The role of teacher educators in supporting STEM curriculum reform - lessons from New Zealand

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Abstract. The beliefs and values teachers hold in relation to curriculum, pedagogy, assessment, and the nature of STEM have a significant influence on the types of teaching and learning their students will experience. Because of this, pre-service and in-service teacher education needs to influence teachers’ beliefs and values as well as their conceptual and pedagogical knowledge if it is to make a difference in classroom practice. This paper considers the introduction of technology education in New Zealand as a way to explore how teacher educators can support STEM curriculum reform.

1. Introduction: The New Zealand context

Aotearoa New Zealand is a democratic nation in the South West Pacific. The original inhabitants, Māori, arrived from Polynesia between 1200 and 1300 AD. European explorers first arrived over 300 years later. Māori gave British colonisers the right to settlement through the signing of Te Tiriti o Waitangi, The Treaty of Waitangi in 1840. In the 1850s, New Zealand was granted limited self-government and by the late nineteenth century was fully self-governing. The country gained full independence in 1947. While The Treaty of Waitangi guaranteed exclusive and undisturbed rights to Māori in terms of preservation of taonga (treasures), the Waitangi Tribunal was established in 1986 to investigate claims where the Crown had failed to meet their contractual promises. This process continues today. In contemporary society, Māori and NZ European/Pākehā populations are significantly integrated. Nearly three quarters of the population identify as being of European descent, 15% as Māori, 12% as Asian and 7% as Pacific peoples.

School is compulsory for all children between the ages of six and 16, although in practice many children attend school from their fifth birthday and stay until the end of Year 13 (17-18 years of age). As a former British colony, New Zealand’s early curriculum was influenced by curriculum development in England. However, New Zealand elements were prioritised from very early on. Since 1989 schools have been self-governing, the national curriculum operating as a framework for schools to develop their own teaching and learning programmes.

The National Certificate of Educational Achievement (NCEA) is a standards-based qualification that was introduced in 2002. Under this system, a large number of standards are available to assess students’ learning in each of the three final years of secondary school, and each standard is worth a pre-determined number of credits. Some standards are constructed by teachers and internally assessed, with moderation monitored by the New Zealand Qualifications Authority. Other standards are externally assessed and take the form of conventional examinations. The system is supposed to give a more accurate picture of a student’s achievement because a student who has gained credits for a particular standard has demonstrated the required skills and knowledge for that standard.
2. Technology as a new curriculum area

Technology was first introduced as an essential learning area within New Zealand’s curriculum framework in 1993 as part of wider school and curriculum reforms. To allow time for teacher professional development and the development of a range of resources, it was to be fully implemented by 1999. The Hangarau (Māori technology) curriculum was also published, although the development of an appropriate technical terminology was not unproblematic. At the same time, the Workshop Craft and Home Economics syllabi were revoked. The changes sent mixed messages to teachers involved in technical education who were unclear whether they were being renamed, replaced, or needing to become something else. In 2007, a new national curriculum framework was released. For technology education, this meant a restructuring of the curriculum strands.

Both the 1993 introduction of technology education and its 2007 restructuring required significant teacher change[8]. The remainder of this paper focuses on some of the initiatives that supported the change process. The intention is to use this example from New Zealand’s introduction of the technology curriculum to explore how teacher educators can support STEM curriculum reform.

3. Policy work

The curriculum is never a neutral assemblage of knowledge, somehow appearing in the texts and classrooms of a nation. It is part of a selective tradition, someone's selection, some group’s vision of legitimate knowledge. It is produced out of the cultural, political, and economic conflicts, tensions, and compromises that organize and disorganize a people[1].

The introduction of technology education in New Zealand was sparked by overseas developments and catalysed by the 1985 national Science and Technology Development Conference. Innovative technology education programmes were developed by enthusiastic teachers in collaboration with teacher educators, interested policy personnel attended key international conferences, and education researchers were commissioned to investigate students’ and teachers’ perceptions about and understandings of technology[7]. A critical mass was growing, and calls to the government to include technology in the curriculum anticipated that it would be “taught by teams of teachers comprising science, social science, design technology, technical and home economics teachers as there were no specialist technology trained graduates at that time” [5]. In other words, the importance of teacher knowledge was identified.

Significant policy work in the late 80s and early 90s set out to define technology as a separate subject area and identify possible implementation strategies. Policy papers drew heavily on research commissioned to explore the rationale for technology education as a distinct learning area, achievement aims, implementation strategies, approaches to teaching and learning in the technology classroom, and resourcing[5]. The draft curriculum for technology education was released in 1993, with the final version published in 1995 and schools required to implement the curriculum framework by 1999.

Additional changes followed, particularly at secondary school, with the 2002 introduction of NCEA as the new national assessment framework and the release of achievement standards for all learning areas, including technology education. Then in 2003 a further review of the curriculum was initiated, and in 2007 a new school curriculum framework was published. For technology education, this meant the restructuring of the curriculum strands. The changes again drew on targeted education research. The technology achievement standards were subsequently updated to reflect the new curriculum. Further change for technology education policy came in 2017, with the introduction of two new technological areas specific to digital technologies: computational thinking for digital technologies, and designing and developing digital outcomes.

The close alignment between education research and policy work was undoubtedly a strength of New Zealand’s approach to implementing technology as a new curriculum area. However, the requirement for teachers and teacher educators to continually upskill in response to the initial and subsequent curriculum changes cannot be under-stated.
4. Teacher professional learning and development

All curriculum statements eventually come to naught if teachers do not change their practice. Furthermore the best formalised curriculum change is based on existing best practice which tabulates what leading teachers are already doing. Hence timely curriculum change depends on there being an intelligence network which is observing and collecting data on current best practice, and which can also disseminate models of excellence throughout the system [2].

To support teacher development when technology education was first being introduced, several universities developed undergraduate and postgraduate programmes in technology education. In many cases, teacher educators were closely involved in the research that was being used to inform policy development, although the relative lack of classroom-based examples to draw on was problematic. Teacher educators also needed to support student teachers to take messages about technology education out into school communities, where previous understandings of technology as either technical craft or ‘using computers’ often persisted.

Another key component fast-tracking the implementation of the new technology curriculum was government funding for a range of professional development programmes. These programmes initially focused on teacher knowledge, facilitator training, and school-based programmes to develop implementation strategies. The programmes were generally delivered regionally by a range of university and private providers, although[5] notes a lack of national consistency in the presentation of the programmes. Socio-political issues, including industrial action by secondary teachers, also impeded the uptake of professional development opportunities.

Key resources were also developed in the late 1990s to support teacher knowledge and practice. These included a television series (with discussion booklets and video copies sent to all schools), case studies of technology education practice in schools, and a series of information booklets, all funded by the Ministry of Education. Many of these initiatives drew on commissioned education research. Technology Educators New Zealand, a professional body for technology teachers, was established in 1997 with membership from the primary, secondary, tertiary and technology-based industries. Communication with members includes regular newsletters and a biennial national conference.

Only two years after the 1999 gazetted implementation of the technology curriculum, a national school sampling study commissioned by the Ministry of Education aimed to elicit the views of teachers from a 10% sample of schools[10]. Of the participants, nearly three-quarters reported that they had received professional development in technology, and that this had helped most of all in terms of knowledge development and ideas to help implement the curriculum. However, around 25% of respondents who had participated in professional development considered it to have been unhelpful, reporting that it was too theoretical or that the facilitators had no practical experience – a conundrum for any new curriculum area when there is limited practical experience amongst the wider education community.

Across all school levels, nearly two thirds of teachers expressed a medium degree of confidence teaching technology. Teaching experience and professional development were identified as important contributors to this confidence. Teacher knowledge was the biggest factor influencing the ease of providing technological learning experiences. Resources that contained ideas for teaching units and relevant samples of work were generally well used, with teachers seeking practical assistance in terms of practical ideas, planning formats, exemplars, and student resources. Perhaps not surprising, some technological areas (like food and materials) were also being implemented more regularly and easily than other areas (like electronics and control technology, and biotechnology). The most common challenges facing teachers in implementing the new technology curriculum were difficulties with resourcing and equipment, finding time in a crowded curriculum, and coming to grips with the new curriculum. Areas identified as needing professional development included PD in the specific technological areas, including practical ideas; planning and teaching skills; issues around progression, assessment and reporting achievement; and ways to specifically support the achievement of Māori students.

In 2000, the Ministry of Education awarded a new national professional development programme to provide assessment guidance for technology education among teacher educators, the
Technology Education Assessment National Professional Development (TEANPD) programme. Once again, previously commissioned research formed the basis of the programme. The research had focused on students’ learning progressions, as well as on teachers’ formative assessment practices in technology education (the Learning in Technology Education and Technology Education Assessment in Lower Secondary projects).

Running alongside the TEANPD, the National Exemplar Project produced resources that captured authentic examples of student work annotated to illustrate learning achievement and quality in relation to the curriculum statements. However, the production of a progression matrix using the technology education exemplars was contentious, with differing views between the exemplar team, researchers, and Ministry of Education staff [5]. At the secondary level, the new senior secondary qualification was also being introduced, and teachers could access professional development programmes associated with the Achievement Standards that had been created. These programmes served as technology curriculum professional development. As Feguson notes, “The teachers were not simply learning about new assessment procedures in their subject but were being challenged by a whole new of technology as a subject in terms of purpose, content, and pedagogy” (p. 30).

From 2003-2013, long-term government funding was allocated to help raise the quality and effectiveness of teaching and learning in senior secondary school technology courses, and to increase participation. The funding focused on building teacher capability, supporting interactions with community experts, and improving alignment between secondary and tertiary technology education. This package of support included the Beacon Practice project – an interventionist approach that involved teachers who had demonstrated best practice in technology education and were willing to progress this further. Through a combination of teacher release time and access to experts. Professional writers were employed to develop case studies, including teacher and student resources. In addition, the Technological Knowledge and Nature of Technology: Implications for Teaching and Learning (TKNoT:Imps) project developed illustrative examples of the five components within the technological knowledge and nature of technology strands of the new curriculum [3][4].

A further component of the TEAPND package enabled technology educators in both pre-service and in-service roles to meet three times a year over several years to develop common understandings about the concepts and pedagogies appropriate for teaching technology. This led to a shared philosophy and purpose for technology education, and in 2010 technology educators from the six main teacher education providers initiated the NZ Association of Academics in Technology Education. In order to capture shared understanding, this group developed the Pre-service Technology Teacher Education Resource[6]. Specifically, the PTTER identified and focused on four aspects of technology critical for teacher education: the philosophy of education, rationale for technology education, technology in the New Zealand curriculum, and teaching technology.

A questionnaire investigating student teachers’ prior beliefs and views about technology was also developed and administered to all student teachers entering either a Bachelor of Teaching degree, or a Graduate Diploma in early childhood, primary or secondary education at New Zealand’s six leading universities for teacher education[11]. This questionnaire recognised the importance and persistence of student teacher values and beliefs, and responses have shaped ongoing program development. In another example of how lecturers were using research to inform ongoing course development, [11] report on an investigation into the effectiveness of a one-year pre-service Graduate Diploma of Teaching for secondary teachers of technology.

According to [6], the mutual trust and respect generated among teacher educators from different institutions, and the resulting development of tools such as PTTER and the pre-course questionnaire, increased the likelihood that graduating teachers would have a shared understanding of the purposes of technology education as conceived in the curriculum. This was significant given that a shared and consistent view of technology and technology education was (and is) still developing within schools.

In order to capture and disseminate the range of resources being produced through the policy, research and professional development programmes, the Techlink website was established in 2003 by the Institution of Professional Engineers New Zealand. For many years it hosted a wide range of resources to support the implementation of the technology education curriculum. These were
subsequently subsumed into Technology Online (http://technology.tki.org.nz/), which forms part of an extensive cross-curricular repository funded by the Ministry of Education.

5. Concluding thoughts

The narrative presented above highlights the interplay that occurred between policy, research, and pre-service and in-service teacher education during the implementation of technology education as a new curriculum area in New Zealand. In particular, synergistic relationships between the Ministry of Education’s policy developers, education researchers and university teaching staff fast-tracked curriculum development that drew on research evidence. Research was also commissioned by the Ministry specifically to inform the development of professional development programmes and resources. Collaboration among teacher education providers was instrumental in creating and growing a shared understanding of teacher education priorities for future technology teachers.

This is not to say that issues did not exist – they certainly did, and in some cases they persist. The issues included, but were not limited to, the upskilling of school leaders around the intention of technology as a new learning area, significant teacher stress and anxiety in the face of ongoing change, the need for Universities to accommodate the curriculum changes in their entry criteria, and ongoing debates about the balance between the theoretical and practical aspects of the curriculum in relation to different students’ learning interests and strengths, and their future trajectories. Other ongoing issues include the limited time available in teacher education programmes to foster the beliefs, values and dispositions intended by the curriculum, and the diverse understandings of technology education that persist in schools.

Many of these issues are likely to beset the introduction of a compulsory STEM curriculum, currently being explored across a range of educational jurisdictions. A key strength of New Zealand’s approach to implementing technology education was the synergistic interplay between policy, research and teacher professional learning and development. Other strengths included the establishment of a strong professional association, provision of long-term funding for teacher professional development, the development of fit-for-purpose teacher education programmes and pathways, and readily available teacher-facing resources.

This story of New Zealand’s development and implementation of technology education is offered to help light the way for those embarking on a journey towards wide-scale curriculum implementation.

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