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ABSTRACT

This paper synthesizes the research of the last decade, with a view to identifying the major trends and issues that have been the focus of inquiry during that period. It is a reflective statement of the current state of knowledge in technology education, and by implication, points to those areas where knowledge is weakest. The paper makes a deliberate attempt to highlight contrasting emphases in the research conducted on opposite sides of the Atlantic and it seeks to stimulate the use of theoretical insights from other areas of educational research in the search for solutions to problems in technology education. It focuses mainly, though not exclusively, on work published in the "Journal of Technology Education," as representing an important forum for reporting research in the United States, and on the "International Journal of Technology and Design Education," as one of the foremost technology education journals in the United Kingdom. The method employed is described as a modified content analysis. All of the articles published in the two journals during the years 1990 to 2000 were listed and classified according to content, as indicated by topic. Subsequent reading of an article often resulted in its being put into more than one category. The categories of articles that emerged were: nature of technology, technology curriculum; outcomes and assessment of technology education; children's thinking in technology; technology teacher education; and gender and values issues in technology education. This research, still a work in progress, reports on all but the last two areas. (Contains 55 references.) (AEF)

An Analysis of Research in Technology Education: What We Have Learned from a Decade of Research.

Glenda Prime

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A N ANALYSIS OF RESEARCH IN TECHNOLOGY EDUCATION: WHAT WE HAVE LEARNED FROM A DECADE OF RESEARCH

Glenda Prime

Perhaps the most significant curriculum innovation of the last two decades has been the inclusion of technology education as a component of general education. This innovation has been widespread, having occurred in the so-called developed and developing countries of both the East and West. The struggle to forge an identity for this new curriculum area has been marked by healthy debate both from within the field and among those outside of it, whose interests are in some way influenced by it. Research has played a major role in this debate. This paper is an attempt to synthesize the research of the last decade, with a view to identifying the major trends and issues that have been the focus of inquiry during that period. It will thus be a reflective statement of the current state of our knowledge in technology education, and by implication, will point to those areas where our knowledge is weakest. In this effort I stand on the shoulders of Foster (1992), who analyzed the research topics of graduate students in industrial education and technology education, and of Zuga (1994), who reviewed research in technology education for the period, 1987 to 1993, and of Petrina (1998a), who reviewed research published in the JTE. The present paper departs from these in at least two important respects, (a) it makes a deliberate attempt to highlight contrasting emphases in the research conducted on opposite sides of the Atlantic, and (b) it seeks to stimulate the use of theoretical insights from other areas of educational research in the search for solutions to problems in technology education.

I chose to focus mainly, though not exclusively, on work published in the Journal of Technology Education, as representing an important forum for reporting research in the US, and on the International Journal of Technology and Design Education, as one of the foremost technology education journals in the UK. I am not unaware of the fact that both of these publications are open to international researchers, but the country of origin of research is usually disclosed.

The method employed might be described as a modified content analysis. All of the articles published in these two journals during the years 1990 to 2000 were listed and classified according to content, as indicated by topic. Subsequent reading of an article often resulted in its being put into more than one category. The categories of articles that emerged were, *nature of technology, technology curriculum, outcomes and assessment of technology education, children's thinking in technology, technology teacher education, and gender and values issues in technology education.* This research, still a work in progress, reports on all but the last two areas of research.

NATURE OF TECHNOLOGY

Discourse on the nature of technology education has been vibrant though inconclusive. At the center of the discussion has been the issue of whether or not there is a core of knowledge, which defines technology as a discipline, and if so, what knowledge constitutes that core. It is interesting that most of the pre-occupation with this issue has been evident among researchers in the U.S. In the U.K. there has been far greater emphasis on the pedagogical aspects of technology education than on questions to do with the nature of technology. Of course, assumptions about the nature of technology are implicit in views about the way it should be taught, but it is in the U.S. literature that explicit discussion about the nature of technology is most evident.

There has been from some a persistent call for clarity about the conceptual structure of technology. Most recently, the call has been set forth in the curriculum document Technology for ALL Americans (International Technology Education Association, 1996), which suggests that such a structure could be concluded around the elements of process, content and contexts. Prior to that, DeVore (1970), Dugger (1988), Lewis (1991), Lewis and Gagel (1992), and Waetjen (1993) had all emphasized the importance of a determination of the disciplinary structure of technology. Indeed such a determination was seen as indispensable to the acceptance of the subject as having a rightful place in the school curriculum, to defining its desirable outcomes, and to a delineation of its content (Waetjen, 1993). After more than a decade of research that structure remains elusive.

Now as we enter the twenty first century, there is a growing belief that our energies may have been misplaced. Lewis (1999) opines that "we may have overdone the quest for structure, forgetting the grander importance purpose of schooling and the educative role of the subject. " (p. 57)
He, along with Zuga (1997), and Petrina (1998), suggests that the obsession with disciplinary structure was influenced by political concerns for status, acceptance and control. Overdone or not, the quest for structure has yielded some valuable insights into the nature of technology and hence technology education.

One of these is the content/process dichotomy in technology. Lewis (1999) describes content and process, as "two pre-eminent ways in which technology educators conceive of curriculum" (p. 56) The effects of viewing these as two dichotomous paths in the subject is seen in sharp contrast when one compares technology education as purveyed through the U.K National Curriculum, with technology education as practiced in the U.S. In the former case, there is a clear emphasis on process, specifically, "designing and making", and in the latter, there has been a continued attempt to find a conceptual structure around which to build the curriculum. It is indisputable that technology is both content and process but the nature of each of these elements, and the relationship of the one to the other needs to be understood, if we are not to follow the same fruitless path along which science education traveled in the 1970's, and from which it has since retreated.

In 1995, Herschbach provided useful insight into the nature of the content or knowledge dimension of technology. He suggested that while technological knowledge has its own abstract concepts, theories and rules it is not "a type of formal knowledge similar to that associated with the recognized academic disciplines " (p. 35). The "distinct epistemological characteristics" that distinguish between technological knowledge and formal knowledge is that the theories, rules, concepts, and structure and dynamics of change are really "applications to real situations" (Herschbach, 1995). If this is so, then the concepts and theories which constitute technological knowledge are necessarily multidimensional, since they are ordered, generated and used through activity and only derive meaning in the context of their application to particular real situations. Perhaps, it is this characteristic of technological knowledge that has defied attempts to impose a structure equivalent to that of the academic disciplines.

In developing his position on the nature of technological knowledge, Herschbach (1995) uses Vincenti's (1984) categorization of knowledge into descriptive, prescriptive and tacit knowledge.

Technological knowledge comprises all these, the content is primarily descriptive and while it draws on the formal knowledge of such disciplines as mathematics, physics or biology, it is not itself a discipline, since its theories derive from specific applications and there is no "clearly generalizable, representative structure characterizing all of technology." (Herschbach, 1995,p.35)

Petrina (1998) makes the same point when he argues for a view of the nature of technology as an interdisciplinary or cross-disciplinary subject. He suggests that the whole issue of whether an area of human thought and activity constitutes a discipline or not is far more of a political question than an epistemological one and that the prolonged attempt to establish technology as a monodiscipline is a political move designed to confer status.

The past decade of research on the nature of technology suggests that it might be more fruitful to turn our focus to a determination of what are the most important outcomes of technology education, as a basis for selection of the technology curriculum. Those aspects of technology that are most disclosive of the descriptive and prescriptive knowledge that we want children to acquire, and those experiences that foster the development of tacit knowledge of technological processes are the ones to be addressed in the curriculum. These will of necessity be context-dependent. In this line of research the work of Petrina (1998) might provide some useful pointers and might prove to be seminal.

On the "process" side of the discussion, McCormick (1996) reminds us that technology is "more of an activity that a discrete body of knowledge" (p. 24) There is widespread acknowledgment that designing and making are at the core of technology, but the role of these processes in technology curricula has been the subject of much debate. Lewis (1999) makes a strong case for a greater role for *making* in technology curricula, while cautioning against any attempts to routinize this activity as though a single technological method exists. The context-specific nature of designing and making suggests that such an approach would not be a true reflection of technological activity. Williams (2000), suggests that both manipulative and cognitive processes are aspects of the procedural knowledge involved in designing and making. The emphasis on one, to the neglect of the other, would represent a distortion. Perhaps the most instructive outcome of the content/process discussion has been the recognition of the importance of context in defining technology. Such processes as evaluation, communication, modeling, generating ideas and research and investigation cannot be claimed as unique to technology but in the context of tools and materials they become technological processes. It is the context that makes them technological or not.

Another useful outcome of the "nature of technology" research has been the discourse on the notion of technological literacy. In spite of an acknowledged lack of clarity about its meaning, and claims that it is primarily an attention getting slogan (Barnett, 1995), the term technological literacy continues to be used to describe the outcome of technology education. In spite of a substantial body of literature on the subject, the ITEA, in 1996, still made the call for the operationalizing of the term. Its recent document (ITEA 2000) implicitly attempts such an operationalization. Some like Lewis and Gagel (1992) and Waetjen (1993) have suggested that clarity about the term will continue to be elusive until the disciplinary structure of technology has been articulated. If as the foregoing part of this discussion suggests, such a structure might not exist in the sense in which it does for the academic disciplines, then Petrina's (1998) suggestion that we abandon the notion of literacy and replace it with "technological sensibility, participation and sagacity" as outcomes of technology education, might be more than a semantic exchange. Petrina describes a person possessing these qualities as "an adult with a complex, political understanding of technology, participating in a democratic, peaceful, sustainable society." While this, in its entirety, is an unrealistic goal for technology education, it calls to attention the political and social dimensions of technology, which are not often explicitly captured in attempts to describe the technologically literate person.

Another even less researched aspect of technological literacy, than its characteristics, is the question of how it is to be assessed or measured. Waetjen (1993) and Lewis (1999) have both pointed to the developmental nature of literacy and of the need for measures that take account of the fact that manifestations of technological literacy would vary from one stage of the child's development to another.

CHILDREN'S THINKING IN TECHNOLOGY

Whether because of, or in spite of the absence of any extensive debate in the UK about the disciplinary structure of technology, technology education has become far more firmly entrenched in the school curriculum in the UK than it has in the United States. In the UK, Design and Technology is part of the educational entitlement of all children, and that fact, along with the centrality of process in the curriculum makes it understandable that there has been considerable research directed at an understanding of children's thinking and learning in technology. By contrast, Lewis' (1999) call, in the U.S., for classroom research that focuses on children's experiences while learning technology has largely been ignored.

How do children acquire technological concepts? How do they acquire technological skills? Under what conditions might such acquisition occur most effectively? How do children think as they engage in design activities? Most of the research addressing such questions comes out of the UK and Canada. Perhaps the most important revelation yielded by such research is the consistent finding that children's problem-solving strategies do not match the linear, stylized, sequential models so prevalent in curriculum materials (Gustafson et al., 2000; Johnsey, 1997; Ridgeway & Passey, 1992; Rowell & Gustafson, 1998). Work by Davies (1996) suggests that even professional designers do not work according to these models and that indeed there is a similarity between children's instinctive design activities and those of professionals. This study also highlighted the importance of talk in children's design activities. Davies (1996) suggests that children use talk to order their thoughts and to relate their thoughts to external reality. It seems too that the processes of manipulating and modeling serve not only to externalize ideas but also to generate them, "as if the hand rather the brain were doing the thinking"(p.10). The implication of this for research is that there needs to be far greater emphasis on research which analyzes children's talk as they engage in technological activities as well as on research which places children at the focal point. Such investigation holds the promise of helping us to understand those activities which are the very heart of technology education, teaching and learning.

Gustafson et al (1999) found evidence that children were not always successful in transferring ideas learned in one context to another. The conditions for such transfer need to be more fully explored, as does the role of knowledge and insight gained in informal settings. In the previous section of this paper it was suggested that the context of children's problem solving was what gave meaning to the processes in which they engaged. Wolff-Michael (1996) suggests that the context of children's problem-solving tasks might be an important determinant of the learning outcomes that are realized. He stressed the importance of providing contexts which "bear similarity with out-of-school and workplace settings in terms of the social, material and open-ended aspects of the tasks to be completed" (p. 108). A final issue of great import for curriculum, is the development of criteria by which we can measure progression in technological thinking and competence. Anning (1994), undertook the kind of detailed classroom observation required to inform this kind of work. Solomon & Hall (1996) used cognitive psychology and the results of teacher action research to search for evidence of progression. They make a call for research that is "close to the ground" to advance our understanding in this area (p. 279). It is evident that this strand of research has been underserved but it is clearly pivotal to progress in technology education. The areas of curriculum development and teacher education must be the poorer for the neglect.

OUTCOMES AND ASSESSMENT IN TECHNOLOGY EDUCATION

An issue not unrelated to the nature of technology itself, is the question of what ought the outcomes of technology education to be, and how ought these outcomes to be assessed. Not surprisingly, the research on opposite sides of the Atlantic reflects differing emphases. The goal of technological literacy, accepted in the US, has proved to be much harder to define in terms that are operational enough to guide its assessment. The International Technology Education Association's *Standards for Technological Literacy* (2000) defines technology as the "ability to use, manage, assess, and understand technology." These standards attempt to identify the content for technology education but as yet the ITEA has not been able to offer much guidance with respect to assessment. Prime (1998) has suggested that conceptual fuzziness about the intended outcomes of a curriculum is often masked by broadly described learning activities, but the design of assessment strategies requires utmost clarity about outcomes. Dyrenfurth et al (1991) described technological literacy as "multi-dimensional" and suggests that it includes practical, civic and cultural dimensions. The imprecise nature of the concept makes assessment difficult. There is therefore relatively little research in the US literature about assessment and less still that is empirical. A wide range of measures has been advocated. These include portfolios, individual and group interviews, observation of performance, and paper- and-pencil tests. Some of these strategies are in keeping with current thinking about assessment, but in the absence of clarity about the outcomes which they are being used to assess, and little empirical data about their use in technology education, their advocates have provided little guidance for those seeking to enact technology education curricula.

In the UK, on the other hand, where there has been a clear emphasis on process in the curriculum, "capability" rather than literacy has been accepted as the outcome of technology education. The notion of capability is easier to operationalise and a considerable amount of research has gone into defining, analyzing and assessing this quality. Anning (1994) sees capability as having four "generic" features that are common to any model of technology education These are: communicating ideas through drawing, acquiring technical skills, acquiring technical knowledge and evaluating (p.167). These four could provide a basis for assessment. In a study of Canadian teachers' views of the nature of technological capability (Kozolanka & Olson, 1994), revealed that those teachers valued the affective outcomes of technology education as the most important aspect of capability. For them, capability was having the qualities that it would take to live and find employment; team-work, and social and intellectual habits like patience, perseverance and good work habits. These were secondary school teachers and the imminence of their students' entry into the world of work must have loomed large in their minds, nevertheless, their concerns draw our attention to these less easily assessed outcomes of technology education, whether the goal is conceived of as technological capability or literacy.

The Pupils' Attitudes to Technology (PATT) studies, originally developed in Europe but undertaken in several countries, have been the best-known attempts to measure the affective outcomes of technology education. These have generally suggested that girls have less positive attitudes to technology than do boys, although there have been some countries where this has not been the case. Equally important has been the finding that school technology experience has not been a significant factor in determining children's attitudes to technology.

The notion of progression has also received some attention in the UK literature. Both Anning (1994) and Solomon & Hall (1996) have begun the work of assessing technological capability from a developmental perspective, in which children's progress along dimensions of capability is being addressed. As reported in the earlier discussion of technological literacy, Waetjen (1993) has pointed to the need to devise methods of assessment that take into account the developmental nature of technological literacy.

In sum, there appears to be consensus that technology outcomes include the development of competencies and qualities with respect to technology. Those competencies include practical capability, knowledge of the impact of technology on societies, and the willingness and knowledge to engage with the political and social dimensions of technology. It is in the relative weight assigned to these competencies that curricular differences are apparent. It is possible that the interests of children in different cultural and economic contexts are best served by differing emphases on these curriculum goals. With respect to assessment of these outcomes, very few advances have been made. Current thinking about assessment has much to inform the field of technology education. The field of cognitive psychology has had a major influence on current approaches to assessment of learning. It is being recognized that, across the curriculum, it is when assessment targets cognitive skills, rather than discrete packets of knowledge, that it has its most beneficial effects on teaching and learning (Glaser, (1987). Further, current views on assessment suggest that assessment tasks ought to require holistic, integrated demonstrations of both declarative and procedural knowledge. (Royer et al,1993) .The work of Herschbach(1995) cited earlier in this paper suggests that this might be particularly applicable to technology education. Kimbell (1994), reflecting on the assessment of technological capability emphasized the importance of holistic judgments, as opposed to those approaches which suggest an atomistic view of capability. Glaser & Silver (1996) have identified six dimensions of cognitive skills, that could provide some promising guidelines for the assessment of learning in technology using the holistic approach advocated by Kimbell. These are knowledge organization and structure, mental models, automaticity, problem representation, procedural efficiency and meta-cognitive skills. While a discussion of the applicability of these to the goals of technology teaching is outside the scope of this paper, it seems likely that the use of these dimensions might provide a useful framework for the design of assessment strategies that assess important outcomes of learning about technology.

THE TECHNOLOGY EDUCATION CURRICULUM

In this section I examine the trends and issues with respect to curriculum as I read them in the literature. My exploration of the research agrees with that of Zuga (1994) when she reported an overwhelming concern with curricular matters. The articles reviewed fell into three broad categories. There were those that addressed approaches to the organization and delivery of technology curricula, those which addressed indicators of quality in technology curricula and those which offered comparisons and descriptions of curricula from different countries. To be sure, the treatment of these issues reflected the ideological positions of the authors with respect to technology and curriculum, but seldom were these assumptions explicitly addressed. Indeed, it is apparent that what was generally lacking in the discourse was an effort to build a philosophical framework to guide curriculum. Aspects of such a framework include the justification for the curriculum, the particular curriculum orientation most applicable to technology curricula, and the epistemological considerations which should undergird the curriculum. The absence of such discussion within the field leaves the curriculum development and implementation processes open to being shaped by political ideology, by the historical antecedents of the technology curriculum, and by organizational factors such as availability of resources. It is true that such factors always influence the curriculum, but a clearly articulated philosophical base provides some measure of safeguard against the loss of focus that can occur when such factors exert too great an influence on the curriculum. An example of this is possibly the cause of the contentions surrounding the early attempts to introduce technology as general education in the UK, and the apparent lack of focus which prompted Lewis (1996) to critique the 1990 Technology Order as failing to "sharply define what was and what was not technology in the curriculum" (p.227).

One explicit attempt to address the issue of a philosophical base for technology education was seen in a series of discussions carried in a special theme issue of the Journal of Technology Education (Vol. 6,no.2) that looked at technology from the perspective of the five curriculum orientations (Eisner & Vallance, 1974); the academic/rationalist, the technical/utilitarian, intellectual processes, personal relevance and social reconstruction. The five articles in that series each outlined the basic tenets of one orientation and sought to determine its applicability to technology education (Erekson, 1992; Petrina, 1992; Johnson, 1992; Zuga, 1992; Herschbach,1992) The importance of such discussion lies in the fact that orientations are more than just theoretical and have implications for all aspects of curriculum design. They provide a coherent rationale for decisions about selection of content, outcomes to be achieved and methods of delivery. The concern to identify a unified conceptual structure for technology that was alluded to in an earlier section of this paper clearly arises from the academic-rationalist perspective, which dominates the field of curriculum. Recently it has been suggested that such a structure might not exist for technology, and indeed, technology curricula developed within the decade do not exhibit such structure. It seems fair to say that the academic-rationalist perspective might not have much to offer the design of technology curricula. The technical/utilitarian and the social reconstruction orientations are probably the ones which are most evident in existing technology curricula. The UK Design and Technology, with its emphasis on process is clearly technical/utilitarian, and the ITEA's emphasis on literacy seems to exemplify elements of the social reconstruction orientation. Zuga (1992) provides a useful exemplar of how this orientation could be used to guide the selection of content in technology. The personal relevance orientation based on the humanistic philosophy of education has been described by Petrina (1992) as absent from all technology curricula that have been described in the literature, yet this orientation seems to accord with many of the stated goals of technology education and indeed Layton (1992) and Barnett (1995) have suggested that a humanistic framework might provide a basis for forging connections between technology and the curriculum.

At the beginning of the decade there were many calls for integration of the technology curriculum with mathematics and science (Gloeckner,1991) but such calls have been criticized as lacking in conceptual warrant, since the transferability of mathematics and science knowledge to children's technological problem-solving has not been demonstrated. It has been suggested that the calls for integration were motivated by a desire to get the subject established through linking it with mathematics and science, two firmly entrenched areas of the curriculum (Foster, 1994). Studies which attempted to show the effectiveness of integrated modules failed to do so (Childress,1996). Towards the latter part of the nineties, concern shifted away from integration towards an identification of the most effective curriculum emphases and methods of delivery. Foster & Wright (1996) surveyed a number of leaders in the field as to their opinions about the most effective models for the design of technology curricula. The results suggested that these experts thought that the approach should change as the learner progressed from the elementary through high school grades. At the elementary level the preferred approach is one which was designated as *constrictive methodology.* This approach placed emphasis on "hands-on activities". At the middle school, the experts favored a *modular approach.* This was essentially an organizational approach which suggested that the curriculum be delivered through self-contained units. At the level of the high school, mathematics/science/technology integration was thought to be most appropriate. At all levels *design and problem solving* was rated highly. Continuing his contribution to the, discourse on approaches to curriculum, Foster (1997) classified existing approaches to elementary technology into those which were organized around *process*, those which emphasized *content,* and those which saw technology not as having an independent place in the curriculum, but as a means of helping pupils to achieve the goals of other curriculum areas.

Quality in technology education was another curriculum issue that came into prominence in the later years of the decade. Hill & Smith (1998), working in a Canadian context and Clarke & Wenig, (1999), describing a US case study, attempted to identify some quality indicators for technology education. In the former case the findings represented the perspectives of one classroom teacher and his students. It is interesting that in this study it was the social dimensions of learning technology that featured most prominently in participants' assessment of what was good about their technology classes. In the second study, indicators of quality were gleaned from a survey of experts. Here the indicators related to; philosophy and mission, instructional quality, and teacher professional development, among others.

An instructive component of the discourse about curriculum in technology education was the descriptions and comparisons of curricula across countries. Lewis (1996), writing about the value of country case studies, suggested that such analyses "can lead to insight that enlarges our vision of the possibilities of the subject" (p. 221). A description of technology education in South Africa, by Ankiewicz (1995), does just that. Here the subject, still in its developmental stages, is seen as having a role to play in the social and economic transformation of the country. Technology is seen as part of the broad general education needed to develop citizens who possess the "higher cognitive skills, creative thinking and problem-solving" abilities, which in one view, is the way to redress "a critical shortage of technological expertise" (p. 248). Ankiewicz sees the importance of making the "technological process" central in technology education to ensure that the process is" transformative" (p. 253). He advocates a pedagogy that is " participatory, critical, values-oriented, multi-cultural, student-centered, experiential, research-minded and interdisiciplinary"(p.253). The subject is seen as having a role to play in the removal of social, economic, and gender inequalities that were the legacy of the previous social order. It is to be taught as a separate subject and is compulsory for the first nine years of schooling. Lewis' (1996) comparison of technology curriculum in the US and the UK served to highlight some of the contrasting aspects of the two approaches, in particular, the content/process distinction and the concomitant literacy/capability issue. Gradwell (1996) traced the historical roots of technology education in England, France, and the United States and suggests that the differences in emphases that are evident in these countries' contemporary technology curricula can be accounted for by their differing histories. A number of developing countries are in the process of introducing technology education as a component of general education and it is evident that in such contexts the subject is seen as having a major role to play in economic transformation through its potential for producing the kind of workforce deemed to be best suited to effecting such a transformation. It is interesting that even though this is the case it is not technology with specific occupational focus that is being advocated but an approach that produces young people with such qualities as,

> leadership, initiative, ability to think and adapt to change, flexibility, ability to transfer skills from one context to another, to work in teams, to be technically competent and proficient, to be able to solve problems and to apply knowledge, skills and competencies in any context (Ogunmola, 2001).

Further, the vision for technology is that it should not merely be an add-on to the curriculum but that it should be a "major contributor to a re-defined curriculum of general education in which practical capability moves to center stage and which is interdisciplinary and has no sovereign subject" (Ogunmola, 2001).

The fore-going review of the curriculum landscape of technology education brings into focus some areas in which we need to clarify our thinking. The first of these has to do with the question of the justification for the place of technology in the curriculum. Academicians in the field need to base their advocacy on a firm footing if policy-makers and other stakeholders, especially teachers, are to be convinced to commit their resources to this subject. The "technology as a discipline" argument, essentially an academic/rationalist one, is hardly sustainable in the light of the fact that there appears to be no unified conceptual structure that defines all technology. All of the curriculum studies reviewed allude to the national economic benefits and to the personal relevance outcomes to be derived from adoption of technology education. These benefits ought to be clearly spelled out and their implications for the curriculum need to be identified. The way in which they are articulated must be a response to local social and economic conditions. The result of this might be that in both form and content technology education curricula look very different from one context to another but that need not be cause for concern. Indeed if we take the stance that it is the nature of technology that it is diverse, then the differences, will not be considered as tensions, but rather, as evidence of its rich potential to foster human development. Such differences as content versus process, and vocational versus general education and practice versus theory become questions of balance when we recognize that practical capability, the ability to function in the real world, is actually the result of a mix of all these. Perhaps our quest for unity in the field has been misguided.

Another curriculum issue has to do with the teaching strategies that are most effective in the teaching of technology. Except for a small number of studies, particularly those done in the UK, we have not addressed this aspect of curriculum. Currently held views from the field of cognitive psychology, particularly, situated cognition, might be instructive in this regard, since it directly addresses the distinction between practice and theory. The links between technology and other areas of the curriculum, especially, but not exclusively, science and mathematics, are obvious, but we do not know much about how to help children to transform knowledge acquired in these areas into a form in which it can be used in their technological activities.

CONCLUSIONS

This paper has reviewed some aspects of the research in technology education, that has been published over the last decade. Following is an attempt to capture the findings of this review in a few succinct statements. They are offered by way of a summary, with the knowledge that much is inevitably lost in any attempt to distill complex ideas into short statements.

1. Technology cannot claim a unique disciplinary structure. Its knowledges are declarative, procedural and tacit and the subject draws on several disciplines.
2. The term "technological literacy" has yet to be defined operationally and is currently being used, in a very general sense to connote all of the outcomes of technology education.
3. Little progress has been made in the area of assessment of technology learning outcomes. Assessments should be holistic, contextualised and should include the conative aspects of technological competence.
4. The "design process", the idea that work in technology proceeds in a uniform sequence, either linear or cyclical, does not stand up to the reality of either children's or designers' practice.
5. In children's thinking, knowledge does not transfer automatically from other areas of the curriculum, even related areas like mathematics or science, to their technological problem-solving.
6. Country comparisons of technology curricula suggest that technology education is valued most for its contribution to economic growth. This goal is seen as being best served by developing broad generalisable technical and non-technical competencies, as opposed to narrow occupational skills.
7. Approaches to the organization of technology curricula should be responsive to local cultural contexts.

Although this review has not addressed the area of teacher education, a cursory glance at research in that area suggests that it is an under-researched area. The issue of values in technology has been recognized as being critical in producing citizens who are capable of making wise decisions about the use of technology, yet we know woefully little about how to help children to develop values. Finally, this review suggests that it is appropriate to echo Zuga's (1999) call for research into gender and technology, particularly women's ways of knowing.

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