From Technology National Curriculum statement through to sustaining classroom practice and enhancing student learning: the New Zealand experience.

Alister Jones and Judy Moreland
University of Waikato
New Zealand

Abstract

This paper will introduce four key aspects of the implementation of a national technology curriculum. Firstly, we will discuss how the structure of the New Zealand Technology Curriculum (*Technology in the New Zealand Curriculum,* Ministry of Education, 1995) attempted to reflect the nature of technology and technological practice. The structure of the curriculum in terms of the broad outcomes and technological areas will be highlighted. The curriculum statement provides a framework within which students can develop an understanding of past technologies as well as those being currently developed in their local community, nationally or internationally. Secondly, a discussion of the need for research of appropriate models of teacher development is presented. Thirdly, an example of a classroom resource that fosters school-enterprise links is discussed. Finally, this paper will examine how developing teachers' formative assessment practices in technology can both sustain classroom practice in technology as well as enhance student learning. Highlighted is the development of both the teachers and students conceptual and procedural technological knowledge base, both, so that classroom practice in technology was more effective and sustainable. The role of research and development in implementation and the way this has informed classroom practice in the New Zealand context, will be highlighted throughout the paper.

Introduction

This paper sets out to review some of the recent research in technology related to the enhancement and sustainability of technology education as a curriculum area in New Zealand and its classroom implementation. The technology curriculum is a new area of learning that is now compulsory for all students from years 1-10. From 1992, when technology education policy was first developed (Jones and Carr, 1993), there has been a sustained research and development focus as a means to inform the structure of the curriculum, its subsequent national implementation, and classroom practice.

First, the background to the innovative structure of the curriculum is described. Second, descriptions are given of the research and development outcomes and strategies related to national teacher development, resource development and classroom implementation in order to enhance and sustain this curriculum innovation.

Background to the national curriculum statement in technology

- *New Zealand national curriculum framework*

The New Zealand Curriculum Framework defines seven broad essential learning areas rather than subject areas. The seven essential learning areas that describe in broad terms the knowledge and understanding that all students need to acquire, are health and well-being, the arts, social sciences, technology, science, mathematics, and language and languages. Schools have flexibility in how the curricula will be achieved and have the responsibility for making implementation decisions. The curriculum framework requires that all national curriculum statements in the essential learning areas specify clear learning outcomes against which students' achievements can be assessed. These learning outcomes or objectives must be defined over eight progressive levels and be grouped in a number of strands. In addition, the framework requires that its principles must be reflected in the learning area documents. These principles relate to learning and achievement, development of school programmes and aspects of social justice and equity. Each strand in a curriculum has a list of achievement aims and is divided into eight levels of achievement objectives, which aim to describe the progression of learning from year 1 to year 13. The technology curriculum follows this format and is discussed below.

- *Technology curriculum statement*

The general aims of technology education in *Technology in the New Zealand Curriculum* (Ministry of Education, 1995) are to develop: technological knowledge and understanding; technological capability; and an understanding and awareness of the interrelationship between technology and society.

Technological knowledge and understanding

It is impossible to undertake a technological activity without technological knowledge and the utilisation and transformation of other knowledge bases. Students need to develop an understanding of the principles underlying technological developments such as aesthetics, efficiency, ergonomics, feedback, reliability and optimisation. These knowledges and principles will be dependent on the technological area and context the students are working in. The understanding of systems is essential in developing knowledge in technology. Students will also need to develop an understanding of the nature of technological practice and how this has similarities and differences in different technological communities of practice. It is important that students have an understanding of a range of technologies and how they operate and function. An understanding of strategies for the communication, promotion, and evaluation of technological ideas and outcomes is integral.

Technological capability

Technological activity arises out of the identification of some human need or opportunity. Within the identification of needs and opportunities students will need to use a variety of techniques to determine consumer preferences. In technological activities students should develop implementation and production strategies to realise technological solutions. Part of this will involve students in developing possible ideas that will lead to solution and develop and use strategies to realise these ideas. Within this students will need to manage time, resources, and people and produce the outcome that meets the identified needs and opportunities. Students should communicate their designs, plans and strategies and present their technological outcomes in appropriate forms. Part of this process is the devising of strategies for the communication and promotion of ideas and outcomes. Throughout the technological activity students should continually reflect upon and evaluate the decisions they are making. Research indicates (Jones, 1997) that this is essential if students are to realise their technological outcomes.

Interrelationship between technology and society
Students should develop an understanding of the ways in beliefs, values, and ethics promote or constrain technological development and influence attitudes towards technological development. Student should also develop an awareness and understanding of the impacts of technology on society and the environment.

Technological areas
The practice of technology in the world outside the classroom covers a diverse range of activities from agriculture through to the production of synthetic materials and electronics. Technology education must reflect this diverse practice and not limit itself to designing and making with a limited range of materials. The development of technology education must reflect the relevant technological activities. Therefore it was essential that a range of technological areas in the teaching and learning of technology that were appropriate in the New Zealand context were developed (Jones and Carr, 1993).

Each technological area has its own technological knowledge and ways of undertaking technological activity. It is important therefore that students experience a range of technological areas and contexts to develop an understanding of technology and technological practice. Theories of learning also point to the fact that the more students can work in a number of contexts and areas, then the more likely they are to develop effective knowledge about technology and transfer this knowledge to other contexts and areas (Jones 1997, Perkins and Salomon, 1989). To develop a broad curriculum it was decided to include a number of technological areas. In the New Zealand technology curriculum the technological areas include: materials technology; information and communication technology; electronics and control technology; biotechnology; structures and mechanisms; process and production technology; and food technology.

From curriculum development with supporting research
The curriculum was fully implemented in 1999, and all schools are required to implement the curriculum in years 1-10. It is optional in years 11-13 (senior secondary school). Therefore, research and development strategies had to be developed to support teachers in this new curriculum area. The Centre for Science, Mathematics and Technology Education Research, University of Waikato has been closely involved in the following areas of research and development to enhance the teaching and learning of technology. These areas are teacher development (Jones and Compton, 1998; and Compton and Jones, 1998) resource development emphasising school enterprise links in association with Technology Education New Zealand and The Royal Society, and research in classrooms (Moreland and Jones, in press; and Jones, Moreland and Northover, in press).

Teacher professional development

The introduction of a 'new' learning area in schools, such as technology, has been somewhat problematic in New Zealand. Teachers' existing sub-cultures in terms of teaching and learning, subject area, and school, in association with their concepts of technology, influence the development of classroom environment and strategies, and consequent student activities (Jones, Mather and Carr, 1995).

In order to introduce technology into the classroom, it is important not only to have a developed concept of technology but also awareness and understanding of technological practice. Technological activity necessitates a technological knowledge base and technics (techniques associated with its practice). The implications of this are that teachers will need to experience technological practice and techniques in some form to become confident in the teaching of technology. Learning about technological practice is not sufficient. It needs to be experienced, reflected on, and critically analysed, in terms of a concept of technology in keeping with the curriculum statement (Jones and Compton, 1998).

Consequently teacher development programmes were developed to enhance teachers' understanding of this new area, (for full details, see Compton and Jones, 1998). These programmes were based on a model that emphasised the importance of teachers developing an understanding of both technological practice and technology education. Two different programmes have been developed and trialed in the New Zealand context. They are the Facilitator Training programme, and the Technology Teacher Development Resource Package programme.

National Facilitator Training Programme
The Facilitator Training Programme was a year-long programme, and ran in 1995 and 1996. It involved training a total of 30 educators - 15 each year, from all over New Zealand. The evaluations by the participants (facilitators) indicated the importance of developing theoretical perspectives in technology education, particularly when having to discuss implementation issues with school managers and boards. The participants also stressed the importance of learning about the techniques and practices of the different technological areas. After the training programme these participants then worked with teachers on a national basis. The evaluations from the teachers on these programmes show that the majority of teachers who participated perceived the facilitators' programmes very positively. The very common call from teachers' personal comments was for more teacher development of this type. This, along with the 87.2% of responses rating the programme as above average or excellent, reflects clearly the success of the facilitators' programmes, and of the training programme overall, as judged by practicing teachers. The responses also showed there was a general perception that the facilitators had a high level of skill in both facilitation and programme development, and a significant number commented specifically that they 'really knew the material well'. The majority of the teachers felt the teacher development programme in which they were involved had met their needs.

Most of the teachers (83%) considered the programmes developed by the facilitators had helped them with their understanding of technology education generally, and the technology curriculum specifically. Over half of the teachers (63%) also found the programme 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 programme helpful in providing them with ideas for classroom activities - even though this was not a primary focus of the programmes.

National Technology Teacher Development Resource Package Programme
The Technology Teacher Development Resource Package Programme was trialed in 14 schools over a 3-6 month period in 1996 and includes video material of technological practice, classroom practice, accompanying explanatory text as well workshop activities. All the evaluations both in the trail schools and from subsequent general use indicate the successful nature of these programmes and the usefulness of the model as a basis for the development of 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
Experience to date would therefore suggest that the following key features should be taken into account when developing technology education teacher professional development programmes consistent with both the New Zealand national curriculum statement in technology and past research findings (Compton and Jones, 1998). These are:

- importance of developing a robust concept of technology and technology education;
- importance of developing an understanding of technological practice in a variety of contexts;
- importance of participants developing technological knowledge in a number of technological areas;
- importance of participants developing technological skills in a number of technological areas ;
- importance of developing an understanding of the way in which people’s past experiences both within and outside of education, impact on their conceptualisation of, and in, technology education;
- importance of developing an understanding of the way in which technology education 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 emphasises effective school/enterprise links

The curriculum document for technology emphasises 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 need to develop an understanding of the nature of technological practice and how this has similarities and differences in different technological 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 Neighbourhood Engineers programme. Each case study incorporates reflective comment 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 able to be used constructively both by classroom teachers and those from the wider community who are interested in becoming involved in technology programmes in schools. Those teachers who are just starting out in the process of developing their classroom technology programmes 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 programmes 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 technology education.

Enhancing and sustaining classroom practice through research and development: the role of formative assessment

There are two research programmes (Moreland and Jones, in press; and Jones, Moreland and Northover, in press) 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.

- *Existing practice – the first research programme*

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 and Carr, 1992) it was found that teachers had developed broader concepts of technology as a result of the teacher development models discussed earlier and the trialing of curriculum material in classrooms (Jones and Compton, 1998, Moreland, 1998). These concepts though were still not broad or detailed enough to take into account many conceptual and procedural aspects. The teachers’ lack of understanding about conceptual and procedural aspects of technology appeared to be confining their assessment in technology to assessing affective aspects of learning such as *did they enjoy it* and the social and managerial aspects such as *working in groups, turn taking, 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) states 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 to enhance student performance at the conceptual and procedural level. The learning outcomes that were identified were often not technological learning outcomes. So feedback was not in terms of technology 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 and Wiliam, 1998). Teachers of technology were not able to articulate what that gap might be in terms of technological 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. There was not a well-developed sense of progression in technology as implied in other subject areas, for example reading, for which there is an established culture in primary schools.

A subject subculture had developed for technology in terms of teachers identifying suitable technology tasks. Their developing concepts of technology had led teachers to improve in the appropriate identification of tasks. However, concepts of technology were not yet robust enough to retain subject integrity. Details of the different technological areas, including the associated knowledge bases, were not well articulated or understood by the teachers. This meant that teachers had difficulties in identifying technological learning outcomes and progression in learning.

Also impacting on teacher assessment practices in technology were the existing subcultures in schools and school-wide policies, teacher experiences and teacher subject expertise. 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 became the focus of assessment in technology. Therefore in terms of the technology curriculum, teachers focused on aspects of the achievement objectives that aligned with social and managerial aspects, for example discussing, exploring, and sharing.

- *Developing formative interactions – the second research programme*

The second research programme undertaken during 1999 was designed to enhance formative interactions between the teachers and students. The conceptual and procedural aspects of learning in technology were highlighted as the means to enhance the formative interactions of the teachers 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 assess. Teachers' developing conceptual and procedural knowledge enabled them to write specific learning outcomes, and they began to move with more confidence between the global dimensions of the nature of technology and the specific technological learning outcomes.

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 provide opportunities for students to develop technological learning outcomes was significant. By investigating a wide range of learning outcome possibilities and then selecting particular learning outcomes teachers pursued a more appropriate approach to technological learning. They became focussed on the technological learning of their students. Teachers were also increasingly cognisant of unexpected and negotiated learning outcomes and were more prepared to allow students to pursue such outcomes. Teacher talk about technology education had a higher profile and was increasingly embedded in teacher conversations. Teacher talk also developed related to the enhancement of learning technological aspects from one unit to the next.

Some difficulties with assessment in technology continued but teachers demonstrated greater confidence with formative assessment, particularly in relationship to providing appropriate technology feedback to the learners. Considered direction was given where deemed appropriate, which led to more considered interactions. 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, and to assess their own progress.

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; an iterative use of the models; and, allowing for multiple outcomes. These are illustrated in some of the teachers' comments below:

> *Thinking about the learning that I wanted to take place enabled very focussed activities to meet the learning outcomes.*
>
> *Dividing planning into conceptual, procedural, societal and technical allowed me to more effectively hone in on the technology involved.*

Also increased were more appropriate pedagogical approaches. A variety of methods were employed by the teachers including student interviewing, conferencing, observation, use of considered portfolios and analysis of appropriate learning outcomes.

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 technological conceptual and procedural aspects rather than just providing a variety of experiences in different technological areas. The use of the models also enabled the teachers to differentiate between the different levels of effectiveness of student learning and to justify the differentiation. The teachers also noticed enhanced student learning in technology. 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.*
> *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 on the teaching and learning in other curriculum areas. All teachers made comment on this, for example:

> *I am looking at making my learning outcomes as being 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.*

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. Many of the teachers commented that the intervention had a direct influence on other subjects, especially with their planning and formative interactions. They have moved from thinking about progression in terms of a series of activities to examining the conceptual and procedural aspects of student learning.

In summary, the models that were developed, coupled with the intervention by the research team, had a major impact on improving teachers' formative interactions and understanding of summative outcomes. As a consequence student learning has been significantly enhanced in technology.

These two classroom based research projects have contributed to a national professional development programme in New Zealand.

Conclusion

For a new curriculum to be introduced and be sustainable a strong emphasis needs to be placed on a coherent and long-term research and development programme which is then able to inform classroom practice. Curriculum implementation requires informed teachers who are able to develop sustainable programmes in order to enhance student learning in technology. This has involved research and development on: teachers' existing practice and student initial experiences; teacher development; resource development both in terms of teacher professional development and classroom material; and strategies for the enhancement of teacher knowledge and student learning. Associated with this is the development of effective mechanisms for the dissemination of the research findings to inform all teachers. This has occurred through teacher professional organisations such as TENZ and the Ministry of Education. However, this is only the beginning of this process 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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