Building Bridges Out Of Walls - Mathematics Education and Technology Education

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Teachers ideas, attitudes and beliefs about a subject are thought to influence the way the subject is taught. This paper reports on a pilot study conducted to explore mathematics educator's views about technology education and its relationship to mathematics. Related mathematics education literature focuses on technology's utilitarian value to mathematics education, with particular emphasis being placed on the use of computers and calculators. Little attention is given to mathematics education's contribution to technology education. Results from the study reflected the approach taken in the literature and suggest that the mathematics educators had difficulty in adopting a balanced view of the relationship between mathematics education and technology education. The paper calls for a broader approach on the part of mathematics education and argues that more attention be given to the interrelatedness of knowledge and the boundaries between the school subject areas.

Introduction

This paper focuses on the relationship between mathematics education and technology education. It has its origins in the difficulties that I experienced as a mathematics educator in coming to grips with the recent New Zealand curricula initiatives in regard to technology.

In New Zealand, the new curriculum framework (Ministry of Education, 1993a) gives technology equal 'billing' along with subjects such as mathematics, science and language. This and other curriculum material portrays a 'newer, broader' vision of technology. It goes beyond definitions that see technology in terms of "mechanical arts and applied sciences" (The Concise Oxford Dictionary, 1990) or definitions which emphasise the latest technologies, such as lasers, computers and robots. An introductory booklet on technology education (Ministry of Education, 1993b:5) provides an example of a definition which sees technology as:-
...a purposeful activity aimed at meeting needs and opportunities through the development of products, systems or environments. It takes place within specific contexts and constraints, and is influenced by value judgements.

While what this definition actually means is worthy of further consideration, of chief interest to this paper is how a 'newer, broader' vision of 'technology' and thus 'technology education' might impact on mathematics education. Ignoring the relationship between the two does not

seem helpful. As noted by Begg (1994:9), *mathematics and technology have lots in common and this commonality needs to be considered.* In part answer to this and the call to make education more relevant the existing curricula subject divisions and their groupings are receiving closer scrutiny. The New Zealand curriculum framework (Ministry of Education, 1993a), for example, talks about 'learning areas' instead of subjects and draws attention to the need for links between 'learning areas'. 'Learning areas' are meant to be broader than subjects and may actually include a number of subjects. In terms of linking the 'learning areas' words such as *interrelated, connections between* and *integrated* are used. With regard to technology in particular, the idea of links with other learning areas is stressed. The introductory booklet, for example, describes technology as a *multi-disciplinary activity*, and says that *each subject can contribute in its own way to students' learning about technology* (Ministry of Education, 1993b:7).

Internationally technology has not had a 'smooth ride' into the school curriculum. Problems associated with terminology and of defining its discipline base, for example, have led to considerable confusion and uncertainty (Lewis & Gagel, 1992). Recognition of technology's apparent pervasiveness and importance has led to major initiatives in many countries. For example, in England and Wales, the introduction of 'technology' into the curriculum has been described as a 'radical departure' from the 'familiar' (Medway, 1993). While there seems an awareness of the importance and pervasiveness of technology, recognition of technology's unique character remains elusive (Burns, 1990). The use of the acronym SMT in literature suggests that science, mathematics and technology can be dealt with together as if they have common concerns. While it appears the relationship between science and technology has received considerable attention the link between mathematics and technology education has not.

What does the introduction of a 'new' approach to technology education mean for us in mathematics education? How, for example, do we go about linking technology education with mathematics? While many questions arise, one factor recognised as having an influence on the success of curricula reforms is the 'ideas, beliefs and attitudes' that teachers have about the nature of their subjects. Dossey (1992:39), for example, notes that a teachers' perceptions of the nature of mathematics are often regarded as being 'more influential on their teaching' than their views are about what is the best way to teach.

Of the few studies in the area of teacher's perceptions of technology most have tended to focus on teachers' ideas of technology rather than their ideas of technology education (Jones and Carr, 1992). Generally, the research indicates that a teachers' past experience and subject subculture

strongly influences their views of technology. Teacher's interests in computing or music, for example, were found to influence their views of technology education (Jones and Carr, 1992). On the issue of 'subject subculture', Jones and Carr (1992:33) found that *science teachers emphasised applications, social studies teachers focussed on societal aspects, and English teachers focussed on journalism, media and drama,* and so on. Studies suggest that the 'subjective realities' of teachers need to be taken into account when planning curricula reforms. Paechter (1991:10), for example, notes that 'subculture retreat' is a *pervasive factor of the negotiation of the new subject of design and technology*, in the UK curriculum. While the literature on teachers perceptions of technology noted the subject subculture influence of other subjects little reference was made to mathematics. What then do mathematics teachers think of technology, technology education and its relationship to mathematics?

The Study

The present study sought to explore aspects of the relationship between mathematics education and technology education. As well as looking at how the mathematics education literature approaches technology a pilot study of mathematics educator's ideas of technology and its relationship to mathematics was conducted.

Due to the somewhat abstract nature of the research question an interview method was felt the best way of drawing out the mathematics educator's ideas. A semi-structured interview involving an interview schedule and prompt material was used. The prompt material consisted of statements from the curriculum material (Ministry of Education, 1993a, 1993b), and Begg's (1993) paper on 'Technology Education and Mathematics', which suggested a link between mathematics and technology. A crucial aspect in the choice of interviewees was the potential of each person to contribute. Rather than attempt to discuss the relationship between mathematics and technology with mathematics educators unfamiliar with the ideas in the new technology curriculum initiatives, it was felt more would be gained by selecting those who already had some background. The five subjects chosen were all participants in a post graduate level mathematics education course. All had taught for a number of years at either the primary or secondary level and had returned to do further studies in mathematics education on either a part time or full time basis. As part of their course of study all had been exposed to readings and discussion on technology and mathematics education.

The interview focused on the mathematics educator's ideas about technology, technology education and technology education's relationship to mathematics. Interviewees were told several weeks in advance of the nature of the interview. Each interview was conducted in the

work setting of each person and lasted approximately 30-40 minutes. Although the interview schedule was used as a guide the interviews were generally free ranging in nature. Data from the interview transcripts was analysed according to the themes in the interview schedule and themes that arose from the interviewees responses.

Perceptions of technology and technology education

UNCERTAINTY ABOUT THE MEANING OF TECHNOLOGY?

The mathematics educator's perceptions of technology were similar to the perceptions found of teachers in other technology education studies (Eg. Jones and Carr, 1992). All expressed uncertainty about what was meant by technology, within a curriculum context, and this uncertainty was carried over to their views about 'technology education'. One said, for example, *I think that probably half the problem is, that what is actually meant by technology is not all that clearly defined, is it?* [I4].

A COMPUTER / CALCULATOR CENTRED VIEW

Generally, all had a fairly unique and somewhat limited view of technology. Although other aspects of technology such as design, invention, building and problem solving were mentioned the frequent references to computers and calculators indicated a clear preference for recent 'hi-tech' type technology. Interviewee 3 said, *at the classroom level, it means kids have to know computers ... have computers and calculators. One of our teachers has a cell phone.* Interviewee 5 said, *I see it as use of things like computers and calculators. Anything technological basically .*

THE INFLUENCE OF EXPERIENCE AND SUBJECT SUBCULTURE

As in other teacher perception studies of technology the participants views in this study seemed linked to their experience. A secondary mathematics teacher with a science background said, *I've never really actually worked out what technology is. I think it's the pesanty side of science, I reckon. It's the applications of science* [I5]. Another, a primary teacher said, *technology can be something that aids you, and technology is looking at how things change ...* [I3]. As would be expected and along with Jones and Carr's (1992) study, subject subculture influence appeared strongest at the secondary level. A heartening aspect noted in the views was that exposure to the new technology curriculum initiatives had challenged the interviewees ideas about technology and even to some extent mathematics. For example, one said, *In the beginning I sort of thought that technology was using calculators and computers. After discussions and so on I find that its not actually only calculators and computers. Its got a broad meaning.* [I2]

Views on the relationship between mathematics and technology education

A STRONG LINK

All participants saw a strong link between mathematics and technology. In two cases the interviewees found it difficult to separate their ideas about mathematics from their ideas about technology. For example, [I1] said, *it is very difficult to distinguish what is technology and what is mathematics, ... it's very much all in together. Where do you draw the line between the two?* Interviewee 5 said, *It depends how we define technology. I mean technology and maths could be the same, couldn't they?*

TECHNOLOGY AS A TOOL

In discussing the nature of the link between technology and mathematics, technology's importance to mathematics appears to be in its utility. Technology is seen largely as an 'aid' or 'tool' to be used in mathematics classrooms. For example, Interviewee 5 said, *To me technology must be a tool. It's a tool which you want kids to have competence in and you want them to have the knowledge and the skills so that they can choose the appropriate tool.* This essentially utilitarian view of technology, when carried over to the broader idea of technology education, places it in a somewhat subservient position in the negotiation of curricula reforms. An example of this can be seen in the responses given about how each learning area contributed to the other. When the participants were asked to comment on technology education's contribution to mathematics education all participants easily provided examples. When, however, the participants were asked to adopt the reverse position and say how they thought mathematics education could contribute to technology education all experienced varying degrees of difficulty. For example, interviewee 2 said, *technology can help maths but I don't see how maths can help technology.* Interviewee 4 said, *It's hard to talk about without illustrating in some sort of specific instance really* . The participants views were generally subject centred in nature with the flow of ideas between mathematics and technology being largely uni-directional (ie. from technology to maths).

AN INTEGRATED APPROACH

All the participants were unanimous in their support for an 'integrated' approach regarding the introduction of technology into schools. Interviewee 3 said, *Its a real integrated subject I guess. Technology draws on everything.* All participants were against technology being introduced as a separate subject and saw the integrated approach as the most appropriate way of linking it to mathematics. One [I2] said, *its not a separate subject. It may go with other subjects.* Another [I5] said, *I am against technology coming in as a separate subject . But that's basically because I am against separate subjects anyway, I would run a much more integrated system* . While an

integrated approach was thought the best approach there appeared differences in their views about what an integrated approach was. One [I2] said, *If you define technology in terms of calculators and computers then of course you can use those tools in classes. In that way I would say you are integrating technology.* While another [I5] said, *I think we* (the school) *will look at which of the current subjects that we've got can pick up what aspects and someone will have to coordinate what's happening.* Although there were differences in their views the predominant view in regard to how integration would work was that existing subjects, including mathematics, would 'pick' what they thought was relevant from technology or would 'identify' the already existing elements of technology education within current practice. For example, Interviewee 1 said, *it is identifying areas within the subjects that are already there and some extras to be added in. But basically a lot of the stuff is actually being taught now.* The notion that subjects or 'learning areas' might negotiate curricula reform as equals seemed absent.

TEACHER DEVELOPMENT

Of the many concerns or problems raised associated with introducing technology education and 'integrating' it with mathematics the chief concern raised by all participants was how teachers would cope. Interviewee 3 for example said, there's *a place for it* (technology education), *but it all comes down to the individual teacher.* The key to the successful integration of mathematics and technology education was seen as dependent on teacher change. This change could be best effected through appropriate teacher development programmes. One participant, for example said, *I think initially its probably going to be teacher development and resources that show that view of mathematics. Once that happens teachers will begin to see the possibilities* [I4].

Conclusion

Although this was only a small scale exploratory study of a selected group of mathematics educators ideas about technology education the results, when coupled with the mathematics education literature on technology, provide useful pointers for planning teacher development programmes and the successful implementation of curricula reforms.

As in other studies of teacher's perceptions of technology and technology education this study found problems with definitions and a narrow computer / calculator centred view of technology education. The influence of past experience and subject subculture on teacher's views of technology education was also found. In regard to subject subculture, as in other studies, nothing unique to a mathematics subject subculture was noted. Perhaps a larger, more random sample of mathematics educators views along with controls for the influence of science and grade level, would enable the identification of characteristics common to a mathematics

subculture. If a teacher's perceptions of a subject influences the way they teach it then a better understanding of how mathematics teachers see technology would be useful in helping realise the links between mathematics and technology education.

Mathematics and technology are seen as very closely linked with technology being recognised as influencing the way we teach, learn and do mathematics. Both this study and the literature suggest that technology is seen as essentially a tool for use in mathematics. A perusal of the ICME 5 (1984)Theme Group 3 papers on technology and Kaput's (1992) review of research in the technology and mathematics education area bears this position out. In addition, the New Zealand mathematics curriculum (Ministry of Education, 1992:14) states that calculators and computers are *learning tools which students can use to reinforce and discover new ideas.* This kind of view about technology is not all that surprising given the lack of a technology education curriculum history from which draw. When, however, this utilitarian view is carried over to the broader concept of technology education difficulties arise. Begg (1993:2) draws attention to this and states that it is *essential that we do not confuse the use of technology with the learning and teaching of technology.* Given that the interviewees generally found it difficult to see how mathematics could contribute to technology education and also their 'pick and identify' approach to integration, technology education will very likely be the weaker partner in the curriculum negotiation process. It is worth remembering at this point that the participants in this study were atypical of mathematics educators generally in regard to technology education. The views expressed here are from mathematics educators who were already familiar with the new curriculum initiatives in technology and thus reflect where ideas are moving rather than reflect where things are still at.

In the title of this paper I used the phrase 'building bridges out of walls'. This to me seemed an appropriate way of summing up my views about the process of linking or integrating mathematics education and technology education. Given the rather one-sided view of the relationship between them, evident in this study, it is my view that the exploration of the boundaries and the establishment of links between learning areas and subjects is one of the important challenges facing mathematics education. While cross curricula links between mathematics and technology are generally acknowledged, when it comes to practice relationships are difficult to realise. In regard to linking mathematics and technology education, Begg (1994) provides some useful ideas about how to 'bridge' the gap. For example, he talks about the contribution that statistics, measurement, and the mathematical processes (problem solving, communication, and reasoning) could make to technology education. Rather than 'retreat' behind so called 'subject subcultures', the introduction of technology education provides us, in

the mathematics education field, with both the opportunity and challenge of rethinking and perhaps even re-conceptualising both mathematics education and technology education. More reflection on mathematics education's contribution, and links to other curricula areas can only enhance its position and lead to an improvement in the quality of education for our children.

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