Confusion or Clarity…has the 2007 New Zealand Curriculum provided primary teachers with clearer understandings of Technological knowledge?

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Abstract

This paper discusses the findings from a research thesis study undertaken during 2007 and 2008. This research study examined primary teachers' understandings of technological knowledge in response to changing notions of technological knowledge in current educational research, and differing definitions of technological knowledge in technology education. The study sought to determine whether current research informing changes in technology education provided primary teachers with clearer understandings regarding technological knowledge and what influenced primary teachers' understandings of technological knowledge. This paper focuses on the main findings regarding teachers' understandings of technological knowledge in response to recent curriculum developments and discusses several resulting implications for technology education.

Introduction:

As technology education in New Zealand undergoes a transition from using one curriculum to another significant differences between the 1995 *Technology in the New Zealand Curriculum* (*TiNZC)* and the 2007 *New Zealand Curriculum* (*NZC*)[1] are evident regarding technological knowledge. Identifying what specifically constitutes technological knowledge is also a recent development in technology education even though references to technological knowledge have been made in the past *TiNZC* (1995) document. The last five to eight years have seen an upsurge in international educational research focusing on what constitutes technological knowledge. As a consequence the *NZC* (2007) informed by this recent educational research attempts to specifically define technological knowledge as unique domain knowledge. This paper examines these recent changes and seeks to answer the question has the 2007 'New Zealand Curriculum' provided primary teachers with clearer understandings of Technological knowledge?

Technological literacy

Even though technological knowledge is acknowledged as an integral part of technological literacy in both the *TiNZC* (1995) and the *NZC* (2007) documents, each curriculum has a different view of technological knowledge and different expectations regarding technological literacy. Technological practice was the main focus for developing technological literacy in the *TiNZC* (1995*)* document (Compton & Harwood, 2006). Students were encouraged to develop capability using an integrated approach as they solved practical problems in response to identified needs and opportunities (Ministry of Education, 1995).

The emphasis for developing technological literacy in the *NZC* (2007) is not only on technological practice, but it also focuses on developing technological knowledge and

[1] Throughout this paper the abbreviated terms will be used for *Technology in the New Zealand Curriculum,* i.e. *TiNZC* (1995) and the *New Zealand Curriculum*, i.e. *NZC* (2007)

understandings related to the nature of technology. This curriculum encourages students to focus on domain knowledge solely related to technology. Along with experiences in technological practice it encourages students to gain specific knowledge about how things work, to understand systems, properties of materials and appropriate uses; and explicitly asks them to critique the impact technology has on society and the environment (Ministry of Education, 2007).

Technology in the New Zealand Curriculum (1995)

Technological knowledge was viewed as a key feature of the *TiNZC* (1995). In this curriculum the strand *Technological Knowledge and Understanding* was viewed more as an adjunct to the *Capability* strand along with the *Technology and Society* strand Technological knowledge was associated with knowledge gained in different technological areas (Jones, 2003) and it also centered on generic principles related to technological practice, for example “aesthetics, efficiency, ergonomics, feed back, reliability and optimization” (Jones, 2003, p. 89). The focus for technological knowledge in this document centred on “understanding the use and operation of technologies; understanding technological principles and systems; understanding the nature of technological practice; and understanding strategies for communication, promotion, and evaluation of technological ideas and outcomes” (Ministry of Education, 1995, p.10).

These understandings of technological knowledge also reflect similar understandings in the literature of this time. For example a focus on understanding the use and operation of technologies can be linked to Vincenti’s technical and operational aspects of *descriptive* and *prescriptive knowledge* (Vincenti, 1984, as cited in Herschbach, 1995). Procedural knowledge, and conceptual understandings can be linked McCormick’s ‘knowing that’ and ‘knowing how’ (McCormick, 1997) and specific principles associated with design, critical pathways, ergonomics and optimization. Societal knowledge can be linked to Pacey’s (1983) cultural aspect that recognizes the way technological outcomes represent different values in society (Pacey, 1983). However even though references regarding technological knowledge are made in the *TiNZC* (1995) document, they really only describe what technological knowledge might look like, not what it constitutes.

Curriculum review

As part of a recent curriculum project undertaken between 2000 -2002 (Ministry of Education, (2007), technology education like all other essential areas underwent a review process. In New Zealand, Compton’s research (2004) informed by current international research had a significant influence on understandings related to technological literacy and technological knowledge in the *NZC* (2007) document. Compton (2004a) in a briefing paper prepared for the Ministry of Education argued that technological knowledge is a key factor in the development and understanding of technological practice, and wider technological literacy. She recommended that technological knowledge should have “a specific focus in technology education” (Compton, 2004, p.1). Her research draws heavily on theoretical understandings developed as a result of international research. In particular, her work reflects Vries’ (2005, 2006) research, and his two notions of technological knowledge, process and volition. Compton also acknowledges the two different ways technological knowledge is acquired. She recognizes technological knowledge is both implicit (tacit) and explicit (procedural). Both these she suggests should be viewed as a continuum of technological knowledge. At one end there is tacit or implicit knowledge and at the other end explicit knowledge. Very young children for example might simply play, explore and learn how things work instinctively by trial and error. While at the other end, Secondary students might after years of experiential learning developed explicit knowledge, enabling innovative and creative outcomes. Technological knowledge may operate at different levels or in different ways as you move along this continuum (Compton, 2004). She further suggests procedural, conceptual, and device or 'thing' knowledge (Baird, 2002) are all sub categories of tacit and explicit technological knowledge (Compton, 2004).

The New Zealand Curriculum (2007)

It is clearly evident that Vries' (2006) two theoretical notions of technological knowledge underpin definitions in *NZC* (2007*).* His first notion views process knowledge as an analytical function, and the second notion defines volition as a critical function (Vries, 2006). The notion, analytical function has served to influence thinking surrounding the introduction of a new independent stand-alone strand *Technological Knowledge.* The notion, critical function acknowledges the role mankind takes when shaping and developing technological outcomes has influenced the development of *The Nature of Technology* strand. The *Nature of Technology* strand seeks to raise students awareness regarding the relationship technology has with society and the way volition influences technological outcomes.

The *Technological knowledge* strand identifies three components*, technological modeling, technological products, and technological systems.* Functional modeling "is used to evaluate design ideas" and "prototyping is used to evaluate the fitness for purpose". "An understanding of material properties, uses, and development is essential to understanding how and why products work". Understanding the "constituent parts of systems and how these work together" is also viewed as an important understanding (Ministry of Education, 2007, p.32). All relate to Vries' (2006) notion of analytical function.

Theoretical understandings reflected in current technology education

Although it is clearly evident definitions of technological knowledge in the *NZC* (2007) are influence by current educational research, the area of technological knowledge associated with developing *tacit knowledge* is not so obvious. Because *tacit knowledge* gained from practical, hands on experiential learning is implicit in nature many ideas associated with just how students should develop their tacit understandings or how to develop this knowledge are still being raised. Compton as early as 1997 recognized the need for hands on learning to develop tacit knowledge (Compton 1997). She later specifically emphasized the need to make tacit knowledge more explicit, particularly for the purpose of teaching technology (Compton, 2004). Her research certainly acknowledges that process knowledge involves both implicit tacit and explicit knowledge (Compton, 2004). So it interesting that this notion of technological knowledge is not clearly made explicit in th*e NZC* (2007). Instead implicit tacit technological knowledge, Compton argues is "developed and evidenced through practice" (Compton, 2004, p. 6) in this case the *Technological Practice* strand. You might argue this stance contradicts other research, which called for this type of learning to be made more explicit (Ropohl, 1997) and that an obvious gap regarding the development of implicit technological knowledge is therefore evident in this document.

Research study

My thesis research study provided a unique opportunity to examine this particular issue and others. Prior to undertaking this research, I was aware of previous research findings that showed teachers during feedback consultation had called for clearer content knowledge in technology education (Davies, 2005). A number of educators during this period also recognized the need to unpick the knowledge bases that are integral to technological practice (Smits, 2000). Research also showed teachers had commented the *TiNZC* (1995) lacked specific information to guide implementation and had complained about the wording in the *TiNZC* document (Davies, 2005). So the chance to examine primary teachers understandings of technological knowledge in response to statements in the *NZC* (2007) was timely.

My research study was carried during 2007 and 2008. The study used a qualitative case study approach to examine primary teacher's understandings of technological knowledge and reasons for teachers' understandings of technological knowledge (Patterson, 2009). Three categories were developed to explore teachers' understandings. Teachers were asked to respond to a number of statements drawn from current educational research, the *TiNZC* (1995) document and recent statements in the *NZC* (2007). These three categories formed the basis for both stages of this research study and enabled later comparative analysis to be undertaken. The category 'educational research' was included to represent current theoretical thinking regarding technological knowledge. Its inclusion was important because this research had informed the development of the *NZC* (2007) document.

Research design

Two sets of data were gathered. Stage one of the research study collected baseline data regarding teachers' theoretical understandings of technological knowledge and some information regarding teachers' teaching backgrounds. Stage two of the research study sought to explain trends identified in stage one of the study and to identify any other arising themes not identified in stage one of the study.Primary teachers were selected for stage one of the study from four Auckland areas listed on the Te Kete Ipurangi (TKI), the online learning centre's schools page http://www.tki.org.nz/e/schools/. These areas were, North Shore City, Waitakere City, Auckland Central, and Manukau City. The schools were randomly. In total, 148 teachers were selected. Twenty-four teachers finally gave their permission to be part of the research. Of the 24 teachers contacted, only 22 teachers returned the completed questionnaire. Teachers for the second stage of the study were also selected from these 22 teachers.

Teachers' responses to statements as part of a questionnaire were analyzed according to the three categories, current educational research, the *TiNZC* (1995) and the *NZC* (2007) document. Teacher's individual responses to each statement were recorded using a four-point scale. Findings for each question were initially analyzed according to whether teachers agreed or disagreed with each statement provided. Four teachers with the highest aggregated scores and three teachers with the lowest aggregated scores were finally chosen for the interview process. One teacher was also selected because they were the only specialist technology intermediate teacher who agreed to be part of the research study. All teachers trained to be teachers at some period during 1995 –2005. A semi-structured interview approach was chosen to interview teachers. This approach not only allowed individual teachers responses from stage one of the research to be clarified, but it also enabled arising themes identified during the interview process to be examined in more depth. Qualitative data collected during stage two of the research was central to this study.

Research findings

Findings from both stages of the research study provided insight into teachers' understandings of technological knowledge. Several themes of significance were identified concerning individual teachers' understandings regarding technological knowledge. The findings showed all teachers agreed that technological knowledge was unique and different to other essential learning areas; that teachers' have similar understandings of technological knowledge to those understandings presented in current educational research; and based on comparative findings, teachers' understandings related more to those curriculum statements in the *NZC* (2007) than the *TiNZC* (1995) document.

The findings that suggested teachers had slightly better understandings in response to statements drawn from the *NZC* (2007*)* than those drawn from the *TiNZC* (1995) document were particularly interesting, especially as statements in the *NZC* (2007) had been quite new to many teachers. Teachers' responses to statements in presented in the *TiNZC* (1995) document were not so positive. The *TiNZC* (1995) document has been in all schools since 1995. You would expect as a result that teachers would be conversant with this document. However my research findings showed teachers' understandings regarding this document were still poor. Responses from teachers when interviewed followed a similar pattern. Findings showed many teachers had problems interpreting guiding statements in *TiNZC* (1995) and many were simply not sure what they meant, *"I'm not sure"* (Teacher 8). *"Not much"* (Teacher 4). *"Yes… I don't know… right the system would be that you're getting a conveyor belt sort of thing, I don't know. I'm not sure on that one"* (Teacher 7).

The opposite was evident regarding teachers responses to statements in the *NZC* (2007). Most teachers when interviewed responded very positively to statements provide from this document. Examples support this view: **"***Yes and that's easy to read, yes, well its machines and inventions and things and looking at why they work and how they do it, definitely and its interesting"* (Teacher 8). One teacher agreed students would need to know about how things function, *"Yes I'd agree with that absolutely. Well an eggbeater, hand eggbeater. They would need to know how things works, turns the cogs, they sort of move in and out with each other and what purposes they would be used for"* (Teacher 2). The *NZC* (2007) document had only recently been distributed to schools at the time the questionnaire was sent out to teachers. During interviews some teachers had only sighted definitions regarding technological knowledge for the first time and for most teachers the interview process offered them the first opportunity to read statements from *NZC* (2007) regarding technological knowledge. So it was surprising that teachers' understandings regarding technological knowledge were in greater agreement with statements from the *NZC* (2007) curriculum than those in the *TiNZC* (1995) document. This was a successful outcome and will have positive implications for technology education in the future. However findings did show teachers still had problems interpreting statements related to systems in both curriculum documents.

Confusion or Clarity

The reasons for confusion in response to statements from the *TiNZC* (1995) could be many. Maybe teachers had never really focused on these achievement objectives in connection to technological knowledge specifically. In this document technological knowledge was viewed as adjunct to technological capability. In this context technological knowledge was associated with knowledge from other areas used when undertaking technology practice (Jones, 2003). Research also shows teachers had problems interpreting statements in this document and found it difficult to use (Davies 2005). In contrast, all teachers when interviewed clearly related to statements associated with the three new components of technological knowledge in the *NZC* (2007) document, "*this one is better. Well because it ties everything in and it goes a lot deeper and it extends it a lot more, gives you a lot more freedom to roam around and use it and apply it whereas the 1995 one you're pretty much stuck with those four things whereas this one allows you to extend, go further if you want to*" (Teacher 2). All teachers found guiding statements in the *NZC* (2007) document easier to interpret and instantly identified with statements, for example in response to statements regarding materials their properties and performance one teacher commented, "*yeah they need to know whether the resource is the right thing for the job and if it's not how they can adapt it if its possible to adapt it so that it can be used. They need to know what things are made of…they need to know it needs to be made out of the right materials*" (Teacher 2).

These comments appear to address earlier concerns about language used in the *TiNZC* (1995). There also appears to have been a conscious effort in the *NZC* (2007) to make statements clear, to explain and expand on different definitions used, for example an " understanding of material properties, uses, and development is essential to understanding how and why products work the way they do" (Ministry of Education, 2007, p. 32). This contrasts to earlier statements in the *TiNZC* (1995) which bulleted achievement objectives with very little immediate explanation; for example, students should develop an understanding of " technological principles and systems" (Ministry of Education, 1995, p. 10). What principles? These are described later in the document but not explained. The need for clear statements appears to be crucial especially because not all teachers have the opportunity to undertake formal professional development in technology education.

There are probably many reasons why teachers found statements regarding technological knowledge in the recent *NZC* (2007) more acceptable. Comparative analysis indicated teachers' had similar understandings of technological knowledge to those represented in both current educational research so it follows understandings in the *NZC* (2007) document informed by current educational research may be linked. These findings are reassuring, as teachers will after all be teaching to this document in the future. As a result of their greater theoretical content knowledge you would also expect greater commitment and confidence from teachers. Research indicates a teachers' view of knowledge has far reaching implications for how they teach (Compton, 1997). It also suggests teachers' understandings are enhanced with increased content knowledge (Jones & Moreland, 2004).

Implications for technology education

Several interesting issues also arose out of the findings from both the quantitative and qualitative stages of the research study that are worth discussing further. The first issue identified a gap in teachers' understandings. This gap related to teachers' notions of technological knowledge regarding the relationship technology has with society. Nearly all teachers acknowledged the importance of knowing about the relationship technology has with society. However they did not associate this knowledge with *societal* *knowledge*, knowledge associated with our material world (‘thing’ knowledge) or the way technologies impact on society within technology education (Patterson, 2009). The second issue related to a gap in curriculum statements. This gap in curriculum statements related to the development of *tacit knowledge* through practical hands on, experiential learning. Both teachers and current educational research recognized that *tacit knowledge* developed during technological practice is an important part of technological knowledge. The *NZC* (2007) in contrast does not make this type of technological knowledge explicit in the technological knowledge strand. The last issue relates to the way each curriculum was developed.

Societal knowledge

Mitcham (1994) identifies two differing dimensions concerning the relationship technology has with society, a human dimension, volition and a social dimension (Mitcham, 1994). From a human perspective, technological knowledge in this context relates to the values humans bring to products when designing or using them. The interdependency involved in this relationship is referred to as volition as well. Vries (2006) claims technological knowledge has two natures, a physical that is neutral, and a functional nature, which is non-neutral (Vries, 2006). From the social perspective, technological knowledge in this context relates to knowledge about society, or societal knowledge. It considers broader issues relating to the way in which ‘things we make bear out knowledge of the world’ (Baird, 2002, p.1). Together these two perspectives recognize technologists need to be aware of their outcomes, their practice and the wider social environment in which they work (Compton & France, 2006).

Although these notions of technological knowledge have always been associated with technological practice in technology education, these two notions of *societal knowledge* are not directly represented in the *NZC* (2007) curriculum within the technological knowledge strand. Instead they are evident in the new strand *The Nature of Technology*. The *Nature of Technology* strand comprises two components. The component *Characteristics of technology* focuses on broader issues related to society in general while the *Characteristics of technological products* component reflect the notion of volition. Separating this aspect of technological knowledge from the *Technological Knowledge* strand may be beneficial. It might allow teachers to focus specifically on these understandings and therefore acknowledge this link. In the past it has been referred to as the missing strand (Mawson, 1999). But there is also the danger that teachers will not link technological knowledge to the way that societal and human values shape everything we make and create (Burns, 1997).

Tacit knowledge

The second issue relates to the development of *tacit knowledge*. It is the accumulated knowledge gained from experiential practical hands on learning. Technological knowledge is often defined by its relationship to activity (Herschbach, 1995). Many educational researchers (for example; Compton 1997, Compton, 2004; Custor, 1995; Herschbach, 1995, McCormack, 1997; Ropohl, 1997; Vries 2005,) acknowledge the development of tacit knowledge as an important part of *process knowledge*. Technology educators also state hands on practical activities are an important part of classroom practice (Jones, Harlow, & Cowie, 2004). Compton (1997) recognized the need for practical abilities to develop tacit knowledge as early as 1997 and later argued that *tacit knowledge* should be made explicit in technology education (Compton, 2004). So it is interesting that the development of *tacit knowledge* is not made more explicit in the *NZC* (2007) document.

Interestingly this study found there appeared to be no gaps in understandings between teachers and researchers regarding the important role *tacit knowledge* plays in the development of technological knowledge. All teachers were adamant that the development of *tacit knowledge* was an integral part of *process knowledge.* And even though Compton (2004a) argues it is implicitly developed through technological practice I still feel this argument fails to guide teachers' understandings in this area. The new *Technological Practice* strand in *NZC* (2007) has three components. These focus heavily on planning in the first two components and dedicate one component to outcome development. Outcome development is associated with the practical hands on development of a technological solution. As a result two thirds of the components focus on planning rather than outcome development. This imbalance I believe disadvantages the development of *tacit knowledge* especially for students in the early years at school. If you link the development of implicit *tacit knowledge* to ongoing trial and error, then you have to argue, that students need to gain this type of knowledge somewhere. To enable informed planning while undertaking technological practice, I believe students first need practical hands on experiential experiences. Presently with so little emphasis on this aspect of learning especially in the primary years, there appears to be limited opportunities to address this concern. I feel this represents a gap in understandings about technological knowledge in the *NZC* (2007) document.

Curriculum development

The last issue relates to the development of technology curriculums in New Zealand. The review process to develop the *NZC* (2007) was very different to the development of the earlier *TiNZC* (1995). The *TiNZC* (1995) was heavily influenced by technology educationalists and extensive teacher consultation. In contrast to the *NZC* (2007) has been profoundly influenced by extensive international and a few national researchers with limited teacher consultation (Davies, 2005). The fact that teachers in my research aligned their understandings more with curriculum statements in the *NZC* (2007) informed by current educational research raised a number of interesting questions. Does curriculum development need to involve extensive teacher consultation? Should theoretical educational research instead drive curriculum development? My findings suggested because these primary teachers' understandings of technological knowledge were similar to those theoretical understandings put forward in educational research that theory should instead drive curriculum development.

Conclusions

This research study however did provide many positive outcomes for technology education. All teachers clearly associated technological knowledge with process knowledge. Technological knowledge as domain knowledge is now clearly defined for teachers in this document. All teachers commented that they found the language used in curriculum statements was clearer and this helped to guide their understandings. And finally the findings showed recent initiatives to provide teachers with clearer understandings of technological knowledge in the *NZC* (2007) have been successful. However even though my discussion of my research findings only represents a small case study of primary teachers, one conclusion in particular raised a very interesting question. How did the teachers I surveyed and interviewed gain their theoretical content knowledge regarding technological knowledge?

My research findings suggested professional development made little difference to teachers' understandings. The amount and duration of any formal professional development also appeared to make no difference (Patterson, 2009). So how the teachers gained such informed theoretical understandings of technological knowledge was an interesting result. Especially if you accept the rationale that teachers hadn't read any current educational literature expressing a similar viewpoint. One reason could be that teachers in their daily lives are already familiar with the technological process that develops tacit knowledge. As children they were natural engineers (Palmer, 1999) and as adults they continue to solve practical problems, for example fixing toys, making curtains, building gardens, renovating houses. You might argue as well teachers should have been more aware of the impact technology makes on society, for example teachers too are consumers of technological outcomes. In their every day activities they also respond to design decisions on a regular basis, for example buying a new toothbrush. So it is interesting teachers did not recognize this as technological knowledge.

Another reason may be that teachers have themselves developed their own theoretical understandings of technological knowledge learnt through trial and error working with students. Or as some recent research suggests, gained their understandings from other practicing teachers. This research indicates students leaving the Faculty of Education gained most of their knowledge through practice and interactions with practicing teachers (Hagger, 2008). Davies (1995) suggests a similar viewpoint. She recognized other teachers in a school were the most useful sources of knowledge for other teachers. These findings were supported my own research conclusions as well. These results suggested teachers mostly gained their understandings of technological knowledge informally while planning with other teachers in a school. So what influences teachers understandings of technological knowledge and technology? An answer to this question could have significant implications for primary teachers and students in the future. But this is another study and another paper.

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