New Zealand Secondary technology teachers' perceptions: "Technological" or "Technical" thinking?

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Abstract

Technology education in the New Zealand context has seen significant change since it's inception as a technical subject. The changing nature of the subject in New Zealand secondary schools is influenced by some teachers' preoccupation with the making of quality outcomes, rather than their enactment of the curriculum, which conceptualises a wider remit. Research into the perceptions of technology teachers' interpretation and enactment of the curriculum suggests that to enable change, teachers need to adopt a form of "technological thinking", in support of their "technical thinking". Technological thinking is a notion presented to support teachers to explore a range of differing pedagogical approaches and learning outcomes, reflective of the intent of the New Zealand curriculum, which aims to foster learning environments that are innovative and responsive to students' social and academic needs.

Introduction

Technology education in New Zealand is heavily influenced by political agenda, community expectations of the purpose of the subject, and differing schools' organisational structures (Reinsfield, 2014). This article describes research, which explores how technology teachers' perceptions influence their interpretation and enactment of the New Zealand curriculum (Ministry of Education (MoE), 2007). Two teachers' perceptions of technology education are described and findings are presented that identify different approaches to the thinking and determination of pedagogical practice. Discussion about how "technological" or "technical" thinking might impact on a teachers' evolving practice, to transition through a troublesome threshold, for deeper understanding of the nature of technology education.

Defining the nature of technology education

Technology education provides unique opportunities to engage students in their learning, through practical means. There are various types of knowledge underpinning the subject, both practical and conceptual in nature (Hill, 2003), and equally important to students' understanding of the nature of technology education. Ferguson (1993) explained a tension however, that could manifest in the engineering field (for example) as a lack of attributed value to the "sensual" knowledge used by skilled workers, who were required to solve solutions during the manufacture of products. From an historical perspective, the role and status of technology education has evolved, but its cross-discilinary nature means that there is no single theoretical perspective that can define it for the purposes of others' understanding (Pacey, 1992). Regardless, technology education exposes students to knowledge that is fostered as the result of working with materials, through the development of a concept or outcome, and in response to an identified problem (Ferguson, 1993; Hill, 2003). The way that this learning occurs however, should be considerate of students' interests, not determined solely by the teacher, community perceptions, or political agenda.

The political context in New Zealand

The New Zealand government's agenda is regularly assessed against future workforce needs and the current skill areas in deficit include engineering, information and communication technology (ICT), electronics, hospitality and tourism, as well as the trades (New Zealand Immigration, 2016). Interestingly, there is a particular shortage of skills in the Canterbury region in construction, engineering, ICT and electronics, trades and transport (New Zealand Immigration, 2016) resulting from the 2011 earthquakes. The 2011 earthquakes led to an estimated rebuild cost of around $40 billion, and the government was required to develop local strategies to address a deficit of skilled builders (Stevenson et al., 2014).

In 2011, the establishment of Trades Academies[1] and the introduction of the Youth Guarantee Scheme[2] in 2013 (Tertiary Education Commission, 2014) suggested a considered political emphasis on vocational pathways. Such an emphasis was described by Young (1998) who argued that the educational framework in the United Kingdom was dominated by the attempts of

> ... Successive conservative governments to maintain divisions between academic and vocational learning [to] siphon off as many young people as possible into vocational education and training programmes, thus excluding them in effect from access to understandings they would need in the future as adults in an increasingly complex and uncertain society (p. 2).

In many New Zealand schools there is an expectation that there is the provision of both vocational pathways and general technology education for all. The challenge for teachers in such a climate is how they manage any tensions that this may cause for their practice, within an atmosphere that has the potential to perpetuate stereotypical and traditional perceptions of the nature and position of a subject like technology education.

With a continued global push towards technological innovation and an increased awareness of its impact on society, it might be reasonable to assume that to this end, technology education has an established role in schools. The New Zealand curriculum provides opportunities to focus student learning on the local and international social issues that intersect with technology (Reinsfield, 2016). However, the means to enable such an approach is influenced by the context within which the teacher is practicing, the influence of government policy, and the expectations of the school community. For example, government policy now mandates that any newly established school should be an Innovative Learning Environment and this adds another dimension to the complex nature of teaching with the New Zealand context.

Osborne's (2016) research describes the impact of Innovative Learning Environments (ILE) on the potential for student learning and discusses recent policy in New Zealand, which advocates for a classroom context that evolves and is responsive to

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[1]Trades Academies were conceptualised with a view to encourage some young New Zealanders to engage with their education and at the same time equip them with workforce skills in the trades (Ministry of Education, 2016).

[2] The Youth Guarantee Scheme is an initiative, which aims to improve the transition from school to further study, work or training and provide pathways from the secondary school context (Ministry of Education, n.d).

change (MoE, 2015). ILE's are purpose built schools, proposed as a means to teach in a school environment where learning is more likely to be innovative and responsive to students' academic and social needs. Policy documents, such as the New Zealand School Property Strategy (MoE, 2011) also assert that ILE's are a means to develop "a world-leading education system", which is able to provide "all New Zealanders with the knowledge, skills and values to be successful citizens in the 21st Century" (p. 2).

The New Zealand curriculum

Technology education in New Zealand is a mandatory subject within the compulsory schooling system, from Years 1 to 10 (age 5 to 14 years). The subject provides an opportunity for schools and teachers to offer future focused learning for all students, regardless of their social or academic need. The reality for some technology teachers however, is that the way that the purpose of the subject is perceived in their school, is heavily influenced by governmental agenda, community expectations, and their own interpretations, which in turn impacts on the nature of their practice.

Technology education can be taught through a variety of different contexts, including structures, control, food, information and communications, or biotechnology. The subject is defined in the New Zealand curriculum statement as

> …Intervention by design, the use of practical and intellectual resources to develop products and systems… that expand human possibilities by addressing needs and opportunities. Adaptation and innovation are at the heart of technological practice. Quality outcomes result from thinking and practices that are informed, critical, and creative (MoE, 2007, p. 32).

Technology education in the New Zealand curriculum (MoE, 2007) has three strands: technological practice, technological knowledge, and the nature of technology. Technological practice is about concepts that inform the development and making of products. Technological knowledge focuses on the processes and properties of materials and how they be used in product development. The nature of technology strand encourages a focus on the conceptual aspect of the subject where students can "critique the impact of technology on societies and the environment and to explore how developments and outcomes are valued by different people in different times" (MoE, 2007, p. 32) and considers why technology evolves. To address the nature strand, teachers are required to find ways to foster critical thinking and encourage discussion around past and future technological responses with a view to making students informed consumers or think "outside of the box" (Reinsfield, 2014).

Teachers' perceptions and practice

In the New Zealand secondary classroom, it is a teacher's professional responsibility to develop programmes that cater to the diversity of their students' academic and social learning needs, based on the curriculum. For technology teachers, a potential predicament arises if pressures force them to choose between this general responsibility for all students and the implementation of specific government initiatives such as trades pathways. It is often the same teachers, and school departments, that are charged with teaching both trades and technology, and in many cases, the provision of both is not possible. This may result in students being directed

into a trades pathway, when they may be better suited to a career based on a broader approach to technology.

The roles and responsibilities of a teacher have changed significantly in New Zealand, and according to the New Zealand Post Primary Teachers Association (O' Brien, Alison & Cross, 2006) technology teachers have been represented on a spectrum from being progressive to regressive and indifferent to their subject's delivery (Institute of Professional Engineers New Zealand (IPENZ), 2001; Jones, Harlow & Cowie, 2003; Mansell, Harold, Hawkesworth & Thrupp, 2001). The way that a teacher responds to change, is likely to be influenced by their perception of the purpose of the subject they are teaching and a teacher's view of the official curriculum and their pedagogical philosophies encompass personally held values and beliefs about the role of education and the purpose of the subject they teach (Alsup, 2006).

Technology education can be conceptualised from many perspectives, with differing interpretations of its purpose. Regardless, technology education should be an entitlement for all students, irrespective of their ability or skill (Reinsfield, 2014). According to the Organisation for Economic Cooperation and Development (OECD, 2014), innovation in teaching is represented through an increased engagement in differing pedagogical practices, which include authentic learning opportunities for students' thinking.

In technology education, authentic learning contexts can be used to support learning about real-world issues, by identifying needs of opportunities within local or global communities (Snape & Fox-Turnbull, 2013). There are clear correlations between the intent of the New Zealand curriculum (MoE, 2007) and technology education, specifically that technology is "intervention by design", uses both practical and intellectual means to develop outcomes; it aims to expand human possibilities, address needs and opportunities, adapt, innovate, be informed, critical, creative and innovative and is influenced by the cultural, ethical, environmental, political and economic context (p. 32).

By engaging students in authentic learning, teachers can provide the opportunity to consider knowledge from a range of disciplines and others' perspectives and consequently, learning from the Nature of Technology strand can be addressed. Oblinger (2007) advocates for authentic learning opportunities because of their real world relevance, opportunities for sustained problem-solving and decision-making, exposure to a range of knowledge and theoretical concepts, collaborative working methods, integrated assessment approaches and potential for students to reflect upon how they are positioned within a community, to determine what is important for them and how they can make a difference. Meaningful learning like this appears to be an obvious solution to engage students in the secondary school context, but whether this approach is embraced in technology education is likely to depend upon teachers' perception of the purpose of the subject.

According to the New Zealand curriculum, it is the teacher's professional responsibility to reflect upon how their teaching facilitates "thinking and practices that are informed, critical and creative" (MoE, 2007, p. 32). Some teachers have found their interpretation of the curriculum difficult because of the need for them to change their conception of the purpose of technology education (Reinsfield, 2014).

For some teachers, there is a propensity to focus solely on the replication of products, which is detrimental to the teaching of curriculum content. The need for a change in practice is reacted to in differing ways, but for some teachers, their response is to sustain or retreat to historically placed practices (Paechter, 1995). In the classroom, whilst the nature of learning should be responsive to student need, it can instead manifest as teacher-driven, be dependent upon the way that curriculum is interpreted and emphasised, and the means with which professionals mediate troublesome knowledge in their professional practice.

Threshold concepts and troublesome knowledge

As well as illustrating how teachers' meaning-making processes were influenced by their context, this research sought to identify and represent threshold concepts that, once understood, could further support the development of technology teachers' practice (Peter, Harlow, Scott, McKie, Johnson, Moffatt, & McKim, 2014). Meyer and Land (2006) described a threshold concept as a means of providing a new or transformed way of interpreting something, or to represent how people perceived a discipline. By identifying the troublesome knowledge (Meyer & Land, 2005) that might limit or moderate learning and practice within a classroom, a deeper understanding of the processes that underpin the interpretation and enactment of an official curriculum can be developed.

According to Meyer and Land (2003) there are five characteristics that define threshold concepts. In the first instance, threshold concepts should be transformative, with the intent to change perceptions. They should be difficult to unlearn and inherent to understanding within a particular phenomenon. Threshold concepts should be bounded and enable the critique of past understandings, to challenge one's own thinking processes. They can also enable educational change, through the development of a new conceptual space (Meyer & Land, 2005).

The notion of liminality (Meyer & Land, 2003) aids the understanding of a transitional space within a teachers' evolving practice, and acknowledges that professional learning can incorporate a threshold where teachers' may be unable or unprepared to achieve a transformed status. For example, teachers who are resistant to change can adopt a form of mimicry (Ellsworth, 1997) to give the impression that they are engaging with curriculum concepts or as a means of coping with the constraints upon their practice. By exploring teachers' understanding of the curriculum, threshold concepts can support the development of strategies (Johnson, 2013) to assist in the transformation of professional practice with a view to, "provoke something else into happening – something other than the return of the same" (Lather, 1998, p. 492).

Research design

This research explored the disparity that exists between the philosophy underpinning the technology curriculum and current practices in New Zealand. The study investigated how six technology teachers' perceptions of technology education was represented through their professional practice, within two school contexts. The overarching question to be considered was:

How do technology teachers' perceptions influence their interpretation and enactment of Technology in the New Zealand curriculum?

A qualitative approach was chosen for this research because it allowed for direct contact with participants in a naturalistic setting, to determine their social arrangements, departmental function, and its implicit and explicit rules. Qualitative research allows data to be collated in a manner that enables comparison of conflicting information and to determine patterns. This approach supports the differing interpretation of data, and facilitates a deeper understanding of the research context or phenomenon (Miles, Huberman & Saldaña, 2014).

Technology education, by its very nature, is presented differently in every school in New Zealand and the case study approach was an appropriate means of studying and reporting within a natural context (Yin, 2003). Thick descriptions emerged from the case study, which promotes the credibility of the research (Shenton, 2004) by providing insight into the issue being considered, even if the reader is not familiar with the research context.

By using multiple data collection strategies within case study research, a more convincing and accurate representation of the context was generated (Casey & Houghton, 2010). Data collection relied on several primary sources, namely the New Zealand curriculum document (MoE, 2007) and it's supporting materials (MoE, 2010), two or three semi-structured interviews per participant, non-participatory lesson observations after the first interview, department meetings, teacher reflections, and teacher-generated resources. For the purposes of this article, attention is paid to the interviews, lesson observations and reflections, where teachers described, enacted and considered their perceptions and practice.

Data analysis

Data analysis followed a sequential process whereby the data was collected with supporting field notes. Findings were recorded and coded, leading to researcher observations (Miles, Huberman & Saldaña, 2014). Data was organised to identify themes in a manner that made the information more accessible. Data condensation processes included the selection. focusing, abstracting and simplifying of information, with a view to strengthen the research validity.

The research context

For the purposes of this paper, findings from two participants, in two secondary school contexts will be presented. The first participant was Colette, a History trained teacher, who had acquired a Certificate in woodwork and had taught in the United States and Australia, before migrating to New Zealand. In contrast, Bernadette had taught technology education in New Zealand for nearly 30 years and had a national reputation for her engagement and enactment of the curriculum, in the area of resistant materials.

Colette

Colette was in her first year of technology teaching in New Zealand, but was an experienced practitioner, having been in the profession for more than 16 years. She had been exposed to minimal professional learning about the New Zealand curriculum but did not percieve that this was significant because she had interpreted curriculum documents overseas. Colette believed that technology students should be allowed to

fail as part of the learning process and that technology education was a place for them to engage in creative problem solving activities, regardless of the material that they were working with. She valued skills development and acknowledged a tension between the practical nature of the subject, and the teachers' ability to support student-centred learning approaches.

Colette acknowledged some difficulty when making the connections between some of the specialised examples presented in curriculum supporting documention (MoE, 2010), and her own specialist area of resistant materials. She appeared to understand the intent of the curriculum, but this was not reflected during the observed lesson. She suggested that this was because the of the school rules defining her enactment, rather than due to her existing understandings. Colette was able to articulate what she could have done to change her teaching to align more closely with the curriculum.

Bernadette

Bernadette had a sound understanding of the curriculum and the necessary skills to interpret it, to make meaning for her specialist area of resistant materials. She asserted that her teaching of the curriculum concepts was well established but had not evolved significantly over the last couple of years due to her Head of Faculty responsibilities. She valued the fostering of relationships with industry, and argued that by doing so, she became motivated to learn new knowledge and skills and offer more authentic programmes to her students at a senior secondary level. Bernadette also valued the development of practical skills and consistently sought ideas that would engage her students in their learning.

Significant here, is the approach that Bernadette adopted when identifying her ideas for enactment in the junior secondary school. She stated that she always approached projects by considering how they would address the *Nature of Technology* strand of the curriculum rather than how to make the products, which could be determined later.

Findings

Both Colette and Bernadette described their beliefs about some of the challenges that were hindering the way that technology education is currently enacted in some classrooms. Colette described a subject culture that limited the possibility for change, stating

> I don't think it's unique to one school… the observation that I have of technology education… it's more about people's egos and them looking successful in the eyes of each other, and one upping each other. So it's like and old boys club where they say "Look at what my kid produced", where in reality it's a cookie cut project… there's one school that teaches technology, they turn out brilliant projects, they look good, they're functional, they're fit for purpose, they tick all of the boxes, but every kid makes exactly the same thing and there is no deviation except for some cutesy little thing at the end.

Colette also descibed a tension in the pedagogical approaches that could be used, to enact the subject, stating

> … To have the opportunity for these students to make stuff and push things and fail, have things fall over and just go, okay, so what did you learn from that? Which is my interpretation of the curriculum… Everything [can] look right and ticks all the little boxes but it's not innovative and the kid is just a robot in the sense that they go over and they drill that hole there because that's where they are supposed to drill that hole and they haven't thought "well what happens if I drill that there?"

Colette argued that a teacher's pedagogical approach manifests as a result of the way that they perceive the subject, and their way of "thinking". She stated

> [Some] technology teachers, they're tradesmen who become teachers and they're quite good at the trade… in other words, a tradesman at the end of the day is not paid to be innovative or creative, he is paid to produce something and get it done and have the quality. Do it and do it right and have it be beautiful… and so its probably part of them feeling safe in doing what they've always done which is "I'm going to work, I fix this thing, I made this thing and at the end of the day, it got passed as a quality product and then when they get in the classroom, it's what they do…

As a Head of Department, Bernadette felt empowered to challenge others' perceptions about the nature of the subject, correcting their mistake if they called the subject "Metalwork or Woodwork". Bernadatte too, recognised that for some technology teachers, their understanding of the subject was limited by their experience. In her view, it was all about the way that she planned for her teaching, stating

> I've never been involved in that old, get your hands dirty stuff, I can do all that but that's not what my vision is about. So ever since I've started teaching, I've always been doing different things in the workshop… we were in this Two Dollar Shop and I saw these sunglasses and I bought six pairs and I thought that's going to be our next project at school, we've going to make sunglasses. I wasn't thinking about how I was going to make them [but] where the trends have come from and what they do and how they hang on your nose and I've got the vision to see that…
>
> I struggled to talk to Simon about it because he's a tradesman, and I've come from the trades too… they want the answers, that's why. It's interesting because I picked up these sunglasses and thought that's a bloody great project for our [Year] 7's and 8's and then I thought how are we going to teach this to them to get them to understand where sunglasses are and where they've come from and where they're going…

Both Bernadette and Colette referred to what they perceived other colleagues found troublesome, in relation to their practice in technology education. They described some teachers who were preoccupatied solely with the production of quality outcomes, whose pedagogical approaches which were at odds with the intent of the technology curriculum. This indicated a disconnect in technology teachers' thinking, which affected their interpretation and enactment of the curriculum.

The threshold concept to emerge from these findings centres upon *how technology teachers' can make meaning of the curriculum, to develop their knowledge for practice.* The research findings suggest that practitioners' approaches to the teaching of their subject is not only affected by their perception and practice, as determined by their school context, but also by the way they *think* about the pedagogical approaches that they should use in their enactment. The concept of "technological" versus "technical" thinking is a means to elaborate this point.

Technological thinking

Technological thinking was represented by Bernadatte, when she described her approach to the "Sunglasses project", designed for a group of Year 7 and 8 students (Ages 11-13). She articulated a thinking process that addressed all three technology strands of the New Zealand curriculum (MoE, 2007, p. 32) and described the types of pedagogical strategies that she would use, as identified below

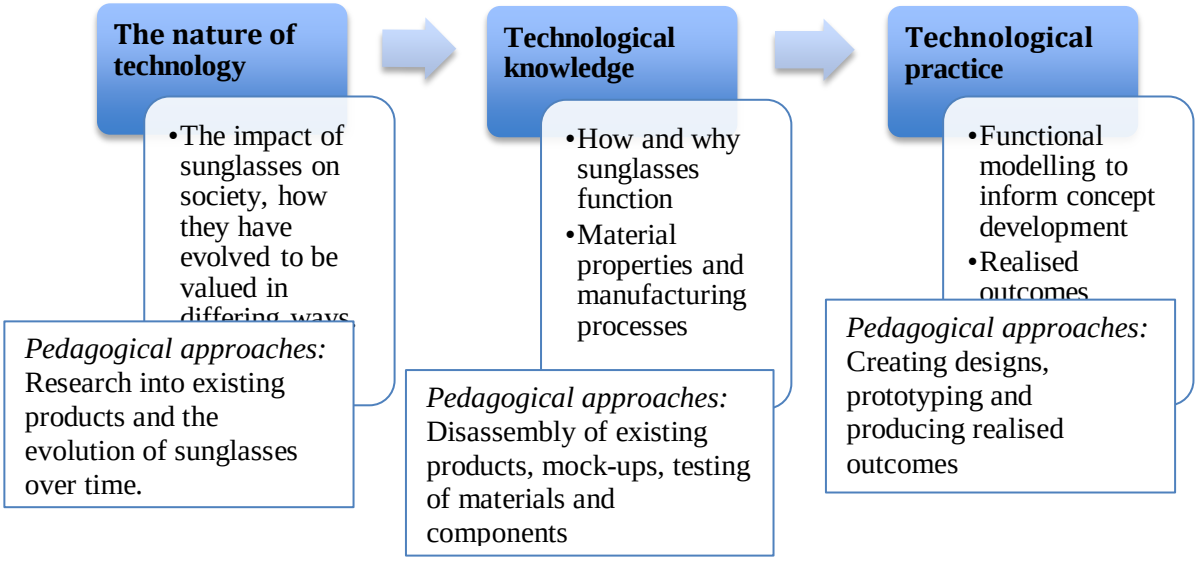

Figure 1: A visual representation of "technological thinking" in practice.

The idea for Bernadette's project was motivated by an existing artefact. She asserted that her interest was piqued not by the replication of the product but by the knowledge underpinning its development. In particular, she was curious about the reasons why sunglasses had developed, to address a societal need. Bernadette had an established knowledge of the curriculum concepts, and the view that by focusing first on the nature of technological development in society, that students' learning would be more meaningful.

For Bernadette, it was important that learning engaged students in the task, and she was consistently seeking ways to develop her own professional practice, and be responsive to each cohort's needs. She was able to interact with her learners, using terminology that aligned with the curriculum concepts, and she used artefacts and a range of experiential tasks to encourage students' problem solving and practical skills. By developing relationships with industry and drawing upon their expertise and resources, Bernadette was able to expose students to learning that might not otherwise be accessible, in an authentic manner (Oblinger, 2007; Snape & Fox-Turnbull, 2013). Key here, is that Bernadette advocated for the production of quality outcomes, but

was not constrained by the processes underpinning their manufacture. She had the professional confidence to know that she could utilise her own understandings, or that of her collegues, to support student's technological practice.

Technical thinking

The notion of "Technical thinking" was alluded to by both Bernadette and Colette through their descriptions of technology teachers, who have come from the Trades. Bernadette and Colette both assert a pedagogical approach that is traditional in style, and with an emphasis on the manufacturing and replication of exisiting products. Both asserted that in their experience, many teachers who came from a trades background preferred order and organisation in the classroom, and that there was a pedagogical emphasis on the quality of outcomes. It is suggested here that such an approach, whilst likely to engage learners, limits students' exposure to all of the technological concepts, as they are presented in the New Zealand curriculum. If technology education is approached solely from a manufacturing perspective, there are likely to be missed opportunities to explore the impact of technology on society or the environment, at a global or local level. If a teacher's thinking starts with the making of an artefact, and pre-determines the stages of production, students are less likely to be involved in decision making processes that can inform their future technological practice in a meaningful way.

Discussion

The nature of technology education remains fluid in the New Zealand context. Some teachers advocate for the replication of existing products, and others align with a contemporary view of the subject, as a means to encourage student engagement in creative and practical tasks, to problem solve and think in a critical manner about a range or global or local issues. There are a variety of factors that can moderate a teacher's engagement with the curriculum and enactment of technology education in the secondary school classroom. The following concepts provide a means with which to explain some of the challenges to teachers' practice.

There are two concepts identified within this article, which can support understandings about the enactment of technology education in the New Zealand context. The first highlights that a teachers' engagement with the curriculum, and understanding of the technological concepts presented within it, will enable, moderate or limit their curriculum meaning making processes and emerging knowledge for practice. The second asserts that there is a gap in some teachers' knowledge that enables them to interpret the generic concepts presented in the curriculum, within their own specialist area of technology education.

The implications are that the way a teacher percieves the subject, as a result of their own experiences and values, determines what they emphasise in the classroom. For example, if a teacher emphasises the making of high quality outcomes, and works in a school where the community expects the same, they are less likely to see a need to change their practice or explore innovative ways to enact the subject, even if they can appreciate that their practice does not represent the intent of the technology curriculum, or fully address their students' interests. In this circumstance, a teacher would need to be motivated to challenge the discourse in their school context, to enable change.

The knowledge required to interpret the generic technological concepts within a teacher's specialist learning area presents an opportunity for future professional learning in New Zealand. Colette experienced difficulty making meaning of the curriculum perhaps because of her lack of engagement with the New Zealand curriculum, or due to her understanding of the ways that generic concepts could be interpreted within her specialist area. She was unable to make sense of examples provided within an alternative learning context, and interpret their meaning, to develop knowledge for her own evolving practice. This finding is pertinent because in New Zealand, there is a common assumption within the technology education community, that specialist teachers will have the expertise to engage with the curriculum as the result of their previous work experience. There appear to be tensions associated with such a view.

If a teacher is making decisions about the learning to occur in their classroom as the result of their own personal experiences or skills, rather than students interests, they are likely to affect student engagement. For student engagement in technology to be maximised, teachers should be negotiating a learning focus that is student-centred and future focused in nature. By adopting such an approach however, teachers need to hold specialist expertise and understand how their knowledge translates to the generic concepts within the curriculum, and with a view to expose students to a range of experiences in technology education.

Conclusion

Regardless of technology teachers' background or previous professional experience, there are implications for their practice derived from how they perceive the nature and purpose of the subject. This research indicates that technology teachers in New Zealand are required to navigate a range of tensions that influence their interpretation and enactment of the curriculum. It is evident that some teachers have a pre-occupation with quality practical outcomes, which is reflective of "technical thinking". Such an approach appears to contrast with advocated for pedagogies, which aim to foster a classroom culture that is innovative in nature, student-centred, or future focused. This article challenges the notion that if a teacher is knowledgeable about their specialist area of technology, they can effectively interpret the generic concepts presented in the curriculum, for their own teaching practice. The identification of a threshold, where teachers find particular knowledge troublesome provides the opportunity to develop professional learning opportunities that can support teachers "technological thinking", which is more likely to support enactment of a range of pedagogical approaches and learning outcomes that are reflective of the intent of the New Zealand curriculum.

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