

Technology Education in New Zealand

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Technology is one of the seven essential learning areas included to achieve the knowledge and understanding that all New Zealanders need to acquire (Ministry of Education, 1993). Responsibility for the implementation of these curricula rests with schools which have flexibility in making implementation decisions. Within the national curriculum framework, all curriculum statements must reflect the principles of the national curriculum framework, specify clear learning outcomes against which students' achievements can be assessed, have learning outcomes or objectives defined over eight progressive levels, and be grouped in a number of strands. The national curriculum framework's principles relate to learning and achievement, development of school programs, and aspects of social justice and equity.

The Technology Curriculum

The general aim of *Technology in the New Zealand Curriculum* (Ministry of Education, 1995) is to achieve technological literacy for all New Zealanders. Technological literacy is seen as an amalgam of three strands aimed at developing technological knowledge and understanding, technological capability, and an understanding and awareness of the relationship between technology and society. Each of these strands is seen as equally important, to be taught as an integral whole rather than as separate parts. This integration recognizes that technology has its own knowledge base, involves practical and procedural skills and techniques, and cannot be separated from the social and cultural environment within which it takes place. Technological activities in the classroom are intended to be based on learners identifying needs and/or opportunities that can be addressed through technological design and problem solving and on learners developing the knowledge, skills, and social awareness necessary to understand and critique modern technological practice.

The practice of technology covers a diverse range of activities. Each technological area has its own technological knowledge and ways of undertaking technological activity, and it was

considered important that students experience a range of technological areas and contexts. Learning in a variety of technological areas and contexts is thought to develop more effective understanding of technological principles as well as enhance the transfer of knowledge between contexts and areas (Jones, 1997; Perkins & Salomon, 1989). Allied to developing a broadly based curriculum was the desire to have the curriculum reflect technologies that were appropriate in the New Zealand context (Jones & Carr, 1993). It was therefore decided to include the following technological areas: materials technology, information and communication technology, electronics and control technology, biotechnology, structures and mechanisms, process and production technology, and food technology.

The technology curriculum also recognizes the centrality of graphics and design in all technological areas, and rather than listing graphics and design as a separate technological area, it is expected to be an integral part of teaching and learning in all areas of technology education.

In 1999 technology became a compulsory part of the school curriculum for years 1–10. It is optional in years 11–13 (senior secondary school). It was therefore necessary to develop strategies to support teachers in the implementation of this new curriculum area, and the Centre for Science and Technology Education Research, University of Waikato, has been closely involved in a number of research and development projects to enhance the teaching and learning of technology. These projects include teacher professional development, resource development in association with Technology Education New Zealand and The Royal Society, and classroom research.

Teacher Professional Development

Teachers' understanding and perceptions of a subject have a considerable impact on their interpretation and subsequent implementation of that curriculum (Goodson, 1985). Because most New Zealand teachers currently have little or no background in either technology or

technology education, their perceptions tend to be narrow, seeing technology as essentially concerned with modern, sophisticated machinery and electronics (Jones & Carr, 1992). While teachers' views of teaching are much more informed, they are subjective, having been developed within the subject subculture with which they identify (Paechter, 1992). For the introduction of technology this was a multiple problem. Not only were teachers' views of technology inconsistent with the much broader view of technology inherent in the technology curriculum statement, but their approach to teaching technology was likely to be dominated by their subject subculture's consensus view of 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).

There was a danger that approaches to teaching technology would be based on techniques more suited to other subjects and that these approaches would be applied to a distorted version of the curriculum. Consequently, teacher development programs were developed to enhance teachers' understanding of technology and technology teaching (Compton & Jones, 1998). In these programs it was seen as important to develop not only a broader concept of technology, but also awareness and understanding of technological practice. The implications of this were that teachers needed to experience technological practice in some form to become confident in the teaching of technology. Learning about technological practice was not sufficient. It needed to be experienced, reflected on, and critically analyzed in terms of a concept of technology that was compatible with the curriculum statement (Jones & Compton, 1998).

Two programs were developed and trialed in the New Zealand context: the National Facilitator Training Program and the Technology Teacher Development Resource Package Program.

National Facilitator Training Program

The Facilitator Training Program was a year-long program and ran for two years, 1995 and 1996. It involved training a total of 30 educators—15 each year—from all over New Zealand. Program evaluations by the participants (facilitators) indicated the importance of developing a theoretical perspective of technology education. This was

found to be particularly helpful when discussing implementation issues with school managers and boards. Participants also stressed the importance of learning about the techniques and practices of different technological areas.

Following the training program these facilitators worked with teachers on a national basis. Teachers' evaluations of these programs were very positive, with 87.2% of responses rating the program as above average or excellent. The majority of teachers commented that the program had met their needs and requested further teacher development of this kind. Most of the teachers (83%) found that the programs developed by the facilitators had helped them with their understanding of technology teaching generally and the technology curriculum specifically. Over half of the teachers (63%) also found the program helped them with their understanding of the concept of technology itself. Approximately three quarters of the teachers (76%) considered the areas of school and classroom implementation had been helpful, and over half of the teachers (66%) had found the program helpful in providing them with ideas for classroom activities—even though this was not a primary focus of the programs.

National Technology Teacher Development Resource Package Program

The Technology Teacher Development Resource Package Program was trialed in 14 schools over a three to six month period in 1996 and included video material of technological practice, classroom practice, and accompanying explanatory text as well as workshop activities. All the evaluations both in the trial schools and from subsequent general use indicate the successful nature of these programs and the usefulness of the model as a basis for teacher professional development in technology education. This resource package (Ministry of Education, 1997) is now used in most schools and forms the basis of nationally funded professional development in New Zealand.

Key Features of Teacher Professional Development

Our experience with these teacher professional development programs, designed to be consistent with both New Zealand's national curriculum statement in technology and relevant research findings, suggests that the

following features are central in their success. In these programs it was important to develop:

- robust concepts of technology and technology teaching;
- understanding of technological practice in a variety of contexts;
- technological knowledge in a number of technological areas;
- technological skills in a number of technological areas;
- understanding of the way in which people's past experiences both within and outside education impact their conceptualization of technology teaching; and
- understanding of the way in which technology content and experiences can become a part of the school and classroom curriculum. This must be based on a sound pedagogy in keeping with the concept of technology education.

Developing Resource Material Which Emphasizes Effective School/Enterprise Links

The curriculum document for technology emphasizes that the link between schools and the community, including business and industry, tertiary institutions, and local authorities, is important to a well-developed, inclusive technology curriculum. It is expected that students will develop an understanding of the nature of technological practice and recognize its similarities and differences between different communities of practice. A successful resource assisting teachers in this area is the Delta Series (The Royal Society of New Zealand, 1999). This is a collaborative venture between TENZ (Technology Education New Zealand), IPENZ (Institute of Professional Engineers of New Zealand), and The Royal Society of New Zealand.

The Delta Series consists of a series of case studies built around school enterprise links. For example, five of the units have involved links specifically established through the IPENZ Neighborhood Engineers program. Each case study incorporates reflective comments from teachers involved. The outside experts associated with the technological activity have also commented on the knowledge and experience they were able to bring to the process. An additional feature is an external perspective provided through comments offered by a reference panel of

experienced technology educationalists, including researchers.

It is hoped that the case studies will be used constructively both by classroom teachers and those from the wider community who are interested in becoming involved in technology education programs in schools. Those teachers who are just starting the process of developing their classroom technology programs will gain an insight into the thinking of others who have taken positive first steps along the path. More experienced teachers will be able to reflect on the experiences and views of others as they work to refine their own programs to better meet the needs of their students and local community. The wider community should be able to see ways in which they too may be able to become involved at all levels of the technology curriculum.

Enhancing and Sustaining Classroom Practice Through Research and Development

There are two research programs (Moreland & Jones, 2000; Moreland, Jones, & Northover, 2001) that have been examining classroom practice in technology, particularly in the area of formative assessment. The first examined existing practice, while the second explored the development of effective formative interactions. This research feeds directly into a resource development strategy for use by classroom teachers.

Research Methodology

The first year of the research (1998) explored teachers' emerging assessment practices in teaching technology. Nine teachers (two male, seven female) from two primary (years 1–6) schools were involved. The teachers' classroom experience ranged from a first-year teacher to a teacher with 16 years of experience. In terms of technology teacher development, three had had minimal involvement; two, moderate involvement; and four, extensive involvement over a whole year.

The research focused particularly on teachers' concepts of technology and classroom practices in technology. A case study approach was utilized to gain an understanding of classroom assessment practices in technology. The project was set within the theoretical framework that technological knowledge and assessment knowledge is socially constructed and context dependent.

The researcher took the role of a participant observer in the classroom during the technology education sessions; this contact involved 100 hours. Several methods of data collection were used including classroom observations, field notes, individual and group interviews, and written responses. Throughout the process, individual and group interviews provided an opportunity to explore student interaction with the classroom activities. Group interviews were valuable since many of the students worked collaboratively and the research endeavored to take this into account. Teachers' observations and comments provided further consideration of context and student performance.

The classroom discussions between the teacher and students and the students themselves were taped and analyzed. Students' written work and teachers' written material, including planning and assessment, were collected and analyzed. All of the analyzed data were then used to write individual case studies for each of the nine teachers involved in the research. The case studies are presented in *Case Studies of Classroom Practice in Technology* (Moreland & Jones, 1999).

The second year of the research was expanded to involve working in five primary schools (years 1–8) with 14 teachers (3 male, 11 female). The teachers' classroom experience ranged from a second-year teacher to a teacher with 26 years of experience, while technology teacher development ranged from minimal involvement to extensive experience, such as a technology facilitator.

Contact during this year included classroom observations, individual and group interviews, and teacher observation and comment. Workshops were an essential part of the process of enhancing assessment procedures, with the teachers attending seven days of workshops: an initial three-day workshop and two, two-day workshops spread through the year. The first three-day workshop focused on discussions of the findings from the 1998 research and the implications. As well, the models for assessment developed by the research team were introduced and trialing began. The second two-day workshop offered the teachers opportunities for reflection and enhancement of the use of the models. The final two-day workshop focused on assessing the use of the models and their further enhancement.

Year One Research Findings (Existing Practice)

After substantial classroom research in

1998, there appeared to be significant problems for teachers in assessing technology. Teachers commented that their difficulties were not just confined to technology but were also related to other subjects. In comparison with earlier research (Jones & Carr, 1992) it was found that, as a result of the teacher development models discussed earlier and the trialing of curriculum material in classrooms, teachers had developed broader concepts of technology (Jones & Compton, 1998; Moreland, 1998). These concepts, however, were still not broad or detailed enough to take into account many conceptual and procedural aspects, and this appeared to be confining teachers' assessment in technology to assessing affective aspects of learning such as enjoyment and the social and managerial aspects such as working in groups, turn-taking, and sharing. Technology had yet to become an integral part of the talk of classroom teachers and the community. This meant that a shared language of technology had not developed to any degree of specificity, which Black (1998) stated is vital for assessment.

In their planning of technology, teachers were focusing on the activities rather than on specific learning outcomes. With this focus on activities it became almost impossible for teachers to provide feedback at the conceptual and procedural level. The learning outcomes that were identified were often not technological and therefore learning in technology was not enhanced.

Formative assessment was not well understood in technology. Like the learner, the teacher needs to have a perception of a gap between a desired goal and where the student is currently operating. They also need to know what action needs to be taken to close the gap in order to reach the desired goal (Black & Wiliam, 1998). These teachers were not able to articulate what that gap might be in terms of conceptual and procedural aspects because they did not know what the desired goal was. They therefore could not know what detailed action to take because they did not know where the student was going, or even the current position of the student.

Also impacting teacher assessment practices in technology were the existing subcultures in schools. What teachers relied on for assessing in technology became largely dependent on what they already did and knew in other curriculum areas. All teachers in

primary schools have common understandings of teamwork, leadership, turn-taking, discussing, depicting ideas, gathering information, describing, reflecting, etc., and these common understandings of social and managerial skills had become the focus of assessment in technology.

Year Two—Developing Formative Interactions

During this year, the conceptual and procedural aspects of learning in technology were highlighted as the means to enhance teachers' formative interactions and the learning outcomes for the students. This resulted in teachers moving from using general concepts about technology to more specific concepts within different technological areas. For the first time teachers were able to identify the specific technological learning outcomes they wished to teach and assess. The teachers' developing conceptual and procedural knowledge enabled them to write specific learning outcomes, and they began to move with more confidence between the generic dimensions of the nature of technology and the specific technological learning outcomes associated with particular technological areas.

This shift in focus from providing a technology experience to providing opportunities for students to develop technological learning outcomes was significant. They became focused on the technological learning of their students. Teacher talk about technology education had a higher profile and was increasingly embedded in teacher conversations. Teacher talk also developed relating to progression and the linking of learning outcomes from one unit to the next as illustrated by this teacher's comments:

I felt we were looking for progression and I felt that the children built on certain things that were covered last time very well. There was a lot more movement in the iterative process this time. The children really started to move backwards and forwards through the design process very well... we might go on to extend by looking at different types of food packaging...going perhaps to the opening mechanism of packages as well...so we can start looking at the ergonomics of packages ...we could go more into specification drawings or perhaps three dimensional conceptual drawings.

Teachers demonstrated greater confidence with formative assessment, particularly in relation to providing appropriate feedback to

the learners. Not only was there more emphasis on providing feedback and assistance to students to develop particular technical skills, there was also more emphasis on 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, to assess their own progress.

The models that were developed in the project had a key role in enhancing the teachers' planning and classroom strategies. The teachers valued the following intervention strategies:

- Identifying specific and overall learning outcomes rather than just activities.
- Identifying procedural, conceptual, societal, and technical learning outcomes.
- Summative assessment during the unit as well as at the end.
- Questioning using technological vocabulary.
- Allowing for multiple outcomes.

These are illustrated in some of the teachers' comments below:

Dividing planning into conceptual, procedural, societal, and technical allowed me to more effectively hone in on the technology involved.

The identification of possible and planned learning outcomes made me more aware of the questioning that would be required.

Evident was the development of initial teacher understanding of progression in student learning in technology. This was reflected in task selection and development. Tasks were identified to develop particular conceptual and procedural aspects rather than just providing a variety of experiences. The use of the models also enabled the teachers to differentiate between the different levels of effectiveness of student learning and to explain the differences. The teachers also noticed enhanced student learning. Their comments were illustrative of this:

Children's differences in learning can be better identified with specific learning outcomes with more effective children coping with more variables.

Have had quality opportunities to show what they can do with improved vocabulary, language, and skills.

The more effective children were engaged all of the time; they had the vocabulary and could use it appropriately. This was evidenced in their mock up and drawing.

The teaching, learning, and assessment strategies that have been developed in this intervention year also impacted the teaching and learning in other curriculum areas. All teachers made comments on this, for example:

I am looking at making my learning outcomes very focused for other curriculum areas to develop more purposeful and structured formative and summative assessment practices. I am thinking more carefully about what I want the children to learn.

I am now probing, in-depth questioning and constantly challenging. I am thinking about how my learning activities link and how I can help children transfer ideas and skills.

This research project has developed intervention strategies that encourage teachers to identify the conceptual, procedural, societal, and technical aspects, task definition, and aspects of holistic assessment. The results are very encouraging with the focus at the conceptual and procedural level rather than in terms of an activity.

General comments made by the teachers at the conclusion of the year included the following:

My technology teaching has made huge leaps forward because of my involvement. It has been very demanding, but the risks have been worthwhile.

The models have helped immensely, and it has been particularly rewarding to see the quality of work that is being produced by the children as a result of the research.

Continuing the Process

To successfully introduce and sustain a new curriculum requires a long-term research and development program that informs classroom practice. In New Zealand, this program has included teacher development, resource development (for teacher development and classroom materials), development of strategies to enhance teacher knowledge and classroom practice, and mechanisms for the dissemination of the research findings to inform all teachers.

Our research has shown that to improve and sustain learning in technology, it is necessary to enhance both teachers' technological knowledge and their understanding of technological practice. Resources and teacher development programs based on these goals have proved very successful in improving teachers' confidence and competence in teaching technology.

While teacher development programs helped to improve teachers' understanding of technology, classroom research has shown that teachers required further help with assessing technology. In particular, teachers found it difficult to identify specific conceptual and procedural aspects of technological learning, relying instead on social and managerial outcomes to define their desired learning. To assist teachers with this problem, well-developed models were used to focus the teachers' attention on the conceptual, procedural, societal, and technical aspects of student learning in technology. These models have allowed teachers to identify their knowledge gaps in technology and encouraged them to develop effective strategies to address these gaps and become more effective in the classroom. As highlighted by Fenstermacher (1994), it is more important that teachers know what they know than for researchers to know what teachers know.

However, while these results are encouraging, this is only the beginning, and more research and development work is required to develop sustained classroom practice in technology consistent with the New Zealand technology curriculum.

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References

- Black, P. J. (1998). *Testing: Friend or foe? Theory and practice of assessment and testing*. London: The Falmer Press.
- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education*, 5(1), 7–74.
- Compton, V., & Jones, A. (1998). Reflecting on teacher development in technology education: Implications for future programs. *International Journal of Technology and Design Education*, 8(2), 151–166.
- Fenstermacher, G. (1994). The knower and the known: The nature of knowledge in research on teaching. *Review of Research in Education*, 20, 3–56.
- Goodson, I. F. (Ed.). (1985). *Social histories of the secondary curriculum*. London: Falmer Press.
- Jones, A. (1997). Recent research in student learning of technological concepts and processes. *International Journal of Technology and Design Education*, 7(1–2), 83–96.
- Jones, A., & Carr, M. (1992). Teachers' perceptions of technology education: Implications for curriculum innovation. *Research in Science Education*, 22, 230–239.
- Jones, A., & Carr, M. (1993). *Towards technology education* (Vol. 1). Hamilton, New Zealand: Centre for Science and Mathematics Education Research, University of Waikato.
- Jones, A., & Compton, V. (1998). Towards a model for teacher development in technology education: From research to practice. *International Journal of Technology and Design Education*, 8(1), 51–65.
- Ministry of Education. (1993). *New Zealand's curriculum framework*. Wellington, New Zealand: Learning Media.
- Ministry of Education. (1995). *Technology in the New Zealand curriculum*. Wellington, New Zealand: Learning Media.
- Ministry of Education. (1997). *Towards teaching technology: Know how 2*. Wellington, New Zealand: Learning Media.
- Moreland, J. (1998). *Technology education teacher development: The importance of experiences in technological practice*. Unpublished master's thesis, University of Waikato, Hamilton, New Zealand.
- Moreland, J., & Jones, A. (1999). *Case studies of classroom practice in technology* (Working Paper 523, Research in Assessment of Primary Technology Project). Hamilton, New Zealand: Centre for Science, Mathematics and Technology Education Research, University of Waikato.
- Moreland, J., & Jones, A. (2000). Emerging assessment practices in an emergent curriculum: Implications for technology. *International Journal of Technology and Design Education*, 10(3), 283–305.
- Moreland, J., Jones, A., & Northover, A. (2001). Enhancing teachers' technological and assessment practices to enhance student learning in technology: A two year classroom study. *Research in Science Education*, 31(1), 155–176.
- Paechter, C. (1992). Subject subcultures and the negotiation of open work: Conflict and co-operation in cross-curricular coursework. In R. McCormick, P. Murphy, & M. Harrison (Eds.), *Teaching and learning technology* (pp. 279–288). Wokingham, England: Addison-Wesley, Open University Press.
- Perkins, D. N., & Salomon, G. (1989). Are cognitive skills context bound? *Educational Researcher*, 18(1), 16–25.
- The Royal Society of New Zealand. (1999). *The Delta series*. Wellington, New Zealand: SIR.

