Have We Arrived Yet? Ascertaining Initial Teacher Education Student Understandings of Technology and Technology Education.

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Abstract

Technology in the New Zealand Curriculum aims to develop in students 'a broad technological literacy' (Ministry of Education, 2007, p.32) to be able to contribute to and interact with a changing technological society. After twenty years of technology being a compulsory part of the New Zealand national curriculum framework, there is an expectation that school leavers will demonstrate a developed or developing technological literacy.

This paper presents research findings of student perceptions of technology and technology education at the threshold of their Initial Teacher Education (ITE). Students are studying to be teachers of technology across early childhood, primary and secondary sectors at the

Faculty of Education, University of Auckland. This paper also contributes to nationwide findings on student perceptions that will inform the development of ITE programmes across all institutions in New Zealand. To facilitate the development of a rich, culturally responsive pedagogy for ITE in technology, it is imperative that programme planning identifies a starting point that aligns with and extends student prior learning.

Findings provide some understanding of the school community interpretation and implementation of the learning area of technology. They also set a benchmark to initiate learning within the distinct philosophical stance necessary to support ITE students as they develop their technological literacy and a culturally responsive pedagogy.

Keywords: *Initial Teacher Education (ITE), technological literacy, student perceptions, personal constructs.*

Introduction

A main intent in learning about technology is that at best it will empower our young to contribute to their future society and environment (Fox-Turnbull, 2010; Jones, Buntting, & de Vries, 2013; O'Sullivan, 2010). It is timely after many years of teaching and learning in our school communities and two curricular iterations (Ministry of Education, 1995, 2007) that we identify and trace the key attributes in learning about technology towards empowerment. Such attributes provide a base line to underpin all teaching and learning to meet this end and to eventually develop technological literacy.

It is also expedient that with impending national learning area reviews, we focus on the crux of technology learning by reviewing the effectiveness of ITE. When establishing a starting point for ITE programme design in technology education it is helpful to explore student feed-in perceptions, to inform initial stage planning.

This research project investigates ITE student perceptions of technology and technology education. The main aim is to establish whether there has been an increase over recent years of a common understanding of the broad intent of the term technology and the nature of technology education. A subsidiary aim is to establish key influences that have guided student perceptions through their own life experiences and schooling or vocational training.

Methods

Technology lecturers from the six main ITE providers within New Zealand (Auckland, Canterbury, Massey, Otago, Victoria, and Waikato universities) jointly developed a framework that later informed technology teacher education practice throughout NZ (Forret et al., 2013).

This framework highlights the need for teachers to have a base understanding of what technology and technology education are about. In 2010 six ITE providers agreed to participate in joint research to investigate the personal constructs of their students. Each institution contributed to the development of a questionnaire which was subsequently used to gather data about the entry and exit knowledge of students. This information was used initially to inform practice at each university.

After gaining ethics approval the University of Auckland piloted the questionnaire with one cohort of technology students, and the following year all technology students were invited to participate in the research.

Prior to any instruction on the first day of class, research participants (student teachers) were invited to complete an anonymous questionnaire about their perceptions of technology, their attitudes towards technology, and experiences that shaped their perceptions of technology. The initial pre-service programmes were the Bachelor of Teaching and the Graduate Diploma: early childhood education, primary, secondary.

Research question

The aim of this research investigated:

> What are pre-service teachers' perceptions of, and attitudes towards, technology and technology education on entry to their teacher education programme?

This was both an exploratory and descriptive study (Neuman, 2003). Use of SPSS analysis enabled the quantitative research to take two forms. Initially the data were used to describe current students' understandings of technology and technology education (descriptive research) (Mutch, 2005). In addition due to the large number of participant responses, SPSS analysis enabled the exploration of differences between factors such as age groups, qualifications, sectors etc. In this way the research became correlational (Mutch, 2005).

Data Analysis

Statistical Package for the Social Sciences (SPSS) 21 was used for the majority of data analysis. Data were screened, cleaned and missing data reviewed (Pallant, 2011). The mean of each variable was never inserted to replace missing data as this can severely distort analysis results (Field, 2009). For this reason the number of participant responses (n) varies between questions as participants did not answer every question.

Frequencies were established for age, gender, course and qualifications being undertaken and whether participants had obtained NCEA credits in technology. Data were presented in frequency and percentages of the total participants. Due to the categorical and ordinal nature of this data, nonparametric statistical analysis was undertaken. When comparing responses between two categorical groups (the sectors and views regarding science and technology) Chi-square tests were performed. When reporting these results the Pearson chi-square value and the level of significance (p) are stated.

When comparing responses between two independent groups (such as those under and over 25) Mann-Whitney U tests were performed. When reporting these results the median, U, Z (if sample size bigger than 30), level of significance (p) and r values are stated. A Kruskal Wallis one-way analysis of variance by ranks was conducted to determine whether differences in opinions were linked with sectors. When reporting these results, the Chi-square value, degrees of freedom (df), mean rank, and p values are reported. A p value of less than 0.05 was considered to be significant (Pallant, 2011).

In order to investigate possible differences in the opinions between those who had attended school after the introduction of the technology curriculum and those who attended school prior to the introduction of the 1995 technology curriculum the total cohort was split into two groups. The first group of 276 students (61%) were aged 17-24 and would have experienced education with technology as a compulsory learning area. The remaining 175 students (39%) were 25 or older, and may have experienced some or no technology education. Frequency data were provided for this group and analysis repeated. As an extensive number of questions were asked, only the statistically significant findings are reported.

In order to investigate whether findings differed between those in the early childhood, primary or secondary sectors the above analysis was repeated. This required transforming the variables to ensure that all students in the primary sector were coded under the one variable. In doing so, students from various pathways were grouped together. For example data from students in the three year BEd were grouped with those completing a 1 year graduate diploma because they were all exiting into the primary teaching sector.

Results

Participants

The following information provides a brief overview of the participants. In total 451 participants were involved in the research but they did not complete every question. For this reason there are slight variations in the total number of participants in the following analysis. As shown in Table 1, the majority (83%) of the participants were female and 274 (62%) participants were less than 25 years old. As discussed above, these students would probably have only experienced a schooling system containing technology education.

Table 1: *Proportion of Male and Female Participants at Each age Group Level*

		Gender		Total *n*(% of total)
		Male *n*(% of total)	Female *n*(% of total)	
Age	17-24	42(10%)	232(52%)	274(62%)
	25-30	16(4%)	55(12%)	71(16%)
	31-36	59(1%)	30(7%)	35(8%)
	37+	13(3%)	51(12%)	64(14%)
Total		76(17%)	368 (83%)	444 (100%)

Whilst 327 (73%) students were from the primary sector, 211 (47%) were undertaking a three year Bachelor of Education (BEd), and 116 (26%) a one year postgraduate diploma in primary teaching. The remaining 122 (27%) students were from the early childhood education sector (ECE). These students were comprised of 36 (8%) who were completing a one year graduate diploma, 49 (11%) were completing a three year BEd ECE and 23 (5%) were completing a three year Pasifika BEd ECE degree but were in the Pasifika pathway. There were 15 students

(3%) completing a one year postgraduate diploma in secondary teacher education. Only 24% of participants had achieved NCEA technology credits and the majority of these (82%) were under the age of 25.

Results

The majority of the participants (n=378, 84%) thought technology was 'very important' or, 'extremely important', with only one person (0.2%) thinking it was not at all important as shown in Table 2.

Table 2 *Participants' Views on the Importance of Technology to New Zealand*

	How important is technology to NZ as a country					Total *n*
	Not at all important *n*(% of total)	Minor importance *n*(% of total)	Moderately important *n*(% of total)	Very important *n*(% of total)	Extremely important *n*(% of total)	
Total	1 (0.2%)	5 (1%)	64 (14%)	180 (40%)	198 (44%)	448

Most students believed technology had a heavy focus on *computers* (70%), 'c*reativity, design, showing others your ideas*' (59%) and '*thinking about the impact of technology*' (59%). Many thought technology was not about '*learning what experts in the community do in their job,*' with over 23% believing this was not or only a marginal focus in technology and the low figure of 17% believing it was a heavy focus of technology, as shown in Table 3.

Students saw commonalities between science and technology as shown in Table 4. For the notions of *problem-solving*, 341 students (76%) thought this applied to both science and technology, whilst 369 (82%) thought *learning new things* and 384 (85%) thought *gaining new knowledge* also applied to both science and technology. Students believed technology or 'science and technology' applied to *making things, creativity, learning about new inventions, planning and designing, and investigating traditional Maori and Pasifika ways*. Experimentation was the only notion identified as being more applicable to science than to technology.

Table 3 *Students' Responses to Questions Investigating what Technology is Mostly about*

	What is technology most about..?			Total *n*(% of total)
	No/marginal focus *n*(% of total)	Some focus *n*(% of total)	Heavy focus *n*(% of total)	
Woodwork,metalwork,sewing,cooking	51(12%)	262(60%)	127(29%)	440(98%)
Computers	10(2%)	125(28%)	312(70%)	447(99%)
Problemsolving	21(5%)	203(45%)	216(48%)	440(98%)
Creativity,design, showing others your ideas	12 (3%)	165 (37%)	265(59%)	442 (98%)
Thinking about the impact of technology	11(25)	162(36%)	267(59%)	440(98%)
Learning about new inventions	30(7%)	219(49%)	191(42%)	440(98%)
Learning about technology over time, place, cultures	36(8%)	222(49%)	186(41%)	444(98%)
Planning & making things	20(4%)	199 (44%)	221(49%)	440(98%)
Learning about electronics and machines	23(5%)	230(51%)	189(42%)	442(98%)
Learning what experts in the community do in their job	103(23%)	264(59%)	75(17%)	442(98%)
Learning about resources/materials	29(6%)	245 (54%)	165 (36%)	439 (97%)
Learning what it means to do technology				
Learning how parts of machines & systems work	34(8%)	223(49%)	183(41%)	440(98%)
	53(12%)	225(50%)	161(36%)	439(97%)

Table 4 *Students' Responses to Questions Investigating Notions Applicable to Science, Technology or Both.*

	What applies to science and which to technology?		
	Science *n*(% of total)	Technology *n*(% of total)	Science and Technology *n*(% of total)
Experiments	210 (47%)	0	236 (52%)
Making things	20(4%)	213 (47%)	212 (47%)
Problem-solving	38 (8%)	66 (15%)	341 (76%)
Creativity	14 (3%)	244 (54%)	188(42%)
Considering the impact of our actions on others	104 (23%)	85 (19%)	248 (55%)
Learning about new inventions	34 (8%)	158 (35%)	251 (56%)
Risk-taking	83 (18%)	74(16%)	284(63%)
Planning and design	6 (1%)	231(51%)	207(46%)
Learning new things	32(7%)	42(9%)	369(82%)
Gaining new knowledge	36(8%)	21(5%)	384(85%)
Investigating traditional Maori and Pasifika ways	68(15%)	188(42%)	164(36%)

A large proportion of the students 'agreed' or 'strongly agreed' with the statements *Technology is a small factor in everyday life* (71%) and *Science & technology are basically one and the same thing* (56%). This contrasts with the 199 students (44%) who believed *Engineering & technology is basically one and the same thing*. Many students 'disagreed' or 'strongly disagreed' with the statements *Results of technology can be good or bad* (71%), *Humans often develop new technologies to improve upon previous ones* (86%) *and Design is a process to turn ideas into products* (81%), as shown in Table 5.

Table 5 *Students' Responses to Questions Investigating the Strength of Their Beliefs and Values Regarding Aspects Related to Technology*.

	Strongly agree n(% of total)	Agree n(% of total)	Neutral n(% of total)	Disagree n(% of total)	Strongly disagree n(% of total)	Total n(% of total)
Technology is a small factor in everyday life	209(46%)	111(25%)	55(12%)	40(9%)	27(6%)	442(98%)
Engineering & technology are same	59(13%)	140(31%)	177(40%)	50(11%)	12(3%)	438(97%)
Results of technology can be good or bad	11(25)	8(2%)	106(24%)	130(29%)	187(42%)	442(98%)
Science & technology are same	97(22%)	151(34%)	127(28%)	50(11%)	14(3%)	439(97%)
Humans develop new technologies to improve one old	6(1%)	8(2%)	41(9%)	159(35%)	228(51%)	442(98%)
Technology can solve environmental problems	31(7%)	104(23%)	199(44%)	81(18%)	25(6%)	440(98%)
Design is a process to turn ideas into products	2(4%)	10(2%)	63(14%)	190(42%)	176(39%)	441(98%)

Results relating to age and presumed experience with technology education

Fifty-five percent (n=42) of all males were under 25 years old. Due to the large number of females, these males only accounted for 10% of the entire group of participants. Sixty-three percent (n=232) of the females were under 25, and accounted for 52% of the entire participants, as shown in Table 6.

A Mann-Whitney U test indicated that those 25 years and older thought technology was less important to NZ (Mdn= 5) compared with students who were under 25 (Mdn=4), U=18310 p<0.001, r=0.21. These same tests also indicated that students under 25 believed *technology was more about computers* (Mdn=3, mean rank score of) than those who were 25 or over (Mdn=3), U= 19738 p<0.001, r= 0.18. More students 25 and over believed *technology had a heavy emphasis on problem-solving* (Mdn=3) compared with those who were under 25 years old (Mdn=2), U= 19330 p=0.002, r= 0.15. More students 25 and over also believed *technology had a heavy emphasis on learning what experts in the community did in their job* (Mdn=2, mean rank score= 236) compared with those who were under 25 years old (Mdn=2, mean rank score =212), U= 20623 p=0.03, r= 0.10. No other significant differences were found using Mann-Whitney U tests for the remaining questions investigating the subject of technology.

Table 6 *Distribution of Males and Females Who Were Younger or Older than 25 Years*.

		Gender		Total (%of all participants)
		Male	Female	
	Under 25 years old	42 (10%)	232 (52%)	274 (62%)
	25 years old or over	34 (8%)	136 (31%)	170 (38%)
Total		76 (17%)	368 (83%)	444 (100%)

Table 7 *Participants' Views of Aspects that Apply to Science only, Technology only, or both Science and Technology*.

		What applies to science and which to technology?		
		Science *n*(% of age bracket)	Technology *n*(% of age bracket)	Science & Technology *n*(% of age bracket)
Problem-solving	Under 25	31 (11%)	47 (17%)	193 (71%)
	25 & over	7 (4%)	19 (11%)	148 (85%)
	TOTAL	38 (8%)	66 (15%)	341 (76%)
Creativity	Under 25	7 (4%)	175(64%)	90(33%)
	25 & over	7(2%)	69(40%)	98(56%)
	TOTAL	14 (3%)	244 (54%)	188(42%)
Learning new things	Under 25	25(9%)	20(7%)	226(61%)
	25 & over	7(4%)	22(13%)	143(39%)
	TOTAL	32(7%)	42(10%)	369(83%)
Investigating traditional Maori and Pasifika ways	Under 25	35(14%)	129(51%)	88(35%)
	25 & over	33(20%)	59(35%)	76(45%)
	TOTAL	68(16%)	188(45%)	164(39%)

When investigating the two age groups views' of notions about science in relation to technology, four aspects were found to be significantly different. The Chi-square value was 12.4 with *p*=0.002 for *problem solving*, 26.1 with *p*<0.001 for *creativity*, 7.1 with *p*=0.03 for *learning new things* and 10.6 with *p*=0.005 for *investigating traditional Maori and Pasifika ways*. Descriptive values for these aspects are provided in Table 7.

No significant differences were found between the two age groups for any of the questions related to values and beliefs about technology education.

Results relating to education sector and understandings of technology education

The majority (61%) of the students in each of the education sectors were under 25, whilst 72 (16%) were between the ages of 25 and 30 as shown in Table 8. Of the 64 (14%) students who were more mature and over 37 years of age, 47 (10%) were in the primary sector.

Table 8 *Distribution of Males and Females in Each Sector*

		Age				Total
		17-24	25-30	31-36	37+	
Sectors (courses)	ECE (111, 111PK, 635)	75 (17%)	9 (2%)	10 (2%)	14 (3%)	108 (24%)
	Primary (107, 628)	192 (43%)	62 (14%)	27 (6%)	47 (10%)	328 (72%)
	Secondary (641, 639)	9 (2%)	1 (0.2%)	2 (0.4%)	3 (0.7%)	15 (3%)
Total		276 (61%)	72 (16%)	39 (9%)	64 (14%)	451 (100%)

The majority of the males (90%) were enrolled in the three-year primary teacher education sector, whilst 70% of all the females were in this sector. Only 5% of the ECE sector and 20% of the secondary sector were males, as shown on Table 9.

As there were three sectors, a Kruskall-Wallis test was used rather than a Mann-Whitney U test to investigate differences in opinions of the importance of technology, the values and beliefs associated with the subject and what the subject entailed. No significant differences were identified between the sectors for the question relating to how important technology is to New Zealand as a country. Differences were also not found to be at a level of significance between the three sectors for the questions stating technology was mostly about; *computers*, *creativity design and showing others your ideas thinking about the impact of technology, learning about technology over time and place and cultures, learning what experience in the community do in the job, learning about resources and materials* and *learning about what it means to do technology.*

Table 9 *Distribution of Males and Females in Each Sector (Percentages Have Been Rounded to a Full Figure).*

			Gender		Total
			Male	Female	
Sectors	ECE (111, 111PK, 635)	Count	5	101	106
		% within Sectors	5%	95%	100%
		% within Gender	7%	27%	24%
		% of Total	1%	23%	24%
	Primary (107, 628)	Count	68	255	323
		% within Sectors	21%	79%	100%
		% within Gender	90%	69%	73%
		% of Total	16%	57%	73%
	Secondary (641, 639)	Count	3	12	15
		% within Sectors	20%	80%	100%
		% within Gender	4%	3%	7%
		% of Total	1%	3%	4%
Total		Count	76	368	444
		% within Sectors	17%	83%	100%
		% within Gender	100%	100%	100%
		% of Total	17%	83%	100.0%

A Kruskall-Wallis test identified that students in the secondary sector believed technology to have a heavier focus on *woodwork, metalwork, sewing and cooking* (Chi-square =6, df=2, *p*=0.05), p*roblem-solving* (Chi-square =7, df=2, *p*=0.03), and *planning and making* (Chi-square =8, df=2, *p*=0.02) than those in the primary and ECE sectors. In contrast, students in the ECE sector believed technology to a heavier focus on *learning about new inventions* (Chi-square =7, df=2, *p*=0.002), *learning about electronic machines* (Chi-square =9, df=2, *p*=0.01), *learning how parts of machines and systems work* (Chi-square =11, df=2, *p*=0.005) than those in the primary and secondary sectors, as shown in Table 10.

Table 10 *Significant Differences in Understandings about Technology as a Subject Between Students from the Three Sectors*

Technology the subject is mostly about…	**Sectors**			**Chi-Square value**	**Degrees of freedom** *(df)*	**Level of significance** *(p)*
	ECE *(mean rank score)*	**Primary** *(mean rank score)*	**Secondary** *(mean rank score)*			
Woodwork, metalwork sewing, cooking	*211*	*220*	*286*	*6.0*	*2*	*0.05*
Problem solving	*202*	*224*	*277*	*6.8*	*2*	*0.03*
Learning about new inventions	*254*	*211*	*186*	*12.4*	*2*	*0.002*
Planning & making things	*232*	*214*	*288*	*7.7*	*2*	*0.02*
Learning about electronic machines	*249*	*214*	*186*	*8.9*	*2*	*0.01*
Learning how parts of machines & systems work	*251*	*212*	*181*	*10.7*	*2*	*0.005*

A Kruskall-Wallis test identified that more students in the secondary sector believed *Design is a process that can be used to turn ideas into products* (Chi-square =13, df=2, *p*=0.002) more than those in the primary and ECE sectors. A Kruskall-Wallis test also identified that students in the secondary sector disagreed more strongly with the statement *Technology is a small factor in your everyday life* (Chi-square =9, df=2, *p*=0.01) and *Science and technology are basically one and the same* (Chi-square =7, df=2, *p*=0.03) than students in the ECE sectors, as shown in Table 11.

When investigating the views of students from the three sectors about what notions applied to science or technology only, or both science and technology, only one aspect was found to be significantly different. The Chi-square value was 11.5, with *p*=0.02 for the aspect of *making things*. Just over 73% of the secondary respondents associated *making things* with technology, whereas 39% and 50% of the ECE and primary students (respectively) associated it with technology. Almost 9% of the ECE students associated it with science whilst no secondary student thought *making things* applied to science.

Table 11 *Significant Differences in Responses Regarding Beliefs and Values of Technology between Students from the Three Sectors*

Technology the subject is mostly about…	***Sectors***			***Chi-Square value***	***Degrees of freedom*** *(df)*	***Level of significance*** *(p)*
	ECE *(mean rank score)*	***Primary*** *(mean rank score)*	***Secondary*** *(mean rank score)*			
Technology is a small factor in your everyday life	*240*	*219*	*146*	*8.7*	*2*	*0.01*
Science and technology are basically one and the same	*246*	*214*	*176*	*7.3*	*2*	*0.03*
Design is a process that can be used to turn ideas into products	*232*	*213*	*318*	*12.6*	*2*	*0.002*

No significant differences were found between the views of students from the three sectors for notions related to experiments, problem-solving, creativity, considering the impact of our actions on others, learning about new inventions, risk-taking, planning and design, learning new things, gaining new knowledge and investigating traditional Maori and Pasifika ways.

Discussion

Prior to the introduction of the 2007 New Zealand Curriculum, (Ministry of Education, 2007) Compton and Harwood, (2003) observed that learners were "rarely provided with learning programmes that ensured coherent, ongoing development of their knowledge, skills and technological practice" (p. 12). Research into the efficacy of technology education at a national and international level reflects similar varied levels of acceptance, interpretation and implementation in school communities. Educating about technology is still "perceived as a modern development concerned primarily with high-tech electronic-based products and services" (Forret et al. 2013, p. 479). It is therefore expedient for all ITE providers to develop a common philosophy, understanding and approach at a national level to technology education.

Regardless of interpretation and acceptance issues, the learning area of Technology is a compulsory part of the New Zealand curriculum for students up until Year 10 (age 14). How then do we best prepare beginning teachers to meet the demands to teach Technology confidently and effectively at such a complex and uncertain time? Ell (2011) in her research into ITE training noted that there were at that time in New Zealand "15 providers of ITE for primary teachers, offering 32 qualifications. There are nine providers for secondary teachers, offering 15 qualifications" and across the six "main universities" in the country "all offer programmes for both sectors" (p. 435). The findings presented in this paper should add to the foundational building blocks already established amongst key providers.

Teachers' attitudes about a subject have been shown to influence students' understandings and views (Dakers, 2005; Head & Dakers, 2005). It is pleasing, therefore, to see a high proportion of students in this study were generally positive and valued the place technology in New Zealand.

Perceptions of a subject discipline are also very important (Compton & Compton, 2013; Dakers, 2005; Jones et al., 2013; McRobbie, Ginns, & Stein, 2000; Rohaan, Taconis, & Jochems, 2010). Unfortunately this study identified some student misconceptions relating to technology. These included a heavy emphasis on computers, thinking the subject did not involve learning about the community of practice and thinking science and technology was basically one and the same.

It is imperative that teachers have a sound understanding of technology to underpin teaching and learning in technology (de Vries, 2005; Forret, Edwards, Lockley, & Nguyen, 2013; Forret et al., 2013; Kaplan, 2009). Students entering ITE programmes represent the end product of school and individual technology teacher interpretation and implementation approaches to the learning area. We would hope that students entering ITE would therefore demonstrate understandings of learning about technology and some evidence of a developing technological literacy (Ministry of Education, 2007).

It is timely now after two decades of technology education being a contributing part to formal education in New Zealand, that we examine the end result of schooling in technology as students enter tertiary training. Increased focus on the actual kinds of learning required to succeed in the 21st Century also heightens focus on the efficacy of this learning area. It is the new ways of thinking, teaching and learning in technology that drives ITE programme planning for tomorrow's citizens (Many, Howard, & Hoge, 2002; McRobbie, Ginns, & Stein, 2000; Zuga, 2004). Significant differences were identified between those students who were 25 years and over and those who were younger than 25. These younger students would have experienced an education that included learning about technology. Significant differences were also found between students across the different sectors (early childhood, primary, secondary). These differences were detailed in the findings section and therefore will not be replicated is this section. It is important however not to diminish their importance. Lecturers who teach across multiple sectors need to ensure they are familiar with the findings, including the perceptions and misconceptions, prior to developing the course material for each semester.

Conclusion

This paper has documented the research and findings from a small part of this collaborative research project. 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. 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 NZ teachers and learners.

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