Aspiring to be the Best: The impact of research on the teaching of technology

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Abstract

In this paper we report on our experience of working collaboratively as part of the *Technological Literacy: Implications for teaching and learning* national research project in New Zealand (Compton, Compton & Patterson, 2011). Moira is the researcher 'on the ground' in the Auckland/Northland region and Jude is the principal of an urban full primary school (year 1-8 or age 5-12) participating in the research project.

Jude responded positively to the initial invitation in 2010 to be a part of this research, with a clear statement of intent that she wanted her school to be 'the best technology primary school in New Zealand'. Realising the challenge in this, Moira and Jude have worked with a core group of staff to develop their subject matter knowledge (SMK) and pedagogical content knowledge (PCK).

The key focus of this paper is on the shifting of teacher understanding related to technology subject knowledge as outlined in the New Zealand Curriculum (Ministry of Education, 2007) and the subsequent development of PCK. The impact of these shifts on the delivery and impact of technology programmes to date are also discussed in terms of student learning.

Introduction

Teaching informed by research has always been encouraged in education. Providing teachers with a sound theoretical background to base their teaching is viewed as an essential factor to support learners in technology (Compton & Jones, 1998). Shifting teacher's theoretical understandings in technology education therefore became a prime focus for teachers involved as part of the *Technological Literacy: Implications for teaching and learning* (*TL: Imps*) research project. This research, led by Dr. Vicki Compton with Ange Compton and Moira Patterson as co-researchers, began in July 2010. The research is in response to the New Zealand Ministry of Education's request for an answer to the following question 'How will the three strands of the technology curriculum work together to develop students' technological literacy'?

The primary aim of this research is to explore and document how technological literacy can be supported through programmes based on the integration of the three strands of the technology learning area in the New Zealand Curriculum (Ministry of Education, 2007). It is specifically focused on exploring how the strands and components of technology work together to support the development of a deep, broad and critical technological literacy as students move from year 1-13 (Compton, Compton & Patterson, 2011). The classroom-based research currently being undertaken involves 92 teachers from throughout New Zealand. Moira is the researcher responsible for providing professional development support to and collecting data from four schools in the Auckland and Northland regions.

This paper reports on one of the schools she is currently working with in Auckland, providing insights from both Moira's and Jude's (the principal of the school) perspective.

Moira recognised early on that teachers needed to use content knowledge confidently to support and enhance children's learning (Farquhar, 2003). To achieve a shift in teachers' understandings both Moira and Jude have worked collaboratively to start the teachers at this primary school on a professional learning journey. A professional development programme, influenced by the Model of Domain Learning (MDL) (Alexander, 2003), was instigated to bridge the gap between teachers' current understandings and contemporary views of educational practice in technology education. With the many changes to expected content in technology in the NZC (Ministry of Education, 2007), it was important to also ensure teachers were well informed about the required subject matter they would need to be teaching. Research indicates (for example Compton & Jones, 1998; Ginns, Norton, McRobbie, & Davies, 2000; Jones & Moreland, 2004) when teachers are introduced to a new curriculum they benefit from professional development focused on developing specific subject matter knowledge (SMK). SMK refers to teacher's understandings of subject matter (Rohann, 2009; Rohann, Taconis, & Jochems, 2010). A summary of literature reviewing the relationships between teachers' knowledge and primary pupils' attitudes towards technology states that teachers' SMK is shaped by their own constructions of knowledge (Rohann et al., 2010). Teachers' understanding of technology have also been seen to influence teachers attitudes to teaching technology, and the pedagogical strategies they employ when teaching it, that is their PCK (Jones & Moreland, 2004). These factors, alongside the teachers self-identified needs, were considered as teachers at this school started on their professional learning journey about technology education as part of the *TL: Imps* project.

Best Technology Primary School

When Jude was approached at the end of 2010, she was very enthusiastic about being part of this research study. An opportunity to up skill her teachers in an area of education she was passionate about meant her commitment; professional leadership and motivation had the potential to positively affect teachers' understandings (Ginns, Norton, McRobbie, & Davies, 2000). The School's technology journey had begun in 2007 when a review of their delivery of the learning area of technology revealed barriers to teaching and learning that included: a lack of teacher confidence in teaching technology, teacher unfamiliarity with technology as represented in the NZC (Ministry of Education, 2007), insufficient resources and equipment, and a lack of a purpose-built space. This review led the school to take steps to begin to address these barriers, beginning with the building in 2008 of a multi-purpose Technology Room adjacent to the existing ICT Room and Information Centre.

An old shabby adjacent classroom was joined to the Information Centre and Library by cutting through walls, to enhance this area as the learning hub of the school. The room was completely modernised with the addition of an expanse of three walls of windows and floor-to-ceiling doors to let in light and provide safety monitoring of the activities out on the new large covered deck. Internal and external storerooms were added. The room was designed to be a multi-purpose room. The kitchen, with stoves, microwaves, sinks and benches, was set in an area featuring red linoleum to signal to children that only food and some bio-technology activities may be conducted there. All other activities are restricted to the remainder of the room or the deck. The room is fully equipped with cooking apparatus, sewing machines, overlockers, tools, etc., to enable the majority of children to be involved in group work at any one time.

The Tech Room proved to be a huge impetus for change. The considerable cost of this asset and the large investment of time and energy by Jude, the Board and Community to raise funds for the outfitting of the room, was a significant incentive to ensure that the room would be well-used for the benefit of children.

At this stage in the school's journey, the aim was simply to ensure that the learning area of technology was on a par with all other learning areas in the school, and delivered as competently. This aim was also perceived by Jude as a strategic way of counter-balancing the increasing pressure of funding ever-changing Information Curriculum Technologies, as she considered much could be achieved within a comparatively modest budget if technology was taught in a more holistic style, and the quality of teaching was high.

Most importantly, what the school gained along the way was a vision and moral purpose to the teaching of technology in the school and this placed technology as learning area in the forefront of their strategic thinking.

Jude by chance read an article by Sir Paul Callaghan (2010) titled 'High Tech is High Dollars' and went on to read his *Wool to Weta: Transforming New Zealand's Culture & Economy (2009)*. New Zealander of the Year twice, internationally renowned scientist, and the brains behind a successful High Tech business, Sir Paul argues that if New Zealand is to have a sound economic future it has to stop thinking of itself as primarily an agricultural country and acknowledge that its past prosperity stemmed from being a world leader in agricultural technology. Sir Paul claims that New Zealand's future prospects of prosperity lie with making High Tech a nation-wide priority. Sir Paul's view that such industry could be environmentally sustainable and not compromise New Zealand's national beauty struck a chord with Jude, as her School is an Enviro School (for details please see http://www.enviroschools.org.nz/Enviroschools-programme-overview).

However what caught Jude's attention most was Sir Paul's claim that there were currently Ten NZ world-leading High Tech businesses that were bringing four billion dollars into the NZ economy. If we had 100 such businesses, we would be on a par with Australia's GDP and its associated economic benefits. Jude's epiphany was that if NZ had 101 such businesses, we would *exceed* our Tasman neighbour's economy. Jude instantly saw the benefits for the pupils going through her school if they were the people to start up, lead, or work in those businesses or design those future products. To achieve such a vision would mean that her school would have to strive to be educational leaders in technology and science education. Together, the Senior Management Team and Board of Trustees decided they owed it to their students to lead - and to succeed.

PD approach

At the beginning of 2011 Jude asked teachers to self-select into one of three professional development projects they wished to be involved in for the next two years. It would be fair to state that for some who ended up in the Tech Team this may have been a choice by default. However, all staff were consulted about the three-option approach and consensus had been obtained before this was embarked on. Jude had a vision of trying to get representation from as many of the teaching teams in the school as was possible and this strategy produced coverage across four out of the five teams. The fifth team still taught technology in-school, but their students (year 7 and 8) were also receiving technology lessons at the neighbouring high school.

After the Tech Team had been established, Moira started working with Jude and this core team of seven teachers. The teachers committed to participating in the TL: Imps research for two years and taught classes that ranged from new entrant/year 1 to year 6. Two teachers taught new entrant/ year 1 classes. One teacher taught a year 2 class One teacher taught a year 3 class. One teacher taught a year 3/ 4 composite class. Two teachers taught a year 5/ 6 composite class. Some of these teachers had participated in previous technology education professional development and were experienced in teaching technology as outlined in the previous technology curriculum (Ministry of Education, 1995). However only one teacher had a more comprehensive understanding of technology particularly as it is now described in the NZC (Ministry of Education, 2007). Consequently this teacher was given a leadership role. Some of the teachers had also worked in the new technology room.

Moira's main focus as researcher in the *TL: Imps* project was to work with teachers to ensure coverage of the three technology strands through the inclusion of the eight components described in the NZC (Ministry of Education, 2007). Explanatory papers for each component (Compton, 2010) are available for teachers to access on a Ministry of Education supported site Techlink (see www.techklink.org.nz). This unique site has been developed for teachers to access curriculum and other material related to technology education. For research purposes it was important that the teachers covered all eight components in their teaching programme during the two-year research study. Current educational directives also recommend teaching the eight components over two years (Compton & Harwood, 2007). Because New Zealand has four terms a year, this model allows for greater focus in teaching for teachers and for students to gain literacy that is of a broad, deep and critical nature (Compton, Compton & Patterson, 2011). This overall programme model for planning was used to guide unit development with teachers involved in the research. Selected units were taught term-by-term in 2011and linked to school themes. As with many schools in New Zealand in 2011, the Rugby World Cup was one such school theme. A major and minor focus was selected for assessment purposes. Components new to technology since the revision of the New Zealand curriculum in 2007, and therefore new to the teachers, were given a major focus. These included components in the Technological Knowledge strand, (technological modeling (TM), technological products (TP) and technological systems (TS) and components in the Nature of Technology strand, (characteristics of technology (CoT) and characteristics of technological outcomes (CoTO).

An overview to guide individual unit planning was developed by the core group of teachers at the beginning of 2011 and revisited at the beginning of 2012 in light of the experiences of all involved during 2011. At the beginning of 2012, the teachers confirmed the major components already selected, and they decided any teacher could select an additional component from the technological practice strand to include as a minor focus. At this time, the group also discussed an issue identified by Moira that related to CoT. This was the first component taught by teachers when the research project started and they were new to understanding technology. Initial impressions of early data collected indicated revisiting understandings associated with this component would benefit all students as many were still unable to identify the defining characteristics technology as a human endeavor or exactly what a technological outcome was. CoT was therefore included twice in the programme overview. The table below provides an outline of what teachers covered in 2011 and what they expect to cover 2012.

Table 1: School 2-year Overview

Term	Year 2011	Context	Major Focus (Assessed)	Minor Focus
1	Unit 1 2011	Containers/Water	CoT	BD
3	Unit 2 2011	Rugby World Cup	TP	PfP
	Year 2012			
T1	Unit 3 2012	Food preparation	TS	TP Master Chief
T3	Unit 4 2012	Jewelry	TM	ODE
T4	Unit 5 2012	Biotechnology, herbal health products	CoTO/CoT	

The Professional Development Programme

Moira's understanding that limited theoretical knowledge prevented teachers from teaching effectively (Ginns, Norton, McRobbie & Davies, 2007) lead to her early decision that the teachers required support to ensure they knew more about what they were teaching. It has been well documented that assistance from external expertise can support and extend teachers' theoretical knowledge, which can then translate into practice (Timperley, Wilson, Barrar & Fung, 2007). Sense making is a complex process involving not only interactions with others but also includes an individual's beliefs, attitude and knowledge (Timperley, Wilson, Barrar & Fung, 2007). Moira therefore saw the development of SMK in a collegial environment as a crucial pre-requisite to enhance teacher's attitudes to and ability in teaching technology. That is, their PCK (Rohaan et al., 2010). After consulting with Jude and considering comments from the core group of teachers involved in the study, a professional development programme influenced by the MDL model (Alexander, 2003) was developed. When developing domain or specific content knowledge, Alexander (2003) describes three stages in the MDL model. Acclimation is the initial stage. Learners at this stage have limited and fragmented understandings. They exhibit little personal interest and require ongoing support to give value to what they are learning (Alexander, 2003). At the second stage, competent learners have greater foundational domain knowledge, their understandings are more cohesive and their personal interest in the area of learning increases (Alexander, 2003). At the third level, proficient learners become experts and domain knowledge becomes broad and deep while interest in specific content knowledge becomes very high (Alexander, 2003). At the beginning of 2010 most teachers exhibited characteristics associated with the acclimation stage.

To achieve a shift in understanding, the professional development initially focused on each teacher's understanding of each component as a whole (Compton & Compton, 2010) and what they needed to know to feel confident to teach their classes. That is their subject matter knowledge (SMK). After this, discussions moved to the interpretation of achievement objectives in the NZC (Ministry of Education, 2007) and the associated indicators of progression at appropriate levels as developed from previous research (Compton & Compton, 2010; Compton & Harwood, 2005). Progression diagrams have also been developed to further support the indicators of progression as described elsewhere (Compton, Compton & Patterson, 2011). The use of the diagrams, showing learning progressions within and across each level of learning in relationship to curriculum achievement objectives, enabled teachers to understand the requirements for teaching to ensure learning in technology was able to be progressed.

Teachers met at the beginning and end of each term to discuss and review their own understandings, and to plan and evaluate learning and assessment experiences. Prior to these meetings Moira asked the teachers to read the explanatory papers for each component. For example, prior to teaching the technological products (TP) component, teachers were asked to read the related explanatory paper. Understandings and or issues as a result of this reading were discussed. Sometimes this engendered debate. For example defining the differences between forming, transformation, and manipulation of materials resulted in the need for a number of examples and these were then linked to proposed units of work. How materials were manipulated to make mascots was discussed in depth. As interest increased and relevance became embedded in practice all teachers increasingly saw the value of content knowledge showing a clear movement of the teachers from the acclimation stage to increasing competence (Alexander, 2003). Periodic follow-up meetings with clusters of teachers working with the same year group also helped to reinforce teacher's pedagogical content knowledge (PCK) and these were run on a more needs basis. Making sense of material became for teachers a journey rather than orderly events (Timperley, Wilson, Barrar & Fung, 2007)

Shifts in Teacher Understanding and Practice

Moira observed that most teachers at the beginning of their journey were a bit fearful of technology. However as the year progressed she noted an increasing interest and confidence amongst teachers resulting in most teachers shifting from the acclimation stage to a position of competence. They were becoming increasingly more familiar with the content knowledge associated with technology. Integrating theory with practice was also noticeably easier for the teachers. For example, by the end of the year when themes were suggested for classroom practice teachers were quickly able to link content knowledge to possible teaching experiences. As teachers planned for their classrooms they successfully interpreted given achievement objectives as guided by the indicators of progression and progression diagrams at different levels.

One teacher's enthusiasm for technology increased hugely to the point she was seen as an expert in the group. Another teacher commented she wanted the core group to continue after the research. Moira photographed Rugby World Cup mascots and students confidently discussed why they chose the materials used. Teachers would proudly share their students work and confidently share their developing understandings with Moira on a regular basis. Many discussions were had about the use of 'difficult' technology terminology with young children and the benefits and problems associated with this were debated amongst the group. After one such conversation with teachers, Moira realised that teachers needed to be more explicit with the students that what they were learning was technology.

On another occasion, a new entrant teacher commented that children didn't even know the word 'materials'. Consequently it was decided that she needed to introduce vocabulary associated with materials first before further technological concepts could be developed.

As the year progressed many teachers commented that technology wasn't that difficult to teach. It had not become a 'teaching extra' but instead they began to integrate it more easily, viewing technology as part of their teaching programme. The teachers enjoyed discussing their successes and difficulties with each other and Moira, and numerous lovely stories started to appear. This supports the view that collegiality among participating teachers appears to be an important factor in successful models of professional development (Timperley, Wilson, Barrar & Fung, 2007).

Impact as Result on Student Learning

Research indicates increased teacher understandings enable greater engagement and improved PCK (Rohaan, 2009) and that this affects teaching and in turn children's understandings of technology (Rohaan et al., 2010). This would certainly appear to be true in this case. Interim interview data collected at the end of 2011 indicated a shift in understandings for the components taught over 2011.

A total of 120 students are participating in the research from seven classes (Two new entrant/ year 1 classes, one year 2, year 3 class, year 3/ 4 and two year 5/ 6 classes.)

As part of the research, 26 of these students were interviewed and judgments made about their understanding of characteristics of technology (CoT) and technological products (TP). Six students from year 1, five from year 2, five from year 3, three from year 4, four from year 5, and three from year 6.

At the beginning of the year, the majority of these students (19 or 76%) exhibited pre-level 1 understandings of CoT and six students (24%) showed level 1 understanding. By the end of the year these figures had changed to 10 students showing pre-level 1 (40%), 14 students showing level 1 (56%) and one student was working at level 2 (4%).

At the beginning of the year, the majority of these students (17 or 68%) exhibited pre-level 1 understandings of TP with eight students (32%) showing level 1 understanding. By the end of the year these figures had changed to four students showing pre-level 1 (16%), 13 students showing level 1 (52%) and eight students were now working at level 2 (32%). This is very good progress for students of this age.

This initial data indicates this cohort of students have shown an improvement in their understanding of these components, albeit a greater shift in learner's understandings regarding TP than CoT. This is consistent with the development of teacher's understandings, where the teacher's knowledge of TP was greater than their knowledge of CoT at the time they were teaching each component.

Jude has also acknowledged there is wide-spread agreement by teachers that students now know that technology helps create the 'made' world and can offer opinions on what technology entails, which is a big shift from the start of the project. School middle managers also reported a consensus that students are becoming more confident using the language of technology... such as talking about brief development and knowing what that means. Students now undertake technological practice in a more 'connected' manner, recognising the importance of the brief and its relevance to the product they are making. One teacher said that even with new terminology students were about to learn, such as 'inputs/outputs', the students were now more confident and able to work out the meaning for themselves. One senior teacher who has been away for a year was astounded when she returned and checked students' prior knowledge and found they knew concepts and terms that she had not expected them to know – and that she now has to come up to speed with herself! Technology teachers at the adjacent high school where the year 7 and 8 student go for additional technology classes have also reported that these students are now standing out in relation to their peer group.

While the increase in technological understandings and skills are impressive, the bigger picture of the gains from a more informed use of the Tech Room should not be overlooked. One Year 3/4 teacher summed up the level of excitement by the students when the room first opened. "You mean we can go in there! We can touch the stuff!'" She said, "their eyes are on stalks. They love being able to produce things themselves." Jude and her team believe that wonderment and awe, and a love of technology as a subject, are the foundations upon which excellence and engagement in learning is built.

2012 the Way Forward...

Regular ongoing in-depth professional development is considered to be the most effective way to change teacher practice. The PD at this school, informed by the MDL model (Alexander, 2003) and a focus on SMK and PCK, appears to have not only successfully shifted teacher theoretical understandings and informed teachers teaching but to have also resulted in measurable changes in *student* understanding.

In 2012 additional teachers have joined the Tech Team of teachers from 2011. A similar format for professional development has been agreed on and it is hoped the original core group will work alongside Moira to support the new teachers with their understandings about technology. In this way, we believe the professional learning of these teachers has the potential to become self-sustaining, meaning when the research input moves out, the school will continue to move on... towards Jude's goal of being the best technology primary school in the country!

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