustration of the D&T[1] process - particularly useful for INSET" (In-service training, (Year 2 teacher)

> "This was a really worthwhile project to be involved in, for the class and myself. I feel the next D&T work we tackle will see a marked improvement ... because of the learning done during this task." (Year 5 teacher)

[1]D&T - Design and Technology, is the National Curriculum title for this activity in the UK.

> "I've learnt a great deal about D&T and what the children are capable of"
> (Year 6 teacher) (Stables, 1992c)

The Learning in Technology Education project, carried out in New Zealand from 1992-1994, involved both primary and secondary teachers for this same purpose. Introducing technology education to the primary teachers illustrated several parallels with the researchers' experience in the UK. At the start of the venture the primary teachers expressed similar confusions about the nature of technology education. But again, following a process of discussing technology education, exploring exemplar activities and then planning, implementing and evaluating their own activities, it became evident that the teachers' understanding (and with it their confidence) had grown (Jones, Mather & Carr, 1994).

In both of these examples, certain aspects are worth highlighting: the teachers were involved in first hand activity; they had opportunities to discuss what they were doing with others going through the same experience; and they were actively encouraged to evaluate their experience. Just as is so valuable with children, the teachers were provided with the opportunity for action and reflection—to be both 'thinkers' and 'doers'.

Building on and Adapting Previous Experience

Once primary teachers become involved in a technology activity, they realize how much they can draw both on their general teaching skills and also on work from other areas such as science, mathematics, and art. Working from strengths is important, but within this it is necessary to help teachers see how previous work might need a shift in emphasis to develop as a technology project. This was the case with a teacher who had taken a topic of "Down our street" with a Year 2 class. This topic initiated science work as children explored the materials the street and the buildings were made from, history work as they investigated the history of street lighting, and art work as they drew the local buildings and made a street scene frieze. However, the teacher was having trouble locating a starting point for the technology work. Following discussions during which we explored the importance of the concept of need and purpose in technology, she introduced to the class an idea that they should think of ways of "improving our street." The addition of this one word, and the shift in emphasis it indicated had an amazing effect on the children's imaginations and within no time they had changed their classroom into a planning office, re-designed the signs and blinds over local shops, explored ways of designing pavements by laying paving slabs in interesting patterns, and building a model to show how the street could be turned into a pedestrian precinct.

Working from teachers' strengths allows them to make a start on a technology project (not necessarily as large as the "Down our street" project became), and from this to build their confidence to embark on activities without feeling they have to know all the answers. As one primary teacher from the Learning in Technology Education project (Jones, Mather & Carr, 1994) said, "It's taking risks, not only asking the children to take risks, but the teacher too…. I think that learning, as far as I'm concerned, is being a co-learner with my children. Not assuming that I know everything." (p. 27)

In the Goldsmiths project, in a questionnaire aimed at identifying the primary teachers' state of readiness to teach technology, there was a common pattern to the teachers' feelings about their own strengths and weaknesses. Often seen as an area promoting confidence was the teacher's ability to introduce and discuss work with children, whereas a common lack of confidence related to lack of skills to support children's making (Stables, 1992c). This latter concern is a very real one and is the reason behind much primary technology in-service work being focused in this area.

Providing Teachers with 'Hands-on' Experience

An approach that breeds both confidence and skill in supporting children's making, is one which provides teachers with opportunities for hands-on practical work themselves. This is common in in-service courses in England and was a feature of the early work done with teachers involved in Project Update in the USA. The value of such activity is that the teachers not only develop the specific skills required, but the activity also provides a reference point for planning classroom activities—how long will the activity take, what resources are needed, what will the children need to be taught, will it be best for them to work as individuals or in groups? Teachers are able to see how best to manage the activity.

Building a Repertoire of Good Practice

An outcome of each of the three projects mentioned here was a collection of classroom activities to be shared. The optional assessment tasks were trialed and evaluated (though not initiated) by the teachers, and modified accordingly before being made available to all teachers in England and Wales. The Learning in Technology Education project produced examples initially of activities drawn up by the research team, but once the teachers had planned and trialed their own, these were added into the bank. Project Update has been set up with a clear aim of supporting the teachers involved to become curriculum writers, as their planned, trialed and evaluated activities are edited into a collection of classroom materials supporting not just technology, but also science and mathematics.

In any area that is as new to the primary curriculum as technology is, sharing good ideas and good practice is imperative. Developing a repertoire of good practice not only enables new teachers to be "fast forwarded" into the venture, it also builds a solid foundation that gives confidence within the profession.

Providing Coherent, Progressive and Continuous Technological Experiences

This repertoire should not only provide good activities and support effective learning in an isolated way, but also should provide a model for progression in order that children have a coherent experience. However, recent research on the UTA project (Kimbell et al, 1996) has shown that England has been very concerned to develop both primary and secondary technology education yet less concerned to ensure that there is clear and smooth progression between the two phases. In particular, very different teaching (and hence learning) styles have developed, creating a discontinuity in the children's experience. As noted earlier, it is very important to consider the developmental needs of the young child, rather than the vocational needs of the country. It is important, however, to take account of the shift in preoccupation that will inevitably be present in the final years of schooling. In England we still have much to learn about how we can manage the shift in emphasis in a way that optimizes the development of the child's capability. There are however promising signs of dialogues developing between primary and secondary teachers as they become aware of the need to address this issue in a positive way. With hindsight it may have been more

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