Initial Teacher Education Students' Perceptions of Technology and Technology Education in New Zealand

Abstract
Quality Initial Teacher Education builds on students' prior knowledge. This paper outlines a large-scale New Zealand study involving 906 student teachers across early childhood, primary and secondary sectors. A questionnaire investigated the influence of demographic and other factors on attitudes and understandings of technology held on the first day of class. Results revealed participants viewed technology positively, and understood the role and importance of key aspects of technology however this varied between age and sectors. These findings allow lecturers to develop a more targeted approach to initial technology delivery, and provide a solid basis for a national longitudinal study.

Keywords Initial Teacher Education (ITE), technology education, technological literacy, student perceptions, personal constructs.

1. Introduction

Technology education has metamorphosized over the years. It has moved from a focus on technical, manual and life skills, to vocational, craft, workshop, industrial arts, through to its many current international forms (Ferguson, 2009; Granshaw, 2015; Jones, Buntting, & de Vries, 2013; Martin & Ritz, 2012). Unfortunately these multiple iterations have led to confusion about the nature and intent of the subject (Medway, 1989). These include confusion between educational technology and technology education (Brown & Brown, 2010), science and technology (Constantinou, Hadjilouca, & Papadouris, 2010; Williams, 2011), engineering and technology (Wicklein, 2006), applied science and technology (Layton, 1993) industrial arts and technology (Clark, 1989; Lewis, 1995; Petrina & Volk, 1995) craft and technology (Autio, Soobik, Thorsteinsson, & Olafsson, 2015), technical and technology education (Lawal, 2014) and vocational education and technology (Leahy & Phelan, 2014; Lewis, 1995).

Although there are common themes within the discipline of Technology Education (Jones et al., 2013), the subject is delivered differently in almost every country. Scandinavia, Switzerland and Austria have taken a craft-oriented approach (de Vries, 2006; Kananoja, 2009; Pöllänen & Urdziņa-Deruma, 2017); the Czech Republic a technical approach (Novakova, 2006), Israel an integrated science and technology approach (Barak, 2006; Kipperman, 2006), whilst New Zealand, Australia, the United Kingdom and South Africa have taken a strong design approach (Jones & Compton, 2009; Stevens, 2009; Williams, 2006). Delivery can be very fragmented and differ regionally in countries such as Germany (Hopken, 2006), whilst others such as Canada and Australia strive to develop a consistent unified approach across states (Hache, 2006; Williams, 2006). For an overview of international delivery approaches at each level of schooling for;

England, Australia, India, South Africa, Canada, France, mainland China, USA, and New Zealand see Jones et al. (2013).

In the last two decades, New Zealand has had two technology curricula. The 1995 document, defined technology education as “a creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems, or environments” (Ministry of Education, 1995, p. 6). While the current 2007 curriculum, defines technology education as “intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities” (Ministry of Education, 2007, p. 32).

In order for technology education to grow as a curriculum subject area, teachers, schools, parents and the community must have a clear understanding of the subject and why it is necessary (Wicklein, 2006). Shulman (1987) suggests that teaching should be based on an understanding of what needs to be learned and taught. For this reason, perceptions of a subject discipline are very important (Compton & Compton, 2013; Dakers, 2005; Jones et al., 2013; McRobbie, Ginns, & Stein, 2000; Rohaan, Taconis, & Jochems, 2010). Teachers need to have the confidence and understanding to teach technology (Rohaan et al., 2010) as this influences student attitudes, ability and career aspirations (Davies, 2000). A sound understanding of technology enables the establishment of clear goals, classroom activities and authentic contexts (Brown & Brown, 2010) which leads to the development of technological literacy (Lewis, 1995; Skophammer & Reed, 2014).

Initial teacher education (ITE) plays a key role in developing student teachers’ understandings (Koster, Brekelmans, Korthagen, & Wubbels, 2005) as initial beliefs are a foundational component of professional preparation (Sanger & Osguthorpe, 2011; Tanase & Wang, 2010). Being cognisant of the beliefs held by ITE students is important in any teacher education programme (Löfström & Poom-Valickis, 2013; Ng, Nicholas, & Williams, 2010). These initial beliefs can influence the quality and process of learning to teach and teaching practice (Stein, McRobbie, & Ginns, 2002; Tanase & Wang, 2010).

A review of 27 empirical studies on student teachers’ beliefs concluded that student teachers use past experiences to filter ITE content (Kagan, 1992) and reinforce rather than challenge prior beliefs and values (Mattheoudakis, 2007). Some factors have been identified may influence student teachers’ views of teaching and learning these include age, programme (Hobson et al., 2008), gender, one's experiences with the teachers they have known, (Saban, Kocbeker, & Saban, 2007) and knowledge and understanding of teaching theories and practice as well as students' perceptions of the subjects they are about to teach (Hobson et al., 2008; Saban et al., 2007). Unfortunately, minimal research has investigated the effects of these factors on the beliefs held by technology education ITE students.

1.1 Research question (RQ) / Current investigation

Based on the literature review, we present three main research questions as listed below:

RQ1. What are the student teachers' views on technology?

RQ1a. How important is technology to New Zealand as a country?

RQ1b. What do you think the subject/learning area called technology is mostly about?

RQ1c. What pedagogical notions do student teachers think are applicable to technology education, both technology and science education, or science education?

RQ1d. What are students' strength of belief and values about technology?

RQ2. How do student teachers' views on technology education differ by age-group?

RQ3. How do student teachers' views on technology education differ by sector?

2. Methods

The research team used survey methods and a descriptive and comparative research design to investigate ITE student views on technology and technology education and how these views differed by age-group and educational sector. After gaining ethics approval, the researchers piloted the questionnaire with one cohort of technology ITE students. Over the following two years all technology ITE students were invited to participate in the research, allowing several waves of convenience sampling.

Prior to any instruction on the first day of class, ITE research participants were invited to complete an anonymous questionnaire about their perceptions of technology, their attitudes towards technology, and experiences that shaped their perceptions of technology education. The participating initial pre-service ITE programmes were the Bachelor of Teaching, and the Graduate Diploma in early childhood, primary, and secondary education. This process was replicated at the six leading universities throughout New Zealand, with the intent of combining the data to give a national overview at a later stage

2.1 Participants

A total of 906 participants were involved in the research. Gender, age, programme, prior experience, subject knowledge and understandings were investigated as research had identified these as potential factors able to influence initial teacher understandings and beliefs (Hobson et al., 2008; Saban et al., 2007). The majority (83.2%) of these participants were female, whilst 64.6% were aged 17-to-24. As the New Zealand curriculum was first introduced in 1995 (Ministry of Education, 1995), this 17-to-24 year old cohort probably have only experienced a schooling system containing technology education. Most of the participants (76.4%) were from the primary education sector, whilst 21% were from early childhood education (ECE) and 3% from the secondary sector. Of the total 906 participants, 865 answered the question concerning whether or not they had achieved national senior assessment credits in technology education. Of these 865, 236 respondents (27.3%) stated that they had achieved such credits, and the majority of these, n = 199 (84.3%), were under the age of 25.

2.2 Instruments

In 2010 technology education lecturers from the six main ITE providers within New Zealand (Auckland, Canterbury, Massey, Otago, Victoria, and Waikato universities) initiated NZ Association of Academics in Technology Education (NZAATE) and agreed to participate in joint research to investigate the personal constructs of their students (M. Forret et al., 2013). Each institution contributed to the development of a questionnaire which was subsequently used to gather data about the entry knowledge of students. This information was used initially to inform practice at each university and was used as the primary instrument in the current investigation. National data is yet to be combined and analysed and for this reason this paper focusses on the data gathered from the nation's largest university.

2.3 Data Preparation and Analysis

Data were screened, cleaned and adjusted for anomalies (Pallant, 2011). Thereafter, in accordance with Bennett (2001), respondents missing more than 10% quantitative questions were removed from the dataset due to the potential for bias. Subsequent analysis suggested that the quantitative data was not missing completely at random (Little, 1988 MCAR test: χ^2 = 1645.218, df = 1507, p = .007) so imputations were not possible. For this reason the number of participant responses (n) varies slightly between questions as some participants did not answer every question.

Statistical Package for the Social Sciences (SPSS) 22 was used for the majority of data analysis, whilst effect sizes were carried out with the assistance of the R statistical package (R Core Team, 2015). To gauge the general magnitude with which participants responded to the ordinal questions, means (*Ms*) and standard deviations are presented. To gauge the extent to which cohorts of interest gave stronger responses to particular ordinal items, Cliff's delta (δ) effect sizes (Cliff, 2014) are reported in accordance with Romano, Kromrey, Coraggio, and Skowronek (2006): $|0.15| \leq \delta \geq |0.32|$ (small), $|0.33| \leq \delta \geq |0.46|$ (medium), $|0.47| \leq \delta$ (large). The R statistical package utilised for this procedure, 'effsize' was created by Torchiano (2015).

In order to investigate possible differences in the opinions between those who had attended school after the introduction of the technology curriculum with those who attended school prior to the introduction of the 1995 technology curriculum (Ministry of Education, 1995), the group was split into two groups. The first group of 576 students (64.6%) were aged 17-24 and would have only experienced education with technology education as a compulsory learning area. The remaining 315 students (35.4%) were 25 or older, and may have experienced some or no technology education.

In order to investigate whether findings differed between those in the early childhood, primary or secondary sectors, the sample was split into three groups. It must be acknowledged that in doing so students from various pathways were grouped together. For example data from

ITE students in the three-year Bachelor of Education degree course were grouped with those completing a one-year graduate diploma because they were all exiting into the primary teaching sector.

Due to the categorical and ordinal nature of this data, nonparametric statistical analyses were undertaken. Where comparisons were made between two cohorts (e.g., younger vs. older age-groups), Mann-Whitney U tests were performed. Where comparisons were made between three cohorts (e.g., ECE vs. Primary vs. Secondary), initial Kruskal-Wallis tests were followed up by paired post-hoc Mann-Whitney U tests and effect size estimates. Where the effect of age-group and sector are assessed, meaningful results are those which meet at least a small effect size ($|0.15| \leq$ □$\delta \geq |0.32|$), and also meet the Bonferroni adjusted level for statistical significance (for sets of questions).

3. Results

3.1 Perceived Importance of Technology to New Zealand

For RQ1a, ITE teachers were asked, '*How important is technology to New Zealand as a country?'* Response options ranged from (1) Not at all important, through to (3) Moderately important, and finally to (5) Extremely important. Of the 900 respondents who answered this question, a majority 764 (84.9%) thought that technology was beyond the moderate level of importance (level 4 or 5), with only one person (0.1%) thinking it was not at all important. The mean response for the question was 4.26 (*SD* = 0.73), suggesting that, on average, participants' view on technology's importance to New Zealand tended slightly toward the extreme, rather than moderate level.

3.2 Perception of What Technology is Mostly About

For RQ1b, student teachers were asked, '*What do you think the subject/learning area called technology is mostly about?'* To answer this question, participants were provided with 13 example subjects/learning areas, and, for each, asked to select either (1) No/marginal focus, (2) Some focus, or (3) Heavy focus on technology. The mean responses (*Ms*) for each question are presented in Table 1 in descending order. Mean responses ranged from 1.96 (approximately 'some focus' on technology) to 2.68 (closer to 'heavy focus' on technology).

INSERT TABLE 1 HERE

Results suggest that participants thought that the subject technology, is mostly about (a) Computers (*M* = 2.68, *SD* = 0.50), (b) Creativity, design & showing others your ideas (*M* = 2.62, *SD* = 0.53), and (c) Thinking about the impact of technology (*M* = 2.59, *SD* = 0.54). Follow up analysis revealed that participants regarded these three subject areas as largely more relevant to technology than (m) Learning what experts in the community do in their job ($0.50 \leq \delta \geq 0.57$, $p < .001$). To note, all other effect sizes for the comparisons between the item with the lowest mean (m) and the other subject/learning areas were either medium or small.

3.3. Notions Applicable to Technology, Science and Technology, or Science

For RQ1c, student respondents were presented with 11 pedagogical notions and asked whether they applied to (1) Technology, (2) Both science and technology, or (3) Science. Table 2 illustrates the results with notions perceived to be more technology-related presented first in the table.

INSERT TABLE 2 HERE

Results suggest that participants thought that the notion of (a) Planning and design, and (b) Creativity were more generally applicable to Technology than Science. On the other hand, respondents thought that the notion of (k) Experiments were more aligned with Science. Follow up analysis revealed that participants regarded notions (a) to (e) as largely more Technology-focused than the notion of experiments ($0.55 \leq \delta \geq 0.72$, $p < .001$). The notions (f) Problem solving to (j) Gaining new knowledge were perceivably aligned quite equally with both Technology for further studyand Science subjects.

3.4 Strength of Students' Beliefs and Values about Technology Education

RQ1d was concerned with pClarifyarticipants' beliefs and values about Technology. For this question, respondents were presented with seven Likert-type questions with response options ranging from 1 = Strongly disagree, to 5 = Strongly agree. Table 3 presents the results in which questions attracting stronger agreement are presented first.

INSERT TABLE 3 HERE

Overall, respondents very much agreed with the statement, (a) Humans often develop new technologies to improve upon previous technologies ($M = 4.38$, $SD = 0.792$). In contrast, respondents generally disagreed with the statement, (g) technology is a small factor in your everyday life ($M = 2.00$, $SD = 1.23$). Follow up analysis revealed that participants agreed to a much larger extent with beliefs (a) to (d) compared with the notion that (g) Technology is a small factor in everyday life ($0.48 \leq \delta \geq 0.83$, $p < .001$).

3.5 The Influence of Age-Group on Student-Teachers' Views of Technology Education

RQ2 asks, *'How do student teachers' views on technology differ by age-group?'* To answer this question, the effect of the two age-groupings (17-24 and 25-&-over) on responses to all of the 32 questions in the study was undertaken. Results are presented in Table 4.

INSERT TABLE 4 HERE

Results revealed that age grouping had two meaningful effects; participants' conceptions of technology: the older group considered technology slightly more important to New Zealand than the younger group ($\delta = 0.23$, $p < .001$); and, the older group thought that problem solving ($\delta = 0.15$, $p < .001$) was more relevant to technology than the younger group.

3.6 The Influence of Sector on Participant Responses

RQ3 asks, *'How do student teachers' views on technology differ by sector?'* To make sector comparisons, three separate analyses were run: ECE versus primary, primary versus secondary, and ECE versus secondary. Results for these three sets of analyses will now be presented in turn.

Where ECE responses were compared to the primary cohort responses (Table 5), there were three small meaningful differences: the primary cohort thought that technology was less important to New Zealand than the ECE cohort (δ= -0.16, $p = .001$); the primary cohort also thought that technology was less focused on learning about new inventions (δ= -0.17, $p < .001$); and, that technology was less concerned with learning about technology over time, place and cultures (δ= -0.15, $p = .003$).

INSERT TABLE 5 HERE

Where the primary cohort's responses were compared with the secondary cohort's responses (Table 6), there were two meaningful differences: the secondary cohort was more inclined to believe that design was a process to turn ideas into products ($\delta = 0.46$, $p < .001$), and, the secondary cohort also thought that technology was more important to New Zealand than the primary cohort ($\delta = 0.32$, $p = .012$).

INSERT TABLE 6 HERE

Where the ECE cohort’s responses were compared with the secondary cohort’s responses (Table 7), there was one meaningful result: the secondary cohort was more inclined to believe that design was a process to turn ideas into products ($\delta = 0.37$, $p < .004$).

INSERT TABLE 7 HERE

4. Discussion

This research has focused on investigating the perceptions, understandings and attitudes of students undertaking ITE. Data was gathered from students in the first session of their technology course at New Zealand's largest university.

Research Question 1. What are the student teachers' views on technology?

Students in this study were positive about technology as they believed it was important to New Zealand. These positive findings support those of the USA (Knezek, Christensen, & Tyler-Wood, 2011) the Netherlands (de Klerk Wolters, 1989), Germany, Turkey and Malta (Sjøberg & Schreiner, 2010). This positive attitude towards technology has been shown to be a prerequisite to effective teaching about technology (Bame, Dugger, de Vries, & McBee, 1993) as it influences students' understandings and views (Dakers, 2005; Hathaway & Norton, 2016; Head & Dakers, 2005; Knezek et al., 2011; Rohaan et al., 2010). A key aspect of ITE is that a learner is unable to participate fully in technology if they do not have the understanding and desire to become involved (Ankiewicz, van Rensburg, & Myburgh, 2001; Reddy, Ankiewicz, de Swardt, & Gross, 2003).

When asked "what do you think the subject/learning area called technology is mostly about?" the strongest response was for the notion of "computers" (as shown in Table 1). Currently "information and communications technology" is one of five technological areas listed in the technology curriculum (Ministry of Education, 2007, p. 32). However the profile of digital technology within the New Zealand curriculum is currently under review (Education.govt.nz, 2016; Parata, 2016), partially due to strong lobbying from the digital technology learning community who believe it should have a much stronger emphasis. There has been much debate as to whether digital technologies should be a stand-alone subject or more strongly emphasized within the technology curriculum (Institute of IT Professionals NZ, 2016). The results from this research suggest that ITE students view computers as a key part of technology. However it is not clear if these students were referring to gaining, using or learning about computers. Historically there has been a confusion between 'educational technology' (involving computers and digital technology) and 'technology education' which is well known and well documented (Brown & Brown, 2010; Compton & Compton, 2013; Jones & Carr, 1992; McRobbie et al., 2000; Medway, 1989; Mrayyan, 2016; Sanders, 2009). For this reason further research is needed to clarify these ITE students' understandings. Any misconception will need to be addressed early in ITE courses, otherwise any discussion or use of a digital device will reinforce these misunderstandings. As there was no meaningful group difference, these recommendations apply to all ITE students in the early childhood, primary and secondary sectors.

Data suggested that many participants were aware that traditional woodwork, metalwork, sewing and cooking were no longer a key focus of technology education. If students entering teacher education have this understanding, less time could be devoted to clarifying the distinction between the traditional and current subject focus. Historically some principals have employed ‘technology teachers’ who taught traditional metalwork, woodwork, sewing and cooking (rather than technology education), stating it was the wish of parents in their communities (Lee, 2003). Current research into parent understandings and expectations of technology education is therefore urgently needed. Do they too understand that there has been a change in the curriculum and what do they feel will best prepare their children for their future lives and careers?

The majority of students in this study believed that a key part of technology education involved considering the impact of technology. Students in New Zealand are required to consider the impact of their actions on others as well as considering others during the development and use of their technological outcome (Compton & Jones, 2004; Lee, 2011). These notions, or aspects of them, have also been included in the technology education curricula of many other countries such as Australia, France, USA and the United Kingdom (Pavlova, 2005, 2006). This understanding may be as a result of the heavy emphasis New Zealand’s curriculum places on acknowledging the interrelationship between technology and society (Mawson 1999) or as a result of the research and professional development related to the nature of technology (NOT)(Compton & Compton, 2011).

Participants in this study believed that the notion that “technology involved learning about what experts do in their job” was meaningfully less relevant than all other conceptions of what the subject entailed, especially “computers”, “creativity, design and showing others your ideas” and “thinking about the impact of technology”. Technology education has a heavy emphasis on learning from others to develop and gain tacit knowledge (France & Compton, 2012; Head & Dakers, 2005; Jones et al., 2013; Slatter & France, 2011). Unless students understand what people do in their jobs they will be unlikely to make links with experts nor will they likely see their jobs as career options (Lonsdale & Anderson, 2012; Lonsdale et al., 2011). This information should provide strong support for all ITE activities highlighting the importance of ‘communities of practice’ (Wenger, 1998).

Participants believed that design applied more to technology than science subjects. They were aware that technology education included design, thinking about the impact of technology, planning, making and problem-solving. A higher emphasis was placed on these design aspects than ‘learning about electronics’, ‘learning what it means to do technology’ and ‘learning about new inventions’. This differs from the early findings of Rennie (1987), Rennie and Jarvis (1995) and Jones (1997) who identified that teachers’ possessed limited perceptions of design and technology. Design is a key part of technology education (Compton & Harwood, 2006; Jones, Buntting, & de Vries, 2011; Ministry of Education, 2001; Pavlova, 2005). If students are entering ITE with the idea that design has a key role within technology education, then they can quickly be moved on to learning how this can be achieved.

RQ2. How do student teachers' views on technology education differ by age-group?
Meaningful differences were identified between students who were 25 years and over and those who were younger than 25. The older group considered technology education slightly more important to New Zealand than the younger group. The older group also thought that problem solving was more relevant to technology education than the younger group. The older group of students contained less 'digital natives' (Prensky, 2004) who are normalized to a world of rapidly changing innovations and 'high-tech' gadgetry. These younger students use technology with ease and accept change more readily (Kinash & Kordyban, 2012; Lei, 2009). This nonchalance with technology may explain differences in the two groups' ranked importance of the subject. This New Zealand research is being extended into a longitudinal study and it is hoped these findings will be explained in further investigations. Findings from this study could reflect OECD (2006) data which states that although industry remains positive about the importance of technology, students are seeing it as less desirable as a study option and the proportion of tertiary science and technology students is reducing.

Younger students (under 25 years of age) would have only experienced an education which encompassed the inclusion of technology. Dewey (1938) believed that teacher education was a process which built on elementary (primary) school experiences. Time therefore needs to be given to all students especially those who have not experienced a lifetime of technology education. Although technology has been a compulsory learning area in New Zealand for over twenty years, a number of inconsistencies and misconceptions have been identified in teachers' understandings of technology (Compton & Compton, 2013). Future ITE students must have the opportunity to examine and confront any inconsistencies with their beliefs about the notion and place of technology education (Amirshokoohi, 2016).

RQ3. How do student teachers' views on technology education differ by sector?
Meaningful differences in views about design were found between students of the different sectors (early childhood, primary, secondary). Many participants in the secondary sector may have had a design background and therefore it is of no surprise they had a stronger understanding of what design entailed (Mc Glashan & Wells, 2013). The most meaningful sector result was that the ECE and primary ITE students were less inclined to agree with the notion that "design is a process that can be used to turn ideas into products". One could argue that the associated pre-conceived notion among earlier educators may hinder opportunities for younger pupils to follow through with this important process. It could be argued that the process of turning ideas into products is applicable to students across all sectors. Therefore, tertiary educators should consider pedagogical interventions that might dispel this misconception among ECE and primary ITE students, and provide a clearer curricular design to enable such opportunities in ECE and primary settings.

It is important to acknowledge the differences between these sectors and to ensure each sector is taught accordingly. It is hard to change beliefs and attitudes and therefore differing amounts of time will needed for each sector (Amirshokoohi, 2016). Lecturers who teach across multiple sectors need to ensure they are familiar with the findings that identify ITE student perceptions and misconceptions prior to developing the course material for each semester.

4.1 Implications

These research findings were initially used to adapt and modify course material but have also enabled an investigation of patterns and trends regarding student understandings and attitudes. Recommendations for further research have been woven through the discussion section. These recommendations highlight the need to clarify parents' views of technology education as well as ITE students' understandings of the role of computers in technology education, and the importance of learning from experts.

Further longitudinal research is needed to investigate if and how attitudes change over time as the students complete their ITE programmes, teach, gain registration and become experienced members of the teaching profession (Ardies, De Maeyer, & Gijbels, 2013). Knowledge that students are entering ITE placing a high value on technology and with an adequate basic understanding of the discipline, enables a change in emphasis in technology education's programmes. As with other countries, numeracy and literacy in New Zealand has received an increased political and social focus which has resulted in other learning areas receiving less funding, status, and time in ITE programmes (O'Neill, 2012). This knowledge will enable the limited time available to be devoted to developing and extending existing notions to develop strategies for successful implementation of the curriculum.

5 Conclusions

Education institutions have a key role to play in the development of sound understandings of technology education (Varda, Koren, Rubin, & Buck, 2013). It is imperative that teachers have a sound understanding of technology to underpin teaching and learning in technology (Compton & Compton, 2011; de Vries, 2005; Forret, Edwards, Lockley, & Nguyen, 2013; M. Forret et al., 2013; Kaplan, 2009). ITE provides insights into curriculum development and provides a conceptual basis for understanding technology. It helps position the teaching of technology among other subjects as well as helping to identify a research agenda for technology education (de Vries, 2005).

Students entering ITE programmes represent the end product of schooling and accordingly provide a view of their individual technology teacher's interpretation and implementation approaches to the learning area. We eagerly anticipate that ITE students would bring increased understandings of learning about technology education alongside evidence of a developing technological literacy (Ministry of Education, 2007).

This paper has documented the research and findings from a collaborative research project into ITE students' initial understandings of technology education. Initial teacher education courses have been altered as a result of these findings. Data will contribute to findings of the same study undertaken by five other leading universities in New Zealand, to provide a national view of technology education efficacy since its inception. It is anticipated that these findings will not only inform ITE programme design, but will contribute valuable material to influence future curriculum development to meet the needs of all New Zealand teachers and learners in technology education.

After many years of technology education the bar needs to be raised, as many students are entering their initial teacher education courses with a well-developed personal construct of technology. Rather than spending valuable lecture time devoted to explaining the meaning of technology and technology education, emphasis can now be placed on how to put this knowledge into practise.

A traditional New Zealand Maori proverb reminds us of the importance to *Whaowhia te kete matauranga* (fill the basket of knowledge).

5.1 Acknowledgement

This data was initially presented at the Technology Education New Zealand (TENZ) Conference in October 2015. The writers would like to acknowledge and thank those who provided feedback at this conference which greatly assisted in the formation of this paper. The writers would also like to acknowledge the financial support of the University of Auckland, Faculty of Education who funded data entry, final analysis and conference attendance.

6. References:

Amirshokoohi, A. (2016). Impact of STS issue oriented instruction on pre-service elementary teachers' views and perceptions of science, technology, and society. *International Journal of Environmental and Science Education, 11*(4), 359-387. doi:10.12973/ijese.2016.324a

Ankiewicz, P., van Rensburg, S., & Myburgh, C. (2001). Assessing the attitudinal technology profile of South African learners: A pilot study. *International Journal of Technology and Design Education, 11*(2), 93-109. doi:10.1023/A:1011210013642

Ardies, J., De Maeyer, S., & Gijbels, D. (2013). Reconstructing the pupils attitude towards technology-survey. *Design and Technology Education: An International Journal, 18*(1), 8-19.

Autio, O., Soobik, M., Thorsteinsson, G., & Olafsson, B. (2015). The development of craft and technology education curriculums and students' attitudes towards technology in Finland, Estonia and Iceland. *International Journal of Contemporary Educational Research, 2*(1), 22-34.

Bame, E. A., Dugger, W., de Vries, M., & McBee, J. (1993). Pupils' attitudes toward technology-PATT-USA. *Journal of Technology Studies, 19*(1), 40-48.

Barak, M. (2006). Engineering and excellence: An old-new agenda for technology education in the Israeli high schools. In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 477-486). Rotterdam: Sense Publishers.

Bennett, D. A. (2001). How can I deal with missing data in my study? *Australian and New Zealand Journal of Public Health, 25*(5), 464-469. doi:10.1111/j.1467-842X.2001.tb00294.x

Brown, R. A., & Brown, J. W. (2010). What is technology education? A review of the "Official Curriculum". *The Clearing House: A Journal of Educational Studies, 83*(2), 49-53. doi:10.1080/00098650903505449

Clark, S. C. (1989). The industrial arts paradigm: Adjustment, replacement, or extinction? *Journal of Technology Education, 1*(1), 7-21.

Cliff, N. (2014). *Ordinal methods for behavioral data analysis*. New York, NY: Psychology Press.

Compton, V., & Compton, A. (2011). Progression in the knowledge and philosophy of technology. In M. de Vries (Ed.), *Positioning Technology Education in the Curriculum* (Vol. 8, pp. 191-216). Rotterdam: Sense.

Compton, V., & Compton, A. (2013). Teaching the nature of technology: determining and supporting student learning of the philosophy of technology. *International Journal of Technology and Design Education, 23*(2), 229-256. doi:10.1007/s10798-011-9176-2

Compton, V., & Harwood, C. (2006). *Discussion document: Design ideas for future technology programmes*. Wellington, New Zealand: Ministry of Education Retrieved from http://www.tki.org.nz/r/nzcurriculum/draft-curriculum/technology_e.php.

Compton, V., & Jones, A. (2004, November). The Nature of Technology: Briefing paper prepared for the New Zealand Ministry of Education curriculum project Retrieved from http://www.tki.org.nzcurriculum/whats_happening/index_e.php

Constantinou, C., Hadjilouca, R., & Papadouris, N. (2010). Students' epistemological awareness concerning the distinction between science and technology. *International Journal of Science Education, 32*(2), 143-172. doi:10.1080/09500690903229296

Dakers, J. (2005). Technology education as solo activity or socially constructed learning. *International Journal of Technology and Design Education, 15*(1), 73-89.

Davies, T. (2000). Confidence! Its role in the creative teaching and learning of design and technology. *Journal of Technology Education, 12*(1), 18-31.

de Klerk Wolters, F. (1989). A PATT study among 10 to 12-year-old students in the Netherlands. *Journal of Technology Education, 1*(1).

de Vries, M. (2005). Teaching about technology. An introduction to the philosophy of technology for non-philosophers. Dordrecht, Netherlands: Springer.

de Vries, M. (2006). Two decades of technology education in retrospect. In M. de Vries & I. Mottier (Eds.), *International handbook of technology education* (pp. 3-11). Rotterdam: Sense Publishers.

Dewey, J. (1938). *Experience in education*. New York, NY: Macmillan.

Education.govt.nz. (2016). Digital technology to become part of the New Zealand Curriculum and Te Marautanga o Aotearoa. Retrieved from http://www.education.govt.nz/news/digital-technology-to-become-part-of-the-new-zealand-curriculum-and-te-marautanga-o-aotearoa/

Ferguson, D. (2009). *Development of technology education in New Zealand schools 1985-2008*. Wellington, New Zealand: Ministry of Education.

Forret, M., Edwards, R., Lockley, J., & Nguyen, N. (2013, 2-6 Dec). *Pre-service teachers' perceptions of technology and technology education.* Paper presented at the PATT 27, Technology Education for the Future: A play on sustainability, Christchurch, New Zealand.

Forret, M., Fox-Turnbull, W., Granshaw, B., Harwood, C., Miller, A., O'Sullivan, G., & Patterson, M. (2013). Towards a pre-service technology teacher education resource for New Zealand. *International Journal of Technology and Design Education, 23*(3), 473-487. doi:10.1007/s10798-011-9199-8

France, B., & Compton, V. (2012). Bringing communities together. In B. France & V. Compton (Eds.), *Bringing Communities Together* (pp. 1-14). Rotterdam: Sense.

Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association, 32*(200), 675-701.

Granshaw, B. (2015). Perspectives on Technology Education in New Zealand: Twenty years of progress? *Australasian Journal of Technology Education, 2*(1), 2-14. doi:10.15663/ajte.v2i1.26

Hache, G. (2006). Developments in technology education in Canada. In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 171-177). Rotterdam: Sense Publishers.

Hathaway, D., & Norton, P. (2016, March 21-26). *A preservice secondary education technology course: Attitudes, knowledge, and learner outcomes.* Paper presented at the Society for Information Technology & Teacher Education International Conference, Savannah, GA,.

Head, G., & Dakers, J. (2005). Verillon's Trio and Wenger's community: Learning in technology education. *International Journal of Technology and Design Education, 15*(1), 33-45. doi:10.1007/s10798-004-6194-3

Hobson, A. J., Malderez, A., Tracey, L., Giannakaki, M., Pell, G., & Tomlinson, P. D. (2008). Student teachers' experiences of initial teacher preparation in England: Core themes and variation. *Research Papers in Education, 23*(4), 407-433. doi:10.1080/02671520701809825

Hopken, G. (2006). Stages of 30 years of technology education in Germany. In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 417-427). Rotterdam: Sense Publishers.

Institute of IT Professionals NZ. (2016). Digital Sciences Learning Area. Retrieved from http://iitp.nz/files/IITP Digital Sciences.pdf

Jones, A. (1997). Recent research in learning technological concepts and processes. *International Journal of Technology and Design Education, 7*, 83-96.

Jones, A., Buntting, C., & de Vries, M. (2011). The developing field of technology education: A review to look forward. *International Journal of Technology and Design Education, 23*, 1-22. doi:10.1007/s10798-011-9174-4

Jones, A., Buntting, C., & de Vries, M. (2013). The developing field of technology education: A review to look forward. *International Journal of Technology and Design Education, 23*(2), 191-212. doi:10.1007/s10798-011-9174-4

Jones, A., & Carr, M. (1992). Teachers' perceptions of technology education: Implications for classroom innovation. *Research in Science Education, 22*, 230-239.

Jones, A., & Compton, V. (2009). Reviewing the field of technology education in New Zealand. In A. Jones & M. de Vries (Eds.), *International handbook of research and development in technology education* (pp. 105-116). Rotterdam: Sense.

Kagan, D. M. (1992). Implication of research on teacher belief. *Educational psychologist, 27*(1), 65-90. doi:10.1207/s15326985ep2701_6

Kananoja, T. (2009). Technology education in general education in Finland. In A. Jones & M. de Vries (Eds.), *International handbook of research and development in technology education* (pp. 51-64). Rotterdam: Sense.

Kaplan, D. (2009). *Readings in the philosophy of technology* (D. Kaplan Ed. 2nd ed.). Lanham, MD: Rowman & Littlefield.

Kinash, S., & Kordyban, R. (2012). Breaking the log-jam: Teaching the teachers about technology. *Learning and Teaching Papers*(46), 58-60.

Kipperman, D. (2006). Science and technology links in the Israeli secondary schools-do we have a reason to celebrate? In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 487-497). Rotterdam: Sense Publishers.

Knezek, G., Christensen, R., & Tyler-Wood, T. (2011). Contrasting perceptions of STEM content and careers. *Contemporary Issues in Technology and Teacher Education, 11*(1), 92-117.

Koster, B., Brekelmans, M., Korthagen, F., & Wubbels, T. (2005). Quality requirements for teacher educators. *Teaching and Teacher Education, 21*(2), 157-176. doi:10.1016/j.tate.2004.12.004

Lawal, A. W. (2014). Technical and vocational education, a tool for national development in Nigeria. *International Letters of Social and Humanistic Sciences (ILSHS), 3,* 53-59.

Layton, D. (1993). *Technology's Challenge to Science Education*. London: Open University Press.

Leahy, K., & Phelan, P. (2014). A review of Technology Education in Ireland; a changing technological environment promoting design activity. *International Journal of Technology and Design Education, 24*(4), 375-389. doi:10.1007/s10798-014-9266-z

Lee, K. (2003). So what do parents want and expect from a technology education programme? - An exploration. *International Journal of Technology and Design Education, 13*(2), 105-115.

Lee, K. (2011). Looking back, to look forward: Using traditional cultural examples to explain contemporary ideas in Technology Education. *Journal of Technology Education, 22*(2), 42-52.

Lei, J. (2009). Digital natives as preservice teachers: What technology preparation is needed? *Journal of Computing in Teacher Education, 25*(3), 87-97. doi:10.1080/10402454.2009.10784615

Lewis, T. (1995). From manual training to technology education: the continuing struggle to develop a school subject in the USA. *Journal of Curriculum Studies, 27*(6), 621-645. doi:10.1080/0022027950270603

Little, R. J. A. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association, 83*(404), 1198-1202. doi:10.1080/01621459.1988.10478722

Löfström, E., & Poom-Valickis, K. (2013). Beliefs about teaching: Persistent or malleable? A longitudinal study of prospective student teachers' beliefs. *Teaching and Teacher Education, 35*, 104-113. doi:10.1016/j.tate.2013.06.004

Lonsdale, M., & Anderson, M. (2012, March). Preparing 21st century learners: The case for school-community collaborations. *ACER Occasional Essays.* Retrieved from http://research.acer.edu.au/cgi/viewcontent.cgi?article=1015&context=policy_analysis_misc

Lonsdale, M., Deery, A., Clerke, S., Anderson, M., Curtin, E., Knight, P., & Bramich, M. (2011). *The benefits of school–business relationships*. Australian Council for Educational Research.

Martin, G., & Ritz, J. (2012). Research needs for technology education: A US perspective. *Journal of Technology Education, 23*(2), 25-43.

Mattheoudakis, M. (2007). Tracking changes in pre-service EFL teacher beliefs in Greece: A longitudinal study. *Teaching and Teacher Education, 23*(8), 1272-1288. doi:10.1016/j.tate.2006.06.001

Mawson , B. (1999). *In search of the missing strand: Technology and society*. Paper presented at the TENZ Conference, Auckland.

Mc Glashan, A. A., & Wells, A. W. J. (2013). The road less travelled: A pre-service approach towards the technology teaching profession. *International Journal of Technology and Design Education, 23*(4), 1-14. doi:10.1007/s10798-012-9218-4

McRobbie, C., Ginns, I., & Stein, S. (2000). Preservice primary teachers' thinking about technology and technology education. *International Journal of Technology and Design Education, 10*(1), 81-101.

Medway, P. (1989). Issues in the theory and practice of technology education. *Studies in Science Education, 16*, 1-24. doi:10.1080/03057268908559958

Ministry of Education. (1995). *Technology in the New Zealand curriculum*. Wellington, N.Z.: Learning Media.

Ministry of Education. (2001). *Design and Graphics Technology. A resource for teachers of years 1-8*. Wellington, N.Z.: Learning Media.

Ministry of Education. (2007). *The New Zealand Curriculum*. Wellington, New Zealand: Learning Media, Ministry of Education.

Mrayyan, S. (2016). Investigating mathematics teachers' role to improve students’ creative thinking. *American Journal of Educational Research, 4*(1), 82-90. doi:10.12691/education-4-1-13

Ng, W., Nicholas, H., & Williams, A. (2010). School experience influences on pre-service teachers' evolving beliefs about effective teaching. *Teaching and Teacher Education, 26*(2), 278-289. doi:10.1016/j.tate.2009.03.010

Novakova, N. (2006). Innovation of the concept and content of technology education in the Czech Republic in context with their development in the countries of Central Europe. In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 463-476). Rotterdam: Sense Publishers.

O'Neill, J. (2012). Rationality and rationalisation in teacher education policy discourse in New Zealand. *Educational Research, 54*(2), 225-237. doi:10.1080/00131881.2012.680046

OECD. (2006). Evolution of student interest in science and technology studies. Paris, France: Organisation for Economic Co-operation and Development, Global Science Forum.

Pallant, J. (2011). *SPSS survival manual: a step by step guide to data analysis using SPSS*. New South Wales: Allen & Unwin.

Parata, H. (2016). NZ Curriculum to include digital technology.   Retrieved from https://www.beehive.govt.nz/release/nz-curriculum-include-digital-technology

Pavlova, M. (2005). Social change: how should technology education respond? *International Journal of Technology and Design Education, 15*(3), 199-215. doi:10.1007/s10798-004-5867-2

Pavlova, M. (2006). Comparing perspectives: Comparative research in technology education. In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 19-32). Rotterdam, Netherlands: Sense.

Petrina, S., & Volk, K. (1995). Industrial arts movement's history, vision, and ideal: Relevant, contemporary, used but unrecognized-part II. *Journal of Technology Studies, 21*(2), 28-35.

Pöllänen, S., & Urdziņa-Deruma, M. (2017). Future-oriented reform of craft education. In E. Kimonen & R. Nevalainen (Eds.), *Reforming Teaching and Teacher Education* (pp. 117-144). Rotterdam, Netherlands: Springer.

Prensky, M. (2004). The emerging online life of the digital native. Retrieved from http://slo.sbcc.edu/wp-content/uploads/prensky-the_emerging_online_lif.pdf

R Core Team. (2015). R: A language and environment for statistical computing. Retrieved from http://www.r-project.org/

Reddy, V., Ankiewicz, P., de Swardt, E., & Gross, E. (2003). The essential features of technology and technology education: A conceptual framework for the development of OBE (Outcomes Based Education) related programmes in technology education. *International Journal of Technology and Design Education, 13*(1), 27-45. doi:10.1023/A:1022386602537

Rennie, L. (1987). Teachers' and pupils' perceptions of technology and the implications for the curriculum. *Research in Science and Technological Education, 5*(2), 121-133.

Rennie, L., & Jarvis, T. (1995). Three approaches to measuring children's perceptions about technology. *International Journal of Science Education, 17*(6), 755-774.

Rohaan, E. J., Taconis, R., & Jochems, W. M. (2010). Reviewing the relations between teachers' knowledge and pupils' attitude in the field of primary technology education. *International Journal of Technology and Design Education, 20*(1), 15-26. doi:10.1007/s10798-008-9055-7

Romano, J., Kromrey, J. D., Coraggio, J., & Skowronek, J. (2006). *Appropriate statistics for ordinal level data: Should we really be using t-test and Cohen'sd for evaluating group differences on the NSSE and other surveys?* . Paper presented at the Annual meeting of the Florida Association of Institutional Research.

Saban, A., Kocbeker, B. N., & Saban, A. (2007). Prospective teachers' conceptions of teaching and learning revealed through metaphor analysis. *Learning and instruction, 17*(2), 123-139. doi:10.1016/j.learninstruc.2007.01.003

Sanders, M. (2009). Stem, stem education, stemmania. *The technology teacher, December/January*, 20-26.

Sanger, M. N., & Osguthorpe, R. D. (2011). Teacher education, preservice teacher beliefs, and the moral work of teaching. *Teaching and Teacher Education, 27*(3), 569-578. doi:10.1016/j.tate.2010.10.011

Shulman, L. (1987). Knowledge and teaching: foundations of the new reform. *Harvard Educational Review, 57*(1).

Sjøberg, S., & Schreiner, C. (2010). The ROSE project: An overview and key findings (pp. 1-31). Oslo, Sweden: University of Oslo.

Skophammer, R., & Reed, P. A. (2014). Technological Literacy Courses in Pre-Service Teacher Education. *The Journal of Technology Studies, 40*(2), 68-81.

Slatter, W., & France, B. (2011). The teacher–community of practice–student interaction in the New Zealand technology classroom. *International Journal of Technology and Design Education*, *21*(2), 149-160. doi:10.1007/s10798-009-9111-y

Stein, S., McRobbie, C., & Ginns, I. (2002). Implications of missed opportunities for learning and assessment in design and technology education. *Teaching and Teacher Education*, *18*(1), 35-49. doi:10.1016/S0742-051X(01)00049-X

Stevens, A. (2009). The introduction and development of technology education in South Africa. In A. Jones & M. de Vries (Eds.), *International handbook of research and development in technology education* (pp. 131–137). Rotterdam: Sense.

Tanase, M., & Wang, J. (2010). Initial epistemological beliefs transformation in one teacher education classroom: Case study of four preservice teachers. *Teaching and Teacher Education*, *26*(6), 1238-1248. doi:10.1016/j.tate.2010.02.009

Torchiano, M. (2015). Cliff's delta effect size for ordinal variables. Retrieved from http://www.inside-r.org/packages/cran/effsize/docs/cliff.delta

Varda, B., Koren, P., Rubin, E., & Buck, A. G. (2013). Changing the image of scientists among college students in Israel. *American Journal of Educational Research*, *1*(9), 396-405. doi:10.12691/education-1-9-8

Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. *Cambridge: Cambridge University Press*.

Wicklein, R. C. (2006). Five good reasons for engineering as the focus for technology education. *The Technology Teacher*, *65*(7), 25-29.

Williams, J. (2006). Technology education in Australia: Twenty years in retrospect. In M. de Vries & I. Mottier (Eds.), *International Handbook of Technology Education* (pp. 183-196). Rotterdam: Sense Publishers.

Williams, J. (2011). STEM education: Proceed with caution. *Design and Technology Education: An International Journal*, *16*(1), 26-35.