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Technology Education in the Primary School: Where Do We Start?

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Abstract

This paper argues that teaching about technology in the primary schools should start where the children are, that is, teaching and learning strategies should be designed with cognisance of children's perceptions and understandings about technology. The paper reports a synthesis of two matched research studies into the perceptions about technology of primary school children in Western Australia and the United Kingdom. The findings indicate great within and between school variation in children's understandings in both countries, and suggest that the nature of those understandings can be traced to the different curricular emphasis currently given to technology education.

This paper reports part of a larger study of the perceptions about technology held by primary school children in Western Australia and the United Kingdom. In both countries, technology has increasingly assumed an important role in the curriculum, but its incorporation has not been straightforward for at least three reasons. First, the introduction of technology education has been confused by multiple interpretations of its content. Second, the curriculum change has not been supported by adequate professional development for the teachers who may need to teach the technology course. Third, as a consequence of these points, there is confusion among teachers about both the content and the pedagogy relating to technology education. We suggest there is a fourth issue relating to technology education which is crucial to the successful teaching of technology: Little attention has been given to the role children's own understandings of technology may play in the teaching-learning activities in the classroom. It is this issue which stimulated the research of which this paper reports part. Specifically, the paper deals with two questions:

1. What do children understand by the word "technology"?

2. Do children's views of technology reflect the way in which technology education is offered in Western Australia and the United Kingdom?

The paper begins with a brief overview of the state of technology education in Australia and the United Kingdom in order to place the study in context.

Technology Education in the United Kingdom and Australia

The history of technology education has been bound up with the interpretation of its meaning with respect to industrial art and design on the one hand, and science on the other (Lewis, 1991). Donnelly (1992, p.26) traces the transformation of technology education in the secondary school in the United Kingdom around 1970 "from a domain inhabited by less able boys, rehearsing routinised manual skills ... and girls, studying cooking and sewing". Prior to this, technology had often been interpreted with a science and engineering emphasis. By the late 1970s, Craft, Design and Technology (CDT) had become a subject in many secondary schools and the connection between technology and design has continued, although the relationship has not always been the same, and has often been the subject of confusion (Donnelly, 1992; Medway, 1989). During the 1980's, CDT began to have closer links with science and the relationship between science and technology has also become one of some debate. Black and Harrison (1985) tried to clarify the confusion in the curriculum about CDT, science and technology, particularly as they relate to the development of technological capability. They suggested that their model for technology education could be implemented by a whole-school approach to teaching technology. Allsop and Woolnough (1990) suggest that as well as the whole-school approach and one based on CDT, there is also an approach based on "hitec". Donnelly (1992) claims that in the shift towards the National Curriculum, technology education has been dominated by CDT rather than by science, as evidenced by calling the subject Design and Technology. This means that the link between technology and science has often been restricted to the application and implications of science in a technological society.

With the advent of the National Curriculum, the extension of technology education into the primary schools in the United Kingdom became widespread, but is a comparatively recent addition to the curriculum. At the primary level, technology was initially combined with science, but then emerged as a separate subject in which design dominates (NCC, 1990). This is emphasised by the definition of technology in the proposed revision of the National Curriculum: Design and technology involves applying knowledge and skills when designing and making good quality products fit for their intended purpose (Department for Education, 1992).

In Australia, the introduction of technology education has had a shorter history and it has been more fragmented than in the United Kingdom, because curriculum has been a state, rather than a national, responsibility. By 1990, every state had some form of technology education. In New South Wales, for example, Technology and Applied Studies was a Key Learning Area in secondary schools and a Technology Studies subject was introduced in 1990. This subject emphasised design but at the primary level, technology was linked with science. In Victoria, Technology Studies was one of the P-10 Curriculum Frameworks and it has a strong bias to the technological process of inventing, planning and evaluating. A different situation existed in Western Australia, where Science and Technology formed one of the seven components of the K-10 curriculum from 1985. Particularly at the primary level, there was little to guide teachers about how to teach technology in this context. Now, in 1993, there is a National Statement on Technology for Australian Schools (Curriculum Corporation, 1993) and we wait to see whether it will be endorsed and implemented nationally. Its four strands of Designing, Making and Appraising; Information; Materials; and Systems separate technology almost completely from science. The definition of technology makes this clear: Technology involves the purposeful application of knowledge, experience and resources to create products and processes that meet human needs.

The changing face of technology education in both the United Kingdom and Australia has left teachers, particularly primary teachers, somewhat perplexed. As is often the case in curriculum innovation, the provision of the professional development which informs and enables teachers to cope with the change has lagged well behind its implementation. In the United Kingdom, technology education occurs in schools to varying degrees and, because of the emphasis on the design cycle in the National Curriculum, technology is frequently taught in terms of model-making and other design and construction activities. In Australia, technology in the primary schools is sometimes combined with science, as demonstrated by the frequent reference to technology in the Australian Science Teachers' Association's primary science journal, Investigating.

The limited curriculum materials for technology education and appropriate inservice training, which includes information about approaches to learning and assessment, for example, means that teachers lack knowledge about both content and pedagogy relating to technology education. There is another potential problem, particularly in Australia, where technology has more closely been allied to science, and this relates to the fact that there is little science taught because teachers generally feel unqualified and lack the confidence to teach it (DEET, 1989). Will they be willing and able to teach technology? What little evidence is available suggests that primary teachers' lack of knowledge about technology could be an impediment to its introduction (Symington, 1987). Other research indicates that teachers' and children's perceptions of what technology means are frequently at odds (Medway, 1989; Rennie, 1987). Taken together, these factors make even more salient the issue tackled in this paper: the need to know what children understand by technology.

Children's Perceptions about Technology

A variety of methods have been used to measure children's perceptions about technology. Free responses, such as those elicited by an open-ended question or drawing, have the best potential to evoke children's dominant thoughts about technology (Rennie & Jarvis, 1993), but the research is rather limited. The Pupils' Attitudes Towards Technology (PATT) project in the Netherlands used an invitation to write about "what comes into your mind" when you hear the word "technology" as one of its methods to find out about children's perspectives (Raat & de Vries, 1986). Electricity, transport, domestic appliances and computers were the dominant themes in their results with 13- and 14-year-old students (Raat & de Vries, 1987). De Klerk Wolters (1989) used the essay with Dutch 10-12 year-olds with similar results. The PATT essay topic has also been used in other countries with similar, wide-ranging responses (Raat, de Klerk Wolters, & de Vries, 1987). In Australia, Rennie and Sillitto (1988) investigated the responses of Year 8 students to the PATT essay topic. They found that children often related technology solely to computers and electricity. Few considered the diversity or pervasiveness of technology in our society, or had a sense of history and change. In the United Kingdom, Moore (1987) asked 11- to 13-year-olds to "draw a technologist at work". He found that these children placed emphasis on design, invention and making things, as well as using computers.

These limited findings indicate that children have a variety of ideas about technology. The understandings and perceptions of technology which they bring to the classroom will play an active role in their learning by interacting with the instructional activities, just as does their knowledge in other subject areas. Hence, teachers need to know about and consider children's perceptions about technology in their lesson planning, so they can avoid a mismatch between their own and children's conceptions of technology, give recognition to what children know and understand, and provide opportunities for children to be challenged to expand their views and increase their understanding. By investigating children's perceptions about technology, this study will provide information which will contribute to the building of "teacher practical knowledge", to which Duffee and Aikenhead (1992) attribute teachers' decisions about their classroom practice.

Method

This paper reports one aspect of a study which investigates children's attitudes and perceptions of technology using three instruments: a questionnaire for upper primary school children, a quiz using pictures instead of written items for lower primary school children and, for both age groups, a combined writing/drawing activity which complements the questionnaire or quiz. In this paper, results are presented for the Writing/Drawing Activity for Year 3 to Year 6 children from Western Australia (who are a subsample of the Year 2 to Year 7 group used to develop the three instruments) and a larger sample of same-age children from the United Kingdom. The unstructured response format of Writing/Drawing Activity allows children to express their most dominant ideas, and thus lends itself to comparison of the responses between the two countries.

Sample

The Western Australian sample consisted of 243 children in Years 3 to 6 (aged 7 to 11 years) from eight schools in the metropolitan area of a large city. The United Kingdom sample consisted of 742 children, also in Years 3 to 6, from 32 schools in the Midlands. Although selected by convenience, the samples in both countries were representative of the different socio-economic areas and cultures of the regions. Data were collected in Western Australia during July/August, 1992, and in the United Kingdom during September/October, 1992.

Instrument

The Writing/Drawing Activity used the essay topic from the PATT studies because this allowed the findings to be placed into an international context. The topic reads: Technology can mean different things to different people. When you read the word "technology" what comes into your mind? To this was added the instruction: Please tell us what technology means to you by writing about it, or by drawing a picture. You might like to do both. The essay topic and instruction were printed on a page and distributed to the children by their usual classroom teacher. Teachers were requested to read aloud the topic and instruction if they thought any child in the class might not understand it. The children were given at least 15 minutes to complete the activity. Some teachers allowed a longer time because it suited their program on that particular day. Teachers were requested not to answer children's questions which related to the nature of technology until after the activity had been completed.

Scoring of the results included information about several variables.

(i) Nature of the response, in terms of whether the response consisted of a drawing, a written response, or both. The presence of humans was noted in terms of whether or not the child included humans in their response, either as actively participating or affected by some aspect of the content of the response.

(ii) Content of the response, in terms of the identifiable ideas or elements of the drawing or writing. The elements were coded using a descriptive framework developed by Rennie and Jarvis (1993) on data from Western Australia (some of which is the basis for this paper). The broad definition quoted earlier from the Australian National Statement on Technology (Curriculum Corporation, 1993) was used as a basis for deciding what could be included as technology.

The framework consists of nine major categories or groups which provide a first level classification of children's responses, including a category for things which are not technology, and a category for knowledge (as distinct from the application of knowledge). A second, more detailed level of classification for the coding of popular categories, such as products, is achieved by further subdivision. Affective reactions to technology and its social consequences are accommodated in an additional, tenth category.

Trials during coding of the Western Australian data from Years 2 to 7 children, produced 92% agreement between coders and 97% for coder stability over a two week interval. During coding of the responses reported here, any uncertainties were resolved by discussion between the authors.

(iii) Quality of response was assessed using a four point scale relating to the comprehensiveness of the total response. The assessment was made by judging whether the response represented no, or an incorrect, understanding of technology (score=0); very limited understanding (a single idea; score=1); some understanding (two unconnected ideas; score=2); or a good understanding (two or more related ideas; score=3). It is recognised that this "scale" will provide a subjective judgment, but it can be used to indicate a progression of ideas among children of different ages.

Results

Nature of the Responses to the Writing/Drawing Activity

In both countries, children had no difficulty responding to the Writing/Drawing Activity. Some younger children did not have a view of technology, and they either indicated this in writing, or they drew an unrelated picture.

Table 1 reports a summary of the nature of the responses. The most common form of response was to both draw a picture and write at least one sentence as well. Labelling of the drawing was not considered to be a written response. Perhaps surprisingly, there was no significant age trend, as it might be expected that younger children would be more likely to respond with a drawing only. There was, however a strong association with sex. Boys were more likely to respond with a picture only than were girls (c2 =10.49, p=.01 and c2 =29.22, p=.00 for Western Australia and United Kingdom, respectively).

Table 1 also indicates that two-thirds of the children in each country included the presence of humans in their response. There was no difference between boys and girls in this aspect of their response. In both samples there was an association with year level, with younger children including more humans in their responses. In Western Australia, the Year 3 children were more likely to include humans than other year levels (c2 =42.50, p=.00), a feature seemingly attributable to the fact that when these young children drew a picture unrelated to technology, they usually drew people. In the United Kingdom, the significant association with age (c2 =38.87, p=.00) was due to a larger number of Year 4 children, and fewer Year 6 children than expected by chance, who included humans in their responses.

Table 1. Nature of the Responses to the Writing/Drawing Activity

Nature of the Response	Western Australia (n=243)	United Kingdom (n=742)
Format of Response		
Writing Only	24.7%	20.5%
Drawing Only	29.6%	18.2%
Writing and Drawing	45.7%	61.3%
Presence of Human		

Humans present	31.3%	31.1%
Humans absent	68.7%	68.9%

Content of the Responses

A wide range of ideas were included in children's descriptions of technology. It became evident during coding that even within the same classes and schools, there was a variety of views mentioned. Overall, the responses were coded into more than fifty separate content divisions (see Rennie & Jarvis, 1993). Most children mentioned more than one idea, in fact the average number of ideas coded per child was 2.90 for the Western Australian children and 2.26 for the British sample. The coding of products into several subcategories accounted for the higher mean number of ideas mentioned in the Western Australian responses. Of the Western Australian children, 20.4% gave responses which incorporated five or more ideas. The corresponding percentage for the British sample was 10.1%. There was a consistent age-related trend in both countries, with older children mentioning more ideas than younger children. The means varied between 1.74 and 3.52 in the Western Australian sample, and between 0.87 and 2.73 for the British children. Thirteen particular ideas were mentioned by at least seven percent of children from either country, and these ideas are listed in Table 2.

Table 2. Percentage of Children in Western Australia and the United Kingdom Mentioning Common Ideas about Technology

Idea/Object	Western Australia	United Kingdom
Product Related Ideas		
Computers	64.5%	26.5%
Electrical Appliances	39.0%	28.8%
General Machinery	23.9%	19.5%
Vehicles, eg cars		

22.7% 19.2%
Telephones
12.4% 6.7%
Design-Related Ideas

Inventing, Inventions

20.1%
7.4%
Designing, Experimenting
10.3% 14.8%
Making models
1.3% 47.4%
Manufacturing
8.1% 4.4%
Temporal Aspects

Modern Things
11.1% 4.4%
Future Things
7.7% 1.6%
Other Aspects

Positive Aspects
eg useful, helpful
15.8% 4.6%
Scientific Things
16.2% 13.3%

The pattern of responses is quite different between the two countries, and the basis for this difference is essentially the strong element of model-making in the British responses and the basically product-oriented view of the Western Australian sample. It can be seen from Table 2 that similar numbers of children in each sample mentioned designing and experimenting, but this was associated with invention in the Western Australian group, and with making models in the British responses. Western Australian children were twice as likely to mention manufacturing than British children, but almost no Western Australian children mentioned making models. Electrical products, particularly computers, were popular responses among the British children, but not nearly as popular as they were among the Western Australian children.

In each country, about one-eighth of the children connected science and technology, and in about half of these cases, this was the only idea expressed. It seems that a significant number of children are confusing science with technology.

Quality of Response

Each response to the Writing/Drawing Activity was given a subjective assessment according to the level of understanding displayed. Table 3 shows the results of this coding and indicates, not surprisingly, that a higher level of understanding is associated with the responses of older children. There are statistically significant age-related trends (c2 =76.47, p=.00 and c2 =94.16, p=.00 for Western Australia and United Kingdom, respectively). Years 4 and 5 children in Western Australia seem to have more understanding of technology compared to children in similar years in the United Kingdom. At the time of the data collection the academic year had just started in the United Kingdom, hence the British children are actually a few months younger at each year level, and this factor may be significant. Nevertheless, even in Year 6, almost half of the children in both samples demonstrated only limited understanding of technology.

Table 3. Children's Understanding of Technology (Percentage)

No Understanding
Limited Understanding
Some Understanding

Good Understanding

Year Level

WA
UK
WA
UK
WA
UK
WA
UK

Year 3

48
42
33
48
19
10
0
0
Year 4

	3	30	71	50	26	17	0	3
Year 5								
	2	15	63	52	32	26	3	6
Year 6								
	5	5	44	42	40	41	11	12

Discussion

The results of the study provide information on several levels. First, children have an enormous variety of ideas about technology, and there is compelling evidence that even children in the same class hold widely differing views. This underscores the need for teachers to be aware of the perceptions of the children in their classroom and structure their lessons accordingly. Technology lessons prepared and implemented without taking children's ideas into account may well engender confusion.

Second, children's views seem to become more complex and coherent as they become older, but many children associate technology only with computers and modern appliances. Of course, it is possible that children have wider and more coherent views than were represented in their responses. This is a weakness inherent in the use of open-ended questions: the respondents may provide only partial information about their understanding. In the larger study, the use of the Writing/Drawing Activity complemented the Technology Questionnaire and/or the Picture Quiz giving a breadth to the data which is not possible to achieve with a single scale. However, the variety of responses on the open-ended Writing/Drawing Activity revealed insights to children's thinking which could not be obtained from the highly structured nature of the Questionnaire or Picture Quiz, and it provides compelling evidence that children in the two countries have varied and different ideas.

Third, the nature of children's perceptions about technology mirror the way technology education is presently offered in the two countries. In the United Kingdom, the power of the design cycle in the teaching of technology seems to have been reflected in the responses to the Writing/Drawing Activity by an emphasis on model-making, an aspect virtually ignored by Australian children. In contrast, and with no coherent approach to technology education in Western Australian primary schools, the responses of these children suggest that they form their ideas about technology from incidental, and often out-of-school sources, like family conversation, television and other forms of media. These children gave a wider variety of responses, notably presenting a product-oriented view, which is consistent with learning about technology from a variety of sources.

Finally, the patterns of results provide an extensive contextual background for the next stage of our research. We are now examining, through interview and observation, the perceptions expressed by individual children in relation to their responses to the instruments in order to trace the connections between children's understanding, the teacher's understanding, and how science and technology are presented in the classroom.

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