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The Multiple Meanings of Technological Practice in Technology Education in New Zealand

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Abstract

Understanding the nature of technological practice is one of the eight achievement objectives specified in the New Zealand technology curriculum (Ministry of Education, 1995). Despite only a small place within the curriculum document, technological practice has become a key concept used in the professional development of teachers and the assessment of technology. This paper describes some of the different points of view about the meaning of technological practice. It also summarises some initial results from a survey canvassing views on technological practice held by those involved in leadership positions in technology education in New Zealand. Experiences of technological practice seem to be genuinely helpful in building teachers' understanding of technology. However, how these translate into what teachers and children do in classrooms is less clear. Though this research suggests that most leaders in technology education agree that children meet the curriculum aims through technological practice I ask whether this approach locks us into always *valuing* technology and constrains the possibilities of being critical. Finally, an alternative to the definition of technological practice listed on the New Zealand Ministry of Education website is suggested.

Keywords

technological practice, critical literacy, school-business partnerships, teacher professional development

Technological practice in the literature

In New Zealand, writing a new curriculum for technology has offered a unique opportunity to learn from local and international experience in technology education and curriculum development in general. The curriculum has been framed around social constructivist learning theory and its design has been influenced by ideas from the literature on situated cognition, particularly in mathematics and science education (see for example, Cognition & Technology Group, 1990, Driver, *et al*, 1994, Hennessy, 1993, Lave & Wenger, 1991, McCormick, *et al*, 1994). As a result, the New Zealand technology curriculum has been structured and written to foster authentic experiences in real problem solving contexts rather than passive experiences geared towards accumulating well-defined bodies of formal knowledge (Smits, 1998). From the outset, the curriculum was written to highlight the social embeddedness of technology.

The concept of technology that underpins the New Zealand curriculum represents technology as an *activity*:

“Technology is a creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems, or environments. Knowledge, skills, and resources are combined to help solve practical problems. Technological practice takes place within, and is influenced by, social contexts.” (Ministry of Education, 1995, p.6)

By implication, technological practice is the *social* activity of technological problem solving. According to the curriculum, creating solutions to technological problems is one aspect of technology education. The other aspects are developing competence and confidence in using existing technologies and the intellectual development of informed members of a technological society (Ministry of Education, 1995, p.7). These different aspects of technology education are represented as three strands of the curriculum – technological knowledge and understanding, technological capability and technology and society (for a summary of the objectives associated with these strands see Notes A).

Separate, complementary or integrated use of the strands of the curriculum, could be used at different times to educate children in technology. However, the integrated approach has become something of a gospel in the New Zealand context. The curriculum document states that “most units of work will include objectives from all three of the strands” (Ministry of Education, 1995, p.10) and that “students’ technological experiences should reflect the interlinking nature of the strands” (Ministry of Education, 1995, pp.31, 35, 41). The argument (admittedly oversimplified) is that technology education = technological practice = the integration of the three strands of the curriculum = technological literacy. The review of the literature below reflects my attempts to track and understand how and why this thinking has come about.

One influential description of technological practice has evolved from the Learning in Technology Education research project run during the mid-1990s at Waikato University under contract to the Ministry of Education (see, for example, Jones, Mather & Carr, 1994). Jones & Compton (1998) and Jones & Moreland (1999a) describe “authentic technological practice” as follows:

“Technological practice includes a knowledge base, how it is used (praxis), and technics (techniques associated with its practice). These interact with each other and are mutually informative. In turn, they are all influenced by, and influence, the conceptualisation of technology and technology education.” (Jones & Moreland, 1999a, p.8)

This definition appeared first in 1994 with one slight change. Instead of technological practice the first two words were technological activity (Jones, Mather and Carr, 1994, p.39). It arose out of research work carried out with teachers to enhance students’ technological capability in which the researchers found that despite conscientious efforts, technology was not very well taught and that integrating the three strands of the curriculum was particularly problematic for teachers. One conclusion reached was that teachers just did not have a strong enough knowledge base in technology or a strong enough understanding of how technological problems are solved to be confident in teaching the new curriculum. For the researchers, this implied that teachers needed more than good resources and good classroom activities (Jones, Mather & Carr, 1994, p.41). Teachers needed to experience technological practice.

This argument was picked up in professional development programmes for New Zealand teachers. Some of this professional development was centred on a series of video examples of technological practice produced by the Ministry of Education (1997a). A key message explicitly drawn out of these videos was that technological practice in the ‘real’ world involved activities that could be associated with the three strands of the curriculum (Ministry of Education, 1997b). Davies (1999) discusses these video resources and suggests that “practice is presented for instruction, not analysis and debate” so that “teachers develop a common rather than a critical understanding of technology” (1999, p.133). However, in evaluating their teacher development programmes Jones and Compton attribute increases in teachers’ confidence in teaching technology to experiences of technological practice (1998, p.62–4).

Recently, Jones and Moreland have also argued that the Ministry of Education videos of technological practice, “coupled with visits to local, innovative businesses”, provide “powerful opportunities” for teachers to “enhance their technological understanding” (Jones & Moreland, 1999b, p.7). However, their own research indicates that even though teachers have been introduced to the concept of technological practice they do not use the term in discussing technology education (Jones & Moreland, 1999b, p.10). In their most recent research into assessment in technology education Jones, Moreland and Northover (1999) have worked with teachers on defining the technical, procedural, conceptual and social outcomes that are embedded in children’s technological practice. This approach seems to be fruitful in helping teachers to translate their personal understanding of technology into pedagogical content knowledge.

There is a growing emphasis on technological practice in the assessment of technology in New Zealand schools. The most recent ‘definition’ of technological practice has arisen out of research and policy work carried out under contract to the New Zealand Ministry of Education by Compton and Harwood (1999) and the current review of the assessment of students in secondary schooling. The process of defining new draft achievement standards in technology (targeted at year 11) has been carried out by an ‘expert’ panel which has written four standards for internal assessment and three standards for external assessment. In five of these standards technological practice forms a key component. It is defined as follows:

“Technological practice refers to the way in which a person or group develops technological solutions. The perspectives of the person or group, along with different knowledge and skills, the society and environment, and the nature of the technological development itself, are all aspects which work together to determine the nature of technological practice. Factors which may underpin these aspects include: values, ethics, social climate, resources, cultural climate, market forces, economic climate, health and safety, individual motivation, presence/absence of an innovative culture, technologies in use, one off or ongoing production constraints.

“Student technological practice occurs when the three strands of the technology curriculum are interacted in the resolving of a technological problem. It is through this practice that students develop technological literacy. For this achievement standard, the student’s technological practice should incorporate ongoing evaluation of their practice.” (<http://www.minedu.govt.nz>) as at 18th December 1999)

This definition has been written for use by secondary teachers. The first paragraph seems to be describing the technological practice of ‘experts’. The second suggests that the school equivalent occurs through problem solving involving all three strands of the curriculum. Interestingly, the definition does not explicitly talk about school learners working with industry experts or use the justifications of economic rationalism. However, technological practice is linked in many people’s minds with school/business partnerships and official documents do make links between technology education, school/business partnerships and economic success.

For example, the guidebook for facilitators of Ministry of Education professional development contracts states that “these crucial links will help to foster a culture that values and promotes technological research and encourages innovation” (Ministry of Education, 1997b, p.5). In another Ministry publication, *Working Together – Building Relationships between Schools and Enterprises*, it is argued that these links inform and motivate students and “develop a better understanding of local, regional, national and multinational enterprises and their contributions to the economy and society” (Ministry of Education, 1999b, p.6). It is assumed that such an entrepreneurial, innovative culture which *values* technology is needed in building New Zealand’s global competitiveness. However, some of the curriculum objectives in the technology and society strand are clearly intended to be used for the *critique* technological developments from the viewpoint of different stakeholders.

The historian of technology, Arnold Pacey, has argued for the need for close and careful scrutiny of technologists’ practices. In his (1983) model of technology-practice, Pacey defines a restricted meaning for technology which focuses on technical knowledge, skill and technique and a much broader definition of technology-practice which is “the application of scientific and other knowledge to practical tasks by ordered systems that involve people and organisations, living things and machines” (Pacey, 1983, p.6). The ordered systems that Pacey uses as examples include ethical systems, belief systems, systems of production, systems for organising work, legal systems etc. They are both cultural systems and organisational systems in which the interests of those who create technologies, and those who use technologies, overlap. He suggests that without deliberate recognition of the interaction of culture and values with technology, technical ‘fixes’ for complex social problems fail, and will continue to fail. The problem, as he describes it, is the narrow tunnel vision of technology specialists and he deliberately coins the new term technology-practice to provide a new language for a broader debate about the processes of developing technological solutions.

Pacey acknowledges that including cultural and organisational elements into technology-practice “may seem likely to make it bewilderingly complex” (Pacey, 1983, p.5). He describes how different people, with different interests, play different parts within the whole system. Some are politically minded and are interested in the organisational aspects of a particular technology. Others are technical people – and he suggests that these technical people are influenced by their embeddedness in the economic, political and social values of their culture as well as by their love of the intellectual, and the practical, power of technology. However, he suggests that we cannot see our own “habits of thinking”. Rather, it is through the interaction of different players, with different agendas, that the whole system of technology-practice operates. Pacey’s description of technology-practice is one of multi-layered systems and not of the practices of individuals or even of small, well defined groups.

The definition of technological practice suggested for use in secondary assessment includes elements of the cultural and organisational systems that Pacey describes. However, it is much more focused on what technologists actually do and so these elements all seem to be viewed through the eyes of the technologist. The technologist acknowledging the consumer’s preferences is the typical strategy for dealing with the social dimensions of a technological development – as though all consumers were one. There does not seem to be scope for stepping outside current technological practice and putting on a critical hat. Repeatedly, leaders of the development of technology education in New Zealand comment on the need to “‘unpick’ the ethics, values and prioritisation of knowledge bases inherent in any technological practice” (Jones & Compton, 1998, p.64). Compton has argued that the purpose of the technology curriculum is to offer opportunities “to develop the level of empowerment necessary to initiate change in entrenched social orders” (1997, p.70). She associates this empowerment with technological capability arguing that “a proficiency in the area of technology can be important for people to feel equipped to comment on others’ technological practice and confidently and competently recommend alternative courses of action” (1997, p.70). Hence, the purpose of technological practice is not necessarily the practice itself, but empowerment to take an active role in constructing our joint technological future.

Others in leadership roles in New Zealand have been concerned about how to develop a critical literacy in technology (Burns, 1997a & b; Davies Burns, 1998; Davies, 1999; France & Davies Burns, 1999; Jesson, 1991; O’Neill & Jolley, 1996/1997; Mawson, 1999; O’Sullivan, 1999, Verbowski, 1992a, b). In Australia, with reference to science education, Hildebrand (1999) has argued that models for learning can be analysed along dimensions of knowledge acquisition and also of participation. She argues that ideas from social constructivism place the learner in an active position with respect to knowledge but that inculcation into a community of practice places the learner in a much more passive position with respect to participation. She argues for combining social constructivism with a much more critical/active role with respect to the scientific community of practice and she says that active criticism “cannot be done as a seduced peripheral participant, abiding by the discourse patterns and performative practices of the scientific community” (Hildebrand, 1999,

p.8). Her comments apply equally to technology education. To conclude, there are multiple viewpoints on technological practice evident throughout the literature reviewed. The research project described below has been designed to find out more about how others in leadership roles have interpreted this debate.

The research project and some emerging results

The research project reported on here is a pilot study of the ways that technological practice is conceptualised by those who have leadership roles in technology education in New Zealand. In July 1998 and in February 1999 the Ministry of Education hosted conferences that were attended by those contracted to provide schools with professional development in technology. I attended both of these conferences and have used the attendance lists as sources of the sample for this study. Some additional names of those who have leadership roles in technology have been added. The sample is a comprehensive but not exhaustive list of those who have been active in technology education in New Zealand. Eighty questionnaires were sent out. Three were returned due to incorrect addressing. Thirty-four completed responses were obtained giving a response rate of 44%.

Those replying indicated that they had the following roles in technology education (some people had multiple roles):

| | Teacher professional development | Pre-service teacher education | Research | Policy development | School teachers or principals |
|-------------------|----------------------------------|-------------------------------|----------|--------------------|-------------------------------|
| Number | 29 | 10 | 9 | 4 | 4 |
| % of total sample | 38% | 16% | 12% | 5% | 5% |

The following seven questions were asked using a questionnaire with a postage paid reply envelope:

1. How important do you think technological practice is for achieving the aims described in the technology curriculum?

No Importance *Little Importance* *Some Importance* *Very Important* *Extremely Important*

2. Please give some reasons for the way you have rated the importance of technological practice.

3. How would you describe the technological practice of *experts*?

5. How would you describe the technological practice of *school aged learners*?

6. How would you describe the relationship between the technological practice of *experts* and the technological practice of *school aged learners*?

7. Is there anything else you would like to comment on in relation to technological practice?

The importance of technological practice in achieving the aims of the technology curriculum (see Notes B) was rated as follows:

| No importance | Little importance | Some Importance | Very Important | Extremely Important |
|---------------|-------------------|-----------------|----------------|---------------------|
| 0 | 0 | 3 | 9 | 22 |

One respondent made the point that technological practice was very important in theory but of little importance in the actual work carried out in primary classrooms.

The main focus of this paper is on the reasons given for the importance of technological practice given by those who answered the questionnaire. The responses were entered into a database and were coded according to categories which emerged from the data. In many cases the respondents made a number of statements which all supported a particular point. Each of these statements was counted into the appropriate category. Some statements referred to more than one category and in these cases they were coded to each category. Six major categories were evident. The number of statements coded to each category is listed below:

| Technological practice is holistic and | Technological practice provides links | Technological practice is essential to | Technological practice provides | Technological practice leads to technological | Technological practice provides |
|--|---------------------------------------|--|---------------------------------|---|---------------------------------|
|--|---------------------------------------|--|---------------------------------|---|---------------------------------|

| | | | | | |
|-------------|-----------------------|----------------------|--------------------------------|----------|------------------------------------|
| integrative | with the 'real world' | technology education | authentic learning experiences | literacy | experiences of practical processes |
| 24 | 21 | 19 | 16 | 10 | 8 |

Two full examples of verbatim responses to this question and associated categories are given below.

| | |
|---|---|
| Technological practice: extremely important | |
| Technological practice is pivotal to the reason for the curriculum. | Essential |
| Because a large percentage of people use technological practice in their work place, it is logical that students should have the opportunity to work in similar ways. | Links with 'real world' |
| Technological practice draws in all the loose ends in a way which will give meaning for learning in this field. | Holistic and integrative |
| The technologist works with technological practice and incorporates values, knowledge and beliefs, whereas technicians can work often in isolation. | Holistic and integrative Links with 'real world' |
| Technology practice gives purpose to the curriculum. | Authentic learning |
| Technology practice prepares students for their future. | Links with 'real world' |

In order to provide reasons for the importance of technological practice it was common for respondents to give an interpretation of the meaning of this term. For example:

| | |
|---|---|
| Technological practice: extremely important | |
| Technological practice is the process of creating technological solutions. | Essential |
| It integrates knowledge and understanding plus consideration of social, cultural and environmental contexts within the systematic process determined by technologists. | Holistic and integrative Links with 'real world' |
| Giving students an opportunity to engage in technological practice across a range of technological areas is an integral part of the process of developing technological literacy. | Technological literacy |
| Students must be given both the opportunity to develop their own practice and to reflect on the practice of a diverse range of technologists. | Practical processes Links with 'real world' |

Verbatim examples of the statements made for each analytical category are listed below.

1. Technological practice is holistic and integrative.
2. Integrates cultural values into practical work.
 - Doing, thinking and valuing come together.
 - Technology is much more than technical knowledge. It involves cultural and organisational aspects. Technological practice binds and develops these three dimensions.
 - Involves the amalgamation of technological knowledge, culture and kinaesthetic to meet needs.
 - Technological practice is grounded in culture, skills, principles and beliefs which impact on and derive from the needs of any/all ethnicities.
 - Develops awareness of issues technologists have to consider such as ethical issues, green technology, birth to death technology, appropriate technology, use of non-renewable resources.
3. Integrates the elements of the New Zealand technology curriculum.
 - Incorporates all aspects outlined in definition of technology and technology education (p.6–7) of curriculum.

- Because it represents all of the technology curriculum objectives as they interact in the resolving of a technological problem.
- Includes all three strands – is an indicator of the holistic view of technology.
- To ensure that technology is seen and taught as a whole.
- 4. Integrates generic skills/cross-curricular knowledge.
 - Develops a number of generic skills such as research skills, working as a team.
 - Allows for the application of knowledge from a variety of curriculum areas.
- 5. Technological practice provides links with the 'real world'.
 - Technological practice is the way in which 'real' people work.
 - Students need to study 'real' technological practice.
 - Using real (as used in the 'outside of school world') materials, processes, techniques etc.
 - Through working alongside, observing, studying technologists they will be encouraged to establish links between what they see and their own practice.
 - Important for teachers to understand the technological practice that happens within the work force.
 - Involvement with 'experts' from the outside.
 - Transfer of skills and processes from school to the workplace.
 - Making students less frightened of life outside school.
 - Prepares students for their future. Our students will end up in these industries and hopefully some in important roles – essential that their learning assists the process and will be meaningful.
- 6. Technological practice is essential to technology education.
 - Is the 'guts' of technology.
 - Technology is a process, to learn about technology you must carry out the process, when carrying out the process you are involved in technological practice.
 - Technological practice is the pivotal reason for the curriculum.
 - Technological practice is what students are developing.
 - What technologists do is central to the curriculum.
 - If it is missing the essence of technology can be lost.
 - It is the very thing teachers should be trying to mirror in their classrooms with the children.
 - Technological practice is an integral part of technological problem solving.
 - If we accept that technological practice is 'doing it', technological solutions and developments can't take place without it.
 - A true understanding of technology requires good understanding of technological practice.
 - Without technological practice students are only likely to be technicians either rehearsing that which they already know or simply making solutions the teacher has thought of.
 - Technological practice forms the centre of learning for technological learning.
- 7. Technological practice provides authentic learning experiences.
 - Because it is the curriculum in practice in the real world – it underpins authentic, relevant learning experiences for children.
 - It provides the need/reason for learning about technological areas and the knowledge and skills specific to technology.
 - Gives purpose to the curriculum.
 - Provides the opportunity for authenticity.
 - Learning by experience is the most valuable form of education.
 - If the students don't engage in their own technological practice they are not 'technologists'.
 - Technological practice involves a process of thinking through a solution to a social or cultural need or opportunity as well as any outcome. Students need to learn this way of thinking and operating if they are to be encouraged to be innovative.
- 8. Technological practice leads to technological literacy.
 - Because technological literacy develops through (is an outcome of) technological practice.
 - Because engaging in it is an integral part of developing technological literacy.
 - Participation in technological activities should produce technological literacy.
 - Cannot become technologically literate without the 'doing' of technology.
 - Aims cannot be met without practice i.e. experience, trial and error, review, evaluation, creativity, innovation, principles etc.
 - Technological literacy develops through linking own practice with the practice of experts.
- 9. Technological practice provides experiences of practical processes.
 - Because it is a way of working to solve practical problems.
 - Because it involves 'practical qualities' which cannot be achieved through studying technology.

- Involves hands on problem solving including adapting, improvisation, creating to meet some need.
- Technological practice is a practical quality which implies that you can improve yourself.
- Students need to develop processes and skills that add efficiency to their work in technology rather than starting from scratch with every project.

Some of the statements made by those who rated the importance of technological practice in the mid-range of the scale were different from the responses summarised above. These respondents were clearly positive about the need for technology education to provide experiences of practical, technological problem solving. However, they also made the following points:

1. Technological practice is integral but not essential.

I don't believe, as some advocate, that all technology education is bound up in technological practice. I think theoretical aspects of technology can be taught as such and aspects of strand C – technology and society – can be taught just like social studies e.g. history of technology, technology and culture. Technological practice is essential and integral but not the totality of technology education.

2. Technological practice does not necessarily foster a critical literacy.

I believe that 'practice' is a far narrower concept than 'literacy'. It reduces technology education to tasks to be performed and produces little cognisance for the critical aspects of technology. It is quite possible to acquire facts, solve problems, transfer learning etc. without ever developing the ability to critique technology. Students must be empowered to do this!

3. Children's actual capabilities can limit their technological practice.

Technological knowledge and understanding are equally, if not more, important – one can know about and understand without getting one's 'hands dirty'. In many units of learning suitable for particular year levels, the capability that students are able to exhibit is far in advance of/or well behind, the appropriate associated knowledge. Therefore, we need to be able to teach knowledge without also having 'capability'.

4. Opportunities for students to gain first hand experience of technological practice are very limited.

- Many owners or managers of businesses, and other places where technological practice is carried out, interpret OSH Regulation 59 to mean that they will not allow persons under the age of 15 years to be in these places under any circumstances; however, the clauses which permit exemption are often not invoked. I believe that Regulation 59 is used by many as an excuse for not having classes make visits.
- Transport costs, particularly in low decile and rural schools, reduce opportunities for visits to be organised.
- There are schools in many rural locations where examples of a wide range of technological practice (places and experts) are not readily available.
- Good resources which are alternatives to visits (e.g. videos, picture sets, illustrated 'big books', OHP transparencies, CD-ROM, etc.) are unfortunately not readily available.

Discussion

To summarise, the research data suggests a high degree of consensus amongst those in leadership roles in technology education in New Zealand. Ninety one percent of those who answered the questionnaire ranked technological practice as important or extremely important for achieving the aims indicated in the curriculum. The reasons given were analysed into the following categories:

| Technological practice is holistic and integrative | Technological practice provides links with the 'real world' | Technological practice is essential to technology education | Technological practice provides authentic learning experiences | Technological practice leads to technological literacy | Technological practice provides experiences of practical processes |
|--|---|---|--|--|--|
| 24 | 21 | 19 | 16 | 10 | 8 |

Within the first category, the following sub-categories were evident: integrates cultural values into practical work, integrates the elements of the New Zealand technology curriculum and integrates generic skills and cross-curricular knowledge.

A small number of respondents also made the following points: technological practice is integral but not essential, opportunities for students to gain first hand experiences of technological practice are very limited,

technological practice does not necessarily foster a critical literacy, and that children's actual capabilities can limit their technological practice.

The justifications given for the importance of technological practice are mainly pedagogical and in many ways these results are not surprising. That the 'guts' of technology education should involve seeking practical solutions to practical problems is hardly controversial. The majority also seem to agree that the complex process of seeking technological solutions is 'technological practice' and that the classroom equivalent "occurs when the three strands of the Technology curriculum are interacted in the resolving of a technological problem" (Ministry of Education, 1999b, www.minedu.govt.nz). The Ministry of Education website states that students develop technological literacy through technological practice and this viewpoint is repeated by 29% of the respondents in the study and criticised by one respondent.

The similarities and uniformity in the responses is interesting in itself, especially when those in leadership roles recognise that the current contractual processes for curriculum development used in New Zealand allow curriculum developers to "develop curricula reflective of their own ideological stance" (Compton & Harwood, 1999, p.2). Those who have carried out the professional development of teachers in technology have, in the main, been on one-year contracts let through the Ministry of Education. These contracted professional developers have heard the argument that technology education must be taught through technological practice (which is achieved through the integration of the three strands of the curriculum) repeatedly at national meetings sponsored by the Ministry of Education. There has been much talk of the need to provide a 'common message' to schools to avoid the confusion that arises when everyone has a different viewpoint. However, does consistency necessarily mean that there can only be one acceptable way to teach technology in New Zealand? Only one person (interestingly, they have a policy background) questions the assertion that all experiences in technology education must involve technological practice. Many have been convinced by the pedagogical arguments made for integrating the three strands of the curriculum but the possibility that this approach could be used as a means of questioning the status quo in social power structures generally seems to have been ignored. In contrast, the argument for providing a technology education which offers pupils experiences of genuine problem posing, and problem solution rather than the approach of using narrow, teacher defined 'design briefs' seems to be favoured by this group of research respondents.

The interpretations that have been made about the purpose of links with the 'real world' are interesting. In the literature there are arguments for teachers to use these experiences to gain content knowledge and knowledge of technological processes. In some places a critical approach to these experiences is recommended. The responses to this questionnaire suggest that these experiences of technology in the 'real' world provide students with models to emulate. There is no suggestion that any critique of practice is appropriate. These views are entirely consistent with the approach to partnership described in government publications cited 'the literature review'. They are also entirely consistent with the view of students as passive, peripheral participants described by Hildegard (1999). However, they are not consistent with developing a critical literacy in technology that recognises and possibly even challenges the costs as well as the benefits offered by technology. In my opinion, knowing about industry practices in technology is a very interesting, important and valuable way of developing technological literacy. However, the *emulation* of current industry/community practice can only give a one eyed view of technology and cannot possibly result in the intellectual development required for true literacy. It seems to me that the argument for the importance of technological practice in technology education in New Zealand has been developed to improve the quality of the experiences that children have in schools. However, because we are not clear enough about the purpose of school/business partnerships one of the unintended outcomes has been a tendency to constrain the possibility of taking a questioning stance towards technology.

Conclusion

Technological practice as defined on the Ministry of Education website seems to be largely accepted by those who participated in this research and in the main pedagogical reasons for this are given. There is a need to find out whether teachers are willing to accept this definition. As already noted, teachers do not tend to talk about technological practice. In my experience, especially with beginning teachers, they find the concept complex and the definition densely written and difficult to understand. To conclude this paper I would like to suggest the following edited version of the Ministry of Education definition of technological practice:

"Technological practice refers to the way in which a person or group develops technological solutions. In industry or community contexts the way that technological solutions are developed depends on how the initial problem is understood, the resources available and the knowledge and skills that the developers have access to and value.

“The broader social and environmental context may also influence the development of technological solutions. For example, the values of one group may lead to their supporting a particular solution whereas another group may oppose it. The views of different stakeholders usually need to be considered. Risks need to be assessed and compromises reached. Health and safety regulations may also influence the development of technological solutions.

“For the individual developers or groups of developers the economic context and the opportunities and constraints offered in the workplace may also be important. For example, whether or not the workplace culture is oriented towards innovation, whether or not there are resourcing constraints or production constraints and what technologies are available to use.

“In the school context, students carry out technological practice when they produce technological solutions. Usually this will involve integrating technological knowledge and an understanding of relevant social issues with practical skills to produce the technological solution i.e. usually the process will involve aspects of each of the three strands of the Technology curriculum. Sometimes it will be necessary to look critically at technological practice in the community or in industry. Technological practice and technological critique, are both integral parts of the development of technological literacy.

For this achievement standard, the student’s technological practice should incorporate ongoing evaluation of their practice against some negotiated criteria.”

This definition provides more flexibility and a more explicit recognition of the need to acknowledge and respond to the positions of *different* stakeholders in any technological development. It also acknowledges the necessity for a technology education to include critical questioning. I hope it will help to encourage further debate about how technological practice as defined in New Zealand and how we can develop a technologically literate society.

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Notes A: achievement objectives

Students' technological experiences should reflect the inter-linking nature of the strands: technological knowledge and understanding; technological capability; technology and society. When involved in any technological activity, students should adapt and apply knowledge, strategies, and skills from a variety of sources.

Strand A: technological knowledge and understanding

Within a range of technological areas and contexts, students should develop an understanding of:

1. the use and operation of technologies
2. technological principles and systems
3. the nature of technological practice
4. strategies for the communication, promotion, and evaluation of technological ideas and outcomes.

Ministry of Education (1995) *Technology in the New Zealand Curriculum*, Wellington: Learning Media, pp.31

Strand B: technological capability

Within a range of technological areas and contexts, students should produce technological solutions. They will:

5. identify needs and opportunities to provide information for possible technological practice
6. with reference to identified needs and opportunities:
 - a) generate possible options and strategies, and select, develop, and adapt appropriate solutions
 - b) produce technological outcomes to agreed quality standards, managing time, and using human and physical resources skilfully, safely, and effectively
 - c) present and promote ideas, strategies, and outcomes throughout technological practice

d) evaluate designs, strategies, and outcomes throughout technological practice in relation to their own activities and those of others.

Ministry of Education (1995) *Technology in the New Zealand Curriculum*, Wellington: Learning Media, pp.35

Strand C: technology and society

Within a range of technological areas and contexts, students should:

7. develop awareness and understanding of the ways the beliefs, values, and ethics of individuals and groups:

- promote or constrain technological development
- influence attitudes towards technological development

8. develop awareness and understanding of the impacts of technology on society and the environment:

- in the past, present, and possible future
- in local, national, and international settings.

Ministry of Education (1995) *Technology in the New Zealand Curriculum*, Wellington: Learning Media, pp.41

Notes B: the aim of technology education

Learning in technology implies becoming confident in using a variety of means to address needs and opportunities and solve practical problems within society. It focuses on know-how as well as knowledge itself, gathering information from diverse sources. It encourages risk taking, lateral and divergent thinking, the development of multiple solutions to problems, trial and error, teamwork, and the management of resources effectively and efficiently.

Technology education explores choice and the factors that influence choice, including culture and society, costs and benefits, aesthetics, and fitness for purpose. It seeks to empower students to make informed choices in the use of technology and in their responses to technological change.

The aim of technology education is to enable students to achieve technological literacy through the development of:

- technological knowledge and understanding
- technological capability
- understanding and awareness of the relationship between technology and society.

Technology education, therefore, involves students in:

- investigating, using, and understanding the technological products, systems, and environments that have been developed in their society
- developing knowledge of the principles and processes of technology
- identifying and exploring needs and opportunities which may be met through technological activity
- creating and evaluating ideas to improve or modify technology in relation to these identified needs and opportunities
- choosing and using materials, tools, and equipment skilfully and safely
- designing their own technological solutions
- working to agreed specifications and quality standards
- recognising the inter-relationship of technology and society—now, in the past and in the future
- feeling empowered to contribute to a technological society.

Ministry of Education (1995) *Technology in the New Zealand Curriculum*, Wellington: Learning Media, pp.8–9