The Enhancement of Technology Education Classroom Practice in New Zealand

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Abstract
This paper reports on a number of New Zealand technology education research studies undertaken over seven years by researchers in the Centre for Science and Technology Education Research centred upon examining and enhancing classroom practice. Early classroom research undertaken in 1992-1994 showed that key aspects for teacher development programmes related to teachers' developing robust concepts of technology and technology education, as well as developing an understanding of technological practice in a variety of contexts. Based on these aspects a national Technology Teacher Development Resource Programme was developed during 1995-1996. This programme included video material of technological practice and classroom practice, accompanying explanatory text and workshop activities. Further research undertaken in 1997 indicated that although teachers developed broader and more consistent concepts about the nature of technology through an examination of technological practice, they experienced difficulties effectively translating this into appropriate classroom strategies for sustaining student learning. The media based resources only took the teachers so far in their understanding of teaching technology. In 1998-2000 a research and intervention programme was undertaken in primary school classrooms aimed towards improving teachers' understanding of teaching, learning and assessing in technology. A planning framework for assisting teachers to detail student technological learning outcomes in different domains was developed. The articulation of the learning outcomes enhanced teacher knowledges in technology education and assisted teachers' formative interactions and summative assessment practices. Subsequently student learning was enhanced.

The New Zealand Technology Curriculum
Technology education is based on *The New Zealand Curriculum Framework* (Ministry of Education, 1993), as with the other essential learning areas of health and well-being, the arts, social sciences, science, mathematics, language and languages. Achievement is described in broad achievement objective terms defined over eight progressive levels and grouped in a number of strands. The framework requires that core principles related to learning and achievement, development of school programmes and aspects of social justice and equity, be reflected in the learning area documents.

The general aim of technology education in *Technology in the New Zealand Curriculum* is to develop student technological literacy through the development of three interrelated strands of technological knowledge and understanding, technological capability, and an understanding and awareness of the interrelationship between technology and society (Ministry of Education, 1995). Technology education in New Zealand is not limited to designing and making with a limited range of materials. Instead a range of technological

areas appropriate to the New Zealand context is defined. It is important that students experience a range of technological areas and contexts to develop an understanding of technology and technological practice. This is achieved through the technological areas of materials technology, information and communication technology, electronics and control technology, biotechnology, structures and mechanisms, process and production technology, and food technology.

Following a trial implementation period from 1994 to 1998, when both *Technology in the New Zealand Curriculum Draft* (Ministry of Education, 1993) and *Technology in the New Zealand Curriculum* (Ministry of Education, 1995) were used, the curriculum was fully implemented in 1999. All schools are now required to implement the curriculum in years 1-10. It is optional in years 11-13 (senior secondary school).

Theoretical perspectives
All research reported on in this paper is based on a sociocultural view of learning where human mental processes are situated within their historical, cultural and institutional setting (Wertsch, 1991 cited in Gipps, 1999), and learning can be seen as a form of cognitive apprenticeship (Brown, Collins and Duguid, 1989). Such a perspective requires that researching processes of learning occur within social settings. Additionally, all the research projects were founded on the principle of enhancing classroom practice. As noted by Black and Wiliam (1998) research that simply interrogates existing practice is likely to sadly confirm findings already known. To be beneficial therefore, research must be linked to programmes of intervention knowing that such intervention is likely to change teachers' roles and ways of teaching. The change strategy used was that of negotiated intervention (Jones and Simon, 1991) and this assisted in moving teachers from existing practices to new negotiated positions. In thinking about enhancing classroom practice then developing teacher knowledge and improving teacher student interactions become essential.

Teacher knowledges
Shulman (1987) strongly emphasises the need for teachers to build a knowledge base for teaching. He suggests that teaching should begin with an understanding of what is to be learned and what is to be taught. His framework includes knowledge of content, general pedagogy, curriculum, pedagogy content, learners, educational contexts and educational ends. Pedagogical content knowledge is acknowledged as important as it identifies the distinctive bodies of knowledge for teaching. A blending of content and pedagogy represents how particular topics are organised for learners. For a new curriculum area such as technology, this presents particular challenges for teachers as they search to construct a coherent, technological content base and appropriate assessment practices.

Subcultural influences
Critical in constructing applicable teacher development programmes concerned with curriculum innovation is the need to account for notions related to teacher change. An understanding of the influence of subject subcultures on teachers' understanding of technological practice, concepts of technology education and an understanding of technology pedagogy is significant in developing teacher development programmes in

technology, in developing suitable assessment practices and in ensuring that effective change occurs (Jones, 1999)*. Teachers have a subjective view of the practice of teaching within their concepts of subject areas (Goodson, 1985). This subject subculture leads to a consensus view about the nature of the subject, the way it should be taught, the role of the teacher, and what might be expected of the student (Paechter, 1992).

Classroom assessment
Consistent with Black and Wiliam (1998) findings, the Centre's research has shown that there is a very close link between teacher formative assessment practice, components of teachers' personal pedagogy and conception of their role. Black and Wiliam (1998) identified that formative interactions with students become distorted if there is a lack of subject knowledge and its construction. Teacher feedback is a key element to effective formative assessment and is usually defined in terms of information that gives the learner the opportunity to see how well they are doing or have done (Sadler, 1989). Quality of feedback is essential in supporting and enhancing learning. Students have been shown to benefit from feedback that identifies both the strengths and weaknesses of their work, enabling them to take control of their own learning. Feedback can also be defined in terms of the effect that it has on the learner and the learning, rather than by its informational content. Teacher feedback is often focussed on praise and promotion of social and managerial aspects of tasks (Mavrommattis, 1997; Butler, 1987). This results in drawing student attention away from the task and may have a negative effect on learning. If summative assessment is to be effective, the information has to be formulated with a structure and a language that reflects a shared understanding between those who are communicating. Black (1998) and Black and Wiliam (1998) believe that the information has to be adequately detailed, have common criteria for grading, have a shared procedure for determining standards and requires clear and agreed documentation. Summative assessment judgements become all the more difficult to make in a new subject area such as technology where there is a lack of a shared subculture on the nature of the subject, a lack of accumulated practical classroom experience and no established summative assessment structure.

1992-1994: An early examination of technology education
During 1992-1994 research examined the influences of subject subcultures, perceptions of technology and technology education on the way in which the curriculum innovation was implemented in primary and secondary classrooms. Twenty-seven classrooms were observed in the Learning in Technology Education Project (Jones, Mather and Carr, 1995).

It was found that the concepts of technology held by teachers had a significant affect on their planning of technological activities and their subsequent classroom strategies. Difficulties in identifying and assessing technological learning outcomes were evident. Though the tasks introduced in the classrooms were considered to be 'good' technological activities in that they lent themselves to technological outcomes for the students, teachers often emphasised learning in areas other than technology, such as language or science. As well, teachers focused on those aspects they were traditionally more comfortable with, for example discussion and group skills. Additionally, where

teachers had a sound technological knowledge base, but a narrow concept of technology education, classroom activities emphasised a design process devoid of links to issues inherent in the technological knowledge and technology and society strands.

The technology implementation strategies developed by the teachers were often positioned within that particular teacher's teaching and subject sub-culture. These subcultures had a direct influence on the way teachers structured the lessons and developed classroom strategies. Teachers developed strategies to allow for learning outcomes which were often more closely related to their particular subject subculture than to technological outcomes. Teachers entering areas of uncertainty in their planned activities often reverted to their traditional teaching and subject sub-culture. The teachers' technology and technology education concepts appeared to be somewhat fragile and transient in nature. This resulted in classroom practice often reverting toward a previous conceptualisation, which was in turn reflected in subsequent classroom practice.

Student concepts of technology and technological activities also influenced teachers' classroom practice. When student initial concepts of technology and technology education were inclusive of those underlying the technology unit, there was a significant level of reinforcement of student initial concepts due to participation in the unit. However, when initial student concepts were markedly different from that on which the technology unit was based, little change was evident in student initial concepts. Instead, initial concepts appeared to constrain student activity, or, alternatively led the student to perceive their activity to be non-technological. Student concepts appeared to have more impact on student technological practice than the teaching strategies employed (Jones, Mather, and Carr, 1995). This was further complicated by teacher limitations in sustaining the planned technology unit, whereby student technological practice and narrower concepts of technology began to affect teacher concepts of technology education. Where teacher concepts of technology were somewhat fragile the student concepts of technology appeared to dominate the learning outcomes; for example: including immaterial robotic arms or flashing eyes to make it more technological.

The research showed that key aspects for teacher development programmes related to teachers developing robust concepts of technology and technology education, as well as developing an understanding of technological practice in a variety of contexts (Jones, Mather and Carr, 1995).

1994: Taking technology to a wider audience
Alongside the undertaking of the LITE Project research (Jones, Mather and Carr, 1995), a series of 10 half-hour videos programmes *Know How!* (Ministry of Education, 1994) were developed to assist in building an understanding of the draft national curriculum statement *Technology in the New Zealand Curriculum* (Ministry of Education, 1993) which was in all schools at the time. The Ministry of Education developed *Know How!* (Ministry of Education, 1994) in conjunction with project review committee members including personnel from the Centre for Science and Technology Education Research. The video programmes presented views of technology education in schools and had a major aim of informing and eliciting responses to the draft national curriculum statement.

They illustrated practical implications of the draft statement and were directed to provide incentives for schools to work towards the implementation of technology.

Not only were they distributed to all schools without charge, they were also aired on national television. This broadcasting served to introduce technology education to the community through broadly defining technology and technology education, justifying the inclusion of technology as an essential learning area for all students in New Zealand schools and demonstrating technology as practiced in classrooms. Whilst the influence of their use has not been researched, anecdotal evidence would suggest they met their purpose as a means to introduce technology to schools and the community, and impacted on the responses received to the draft statement.

1995-1996: Developing a national teacher development programme
Based on key findings of the Learning in Technology Education Project (Jones, Mather and Carr, 1995) a national Technology Teacher Development Resource Programme was developed by the Centre for Science, Mathematics and Technology Education Research (Ministry of Education, 1997) during 1995-1996. This programme included video material of technological practice and classroom practice, accompanying explanatory text, and workshop activities (*Know How 2: Towards Teaching Technology*, Ministry of Education, 1997). The first module of videos was developed to encourage teachers to reflect on the nature of technological practice in a range of settings, for example: white-ware manufacturing; stage production; noise control; street design and development; and manufacturing and marketing dairy products. Further modules explored implementation and classroom issues, additional video material showed examples of technology education in real classrooms, and other written material introduced more classroom material and assessment strategies. Though teacher development programmes developed from the resource package varied in accordance with the needs and resources of schools involved, the developers, through the package components and guidelines, attempted to emphasise that all programmes should have a commitment to developing an understanding of technology, technology education and technological practice. The programme aimed for conceptual development, as well as offering practical guidelines for classroom implementation.

The teacher development resource package was trialed in 14 schools before nationwide distribution to all New Zealand schools. Teachers at all trial schools experienced some level of conceptual change as teacher concepts of technology were broadened. Working through the package had a positive impact on teacher understanding of the technology curriculum with all stating they now felt more comfortable and/or confident in using the curriculum. An increase in understanding of the curriculum in the majority of cases also corresponded to a positive effect on people's perception of both their ability to use the curriculum effectively, and/or their attitude to technology education generally. Eight of the schools (57%) specifically mentioned the videos as adding significantly to the strength of the package as a resource. The overall evaluation for the package was that it was perceived to be a positive initiative as the package provided schools with a comprehensive resource from which to base their teacher development programmes.

School-based teacher development supported by such a package was perceived by all to be an effective and favourable means of teacher development.

As well as being used in schools as the basis of teacher development programmes, the videos were also transmitted nationwide via television. This provided valuable ongoing exposure for technology education. The broadcasting captured a wide audience and granted a snapshot view of this new curriculum area.

1997: More research using video material
Moreland (1998) followed five primary teachers through their participation in a teacher development programme based on the critical examination of technological practice. The programme used videos depicting authentic technological activity in different technological areas as a base for instruction, and business visits as a way to give teachers opportunities to engage with experts in different technological areas. The findings of this research indicated that after involvement in the programme, the teachers constructed knowledge and understanding of these communities of practice. Further, they broadened their understanding of technological activity and technological principles that led to broader technological opportunities for classroom programmes. Technological pedagogy was informed by enriched concepts of technological practice and broader concepts of technology and technology education.

Yet an increased understanding of subject knowledge and broadening concepts of technology education were difficult to translate into appropriate learning outcomes for students. Most teachers continued to look for language and science outcomes and social skills, rather than technological outcomes. These aspects were also reflected in the teachers' assessment practices. The teachers' assessment procedures related more to their existing subcultures than assessment in technology.

1998: A further examination of technology education classroom practice
The examination of the research undertaken previous to 1998 indicated that teachers had developed broader concepts of technology, technological practice and technology education, and accumulated more classroom experience in teaching technology. However, successful translation of teacher knowledge into suitable learning goals for students, appropriate formative interactions and befitting summative assessment practices was continuing to prove problematic. New research was needed to forge a way forward.

A three-year study began in 1998 where 9 primary teachers' practices in planning, teaching and assessing technology were examined. Teachers were endeavouring to teach in all seven technological areas. Though teachers attempted to introduce tasks reflective of the three strands of the curriculum (Moreland and Jones, 1999), the capability strand had the most weighting in their actual classroom practice where technology was taught as designing, making and testing. All teachers acknowledged they had difficulty in understanding specific technological concepts. A sophisticated, complex technological knowledge base from which to teach had yet to develop.

Teachers were able to identify suitable technological tasks for their students but had difficulty identifying suitable technological learning outcomes and associated technological knowledge. With the focus on tasks it became almost impossible for teachers to provide feedback to enhance student performance at the conceptual and procedural level and whether students had completed the task was the basis for assessment. Teachers therefore, had difficulties making statements about student learning useful for future teaching and learning.

The collaborative nature of technology was often over-emphasised at the expense of other technological learning outcomes. Students often became confused as to the main purpose of the task, believing that social and managerial aspects were more important than technological aspects. For instance, students thought it more important to draw co-operatively with their partner than to create a drawing that would show their initial product ideas.

Teacher-student interactions were frequently praise-based and related to task completion, rather than related to enhancing students' technological understanding. When all attempts were accepted without discrimination, students were not required to reflect on their work in terms of whether they had met the objectives of the task, or how well the objectives had been met, or what they might do next. The opportunities to build on relevant conceptual, procedural and societal technological aspects were lost.

1999-2000: Enhancing teacher technological knowledge to enhance student learning
Based on the findings of 1998 an intervention centred on planning strategies that compelled teachers to articulate intended learning outcomes in concise technological terms was developed by the Learning in Technology Education (Assessment) Project (Moreland and Jones, 2000). Working with 13 primary teachers the researchers endeavoured to provide the means for teachers to develop a mental framework that assisted decision-making in planning for teaching technology. As technology education is concerned with exploring and solving complex, interrelated technological problems that involve multiple conceptual, procedural, societal and technical variables, the research team devised a planning format (see Figure 1) based on those variables as well as student technological practice which is the operationalisation and integration of the conceptual, procedural, societal and technical aspects when undertaking and completing the technology task. When students work across these aspects, the development of student technological literacy is enhanced.

Figure 1: Planning for learning and assessment in technology (Moreland, Jones and Chambers, 2000)

Task definition:			Tech Area/s:
Student technological practice:			
Conceptual Learning Outcomes	**Procedural Learning Outcomes**	**Societal Learning Outcomes**	**Technical Learning Outcomes**

Its use resulted in teachers moving from using general concepts about technology to more specific concepts within different technological areas. The teachers were able to choose more suitable tasks that had the potential to develop student learning in technology. This shift in focus from providing a technology experience to providing opportunities for students to develop technological learning outcomes was significant. They became focussed on the technological learning of their students. By undergoing a process of articulating concise intended learning outcomes, the teachers were able to deduce what they personally needed to know to teach technology. The articulation also provided a means to make decisions about what they wanted students to learn and it underpinned their subsequent formative interactions.
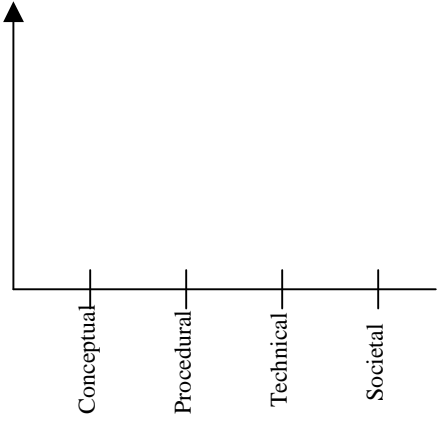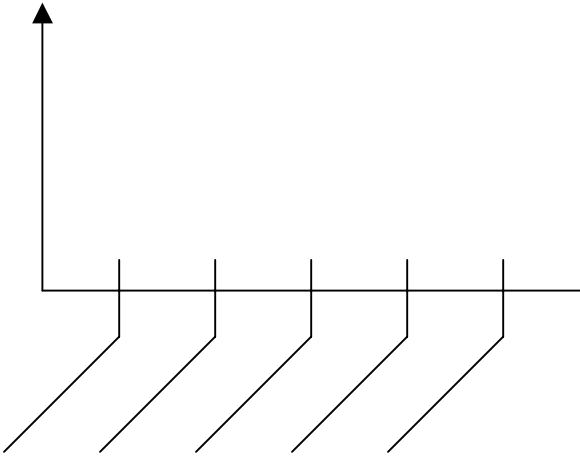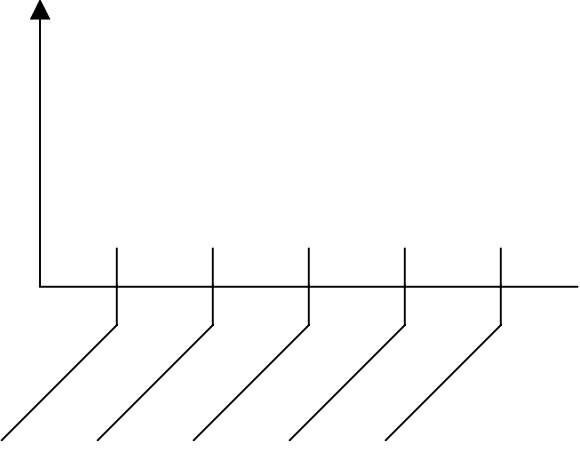
Teachers demonstrated greater confidence with formative assessment, particularly in relation to providing appropriate technology feedback to the learners. Considered direction was given where deemed appropriate, which led to more considered and purposeful interactions. There was more emphasis on providing feedback and assistance to students to develop particular conceptual and procedural aspects rather than social and managerial aspects. Additionally there was less emphasis on praise as the sole formative interaction and more emphasis on assisting students to move on, to reflect, and to assess their own progress.

The planning framework that compelled teachers to articulate intended technological learning outcomes also informed summative assessments. A holistic profile was developed to summatively record information related to the dimensions of technology (See Figure 2, Moreland, Jones and Chambers, 2000). The summative assessment profile includes a task definition, an overall statement related to student technological practice; graphs of conceptual, procedural, societal and technical aspects related to the ways these have been incorporated into the outcome, generic[1] and specific[2] graphs, a statement about student attitudes throughout the task, and a statement giving advice about future learning.

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[1] Generic aspects are those defined as common to more than one technological area
[2] Specific aspects are those defined as particular to one technological area

Figure 2: Holistic Profile of Individual Student Learning in Technology (Moreland, Jones and Chambers, 2000)

Task definition:	
Overall judgement of student technological practice:	**How the student brought the CPST aspects together to complete the task:** Conceptual Procedural Technical Societal **Comments:**
Student learning related to generic aspects across technological areas: **Comments:**	**Student learning related to specific aspects within a technological area:** **Comments:**
Attitudes:	
Where to next:	

This summative framework helped teachers to visualise important aspects of technology assessment as well as provide a comprehensive summary of student achievement. Additionally, it enhanced teacher communication related to student achievement in technology. Completed teacher-annotated profiles provided a means to interpret other student work from other classrooms. Evident was the development of initial teacher understanding of progression in student learning. Using the summative framework assisted the teachers to differentiate between the different levels of effectiveness of student learning and to justify the differentiation.

From the research and development strategies adopted in the 1998-2000 project it was found that to enhance and sustain learning in technology there needed to be a focus on translating teacher knowledge to specific and detailed technological learning outcomes in conjunction with appropriate pedagogical approaches to realise these. The frameworks focussed teacher attention on the conceptual, procedural, societal and technical aspects of student learning in technology as well as overall aspects of student technological practice. This resulted in increasingly skilled delivery of technology education programmes, enhanced formative interactions and developing summative practices. All were based on clearly identified learning outcomes and increasingly comprehensive shared concepts of learning in technology education.

Concluding remarks
The research projects undertaken before 1998 were based on strengthening teacher knowledge of technology, technological practice and technology education. Multi-media approaches were partially successful in achieving this. However, although teachers had broadened their understanding of those aspects they still found difficulties in successfully translating this increased knowledge into effective, sustainable, contiguous classroom practice and appropriate learning goals for students.

The results of the research undertaken during 1998-2000 provide a different story. Here, teachers' use and interrogation of the planning and assessment frameworks provided the mechanisms for translating teacher knowledge of technology and technological practice into appropriate classroom practice and appropriate learning goals for students. As a consequence student learning was significantly enhanced in technology. Students using more complex technological language and their more sophisticated technological processes and solutions indicated this.

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