'Technologists' Alongside: Impact on Student Understandings in Technology

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Massey University

Palmerston North

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Cliff Harwood

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ABSTRACT

This research focuses on ascertaining the impact of technologists working alongside students; in particular the influence their involvement has on their understandings *of* and *about* Technology.

The research was conducted within an interpretive paradigm. Quantitative and qualitative data were gathered using a mixed methods approach which consisted of a written questionnaire, followed by purposive interviews. The participants in the study were students in years 11 and 12 in 2005. Data from these participants were also gathered in 2006.

The research findings identified that when students work alongside a technologist(s) to resolve problems embedded within real-life contexts, their concepts of technology and its purpose are enhanced. These findings also highlighted the importance of ensuring that student learning intentions (those learning outcomes which are planned) are shared between all parties involved in the learning environment (teachers, practicing technologists and students), so that interactions between students and technologists have a positive influence on student learning.

This research concludes that the involvement of practicing technologists, in student learning in technology education, offers the potential to enhance student's technological practice and their learning in technology generally.

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INTRODUCTION

1.1 Overview of the Chapter

This chapter provides an introduction and background to the research report. Section 1.2 introduces the context in which this research was conducted. The section includes a brief overview of the New Zealand school structure and the history of technology education in senior secondary school. An overview of the technology curriculum, *Technology in the New Zealand Curriculum* [TiNZC] (Ministry of Education, 1995) is presented alongside recent developments for this curriculum. Qualifications for technology in senior secondary (years 11-13) and two projects that are currently supporting the delivery of technology education in New Zealand schools, *Futureintech* and *Growth and Innovation Framework (GIF) - Technology Education* initiative are also presented. Section 1.3 presents a rationale for the research, Section 1.4 the research questions, and Section 1.5 provides an overview of the thesis structure and a discussion on the potential significance of this research.

1.2 Context of this Research

Technology in the New Zealand Curriculum (Ministry of Education, 1995) is now in its tenth year of being offered as a compulsory part of the school curriculum for all students in years 1-10, in New Zealand primary, intermediate and secondary schools.

The New Zealand Secondary School

Secondary schools were established in New Zealand to educate students from school years 9-13[1]. In rural communities and schools of special character (for

[1] New Zealand children begin their compulsory education at age 5. Prior to this they may enrol in Early Childhood Education Centres (ECEC). Children usually enrol in ECEC from age 3.

example private schools, schools based on religious grounds) secondary schools may also include students in years 7-8.

Up to and including year 10, secondary school students receive a compulsory core curriculum, defined by the New Zealand Curriculum Framework (Ministry of Education, 1993a). This includes study in each of the seven Essential Learning Areas – English and Languages, Social Studies, Science, Technology, Mathematics, The Arts, Physical Education and Health. From years 11-13 secondary schools offer a variety of specialist focused subjects to prepare students for ongoing tertiary education and/or entry into the workplace.

Senior secondary students (years 11-13) are provided access to qualifications listed on the New Zealand Qualifications Framework[2] (NZQF). The NZQF was introduced to provide a "system for organizing and understanding the relationships between, and purposes of, qualifications across the education sector" (Ministry of Education, 1999, p.4). As such, the NZQF offers a 'seamless' opportunity for New Zealanders to be awarded qualifications, in secondary schools and in post-school education and training.

The New Zealand Qualifications Authority (NZQA), a government department that is independent of the Ministry of Education (MoE), administers the NZQF. The qualifications on the NZQF specifically available for secondary school students include the National Certificate in Education (NCEA) at Level 1, 2 and 3, and Scholarship. Students access these qualifications by either demonstrating competency against: 'achievement standards' and/or 'unit standards'.

Technology in Secondary Schools

In 1999, *Technology in the New Zealand Curriculum* (Ministry of Education, 1995) was gazetted as a compulsory learning area in New Zealand's national curriculum for all students from years 1-10 and as an optional subject for study in senior secondary school (years 11-13). The aim of technology education as identified in

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[2] The NZQF is comprised of 10 levels – Level 1 is the least complex and Level 10 the most. Levels 1-3 are standards expected of senior secondary education and basic trades training. Levels 4 - 6 approximate to advanced trades, technical and business qualifications. Levels 7 and above approximate to advanced qualifications of graduate and postgraduate standard.

the TiNZC (Ministry of Education, 1995) is to enable students to achieve technological literacy through development of:

- *technological knowledge and understanding;*
- *technological capability;*
- *understanding and awareness of the relationship between technology and society.*

Prior to 2002, the majority of teachers of senior secondary students resisted introducing technology into school curricula, due to there being no qualifications available within general education to credential students for their achievements in technology (Harwood, 2002; Mawson, 1998). This situation was addressed when technology achievement standards were registered on the NZQF and became available for examination in 2002.

TiNZC (Ministry of Education, 1995) is currently being reviewed under the New Zealand Curriculum and Marautanga[3] Project (*NZCMP*). This project is reviewing all compulsory and optional curricula taught in New Zealand schools. The latest draft of the Technology Curriculum Learning Area Introduction[4] (2006) has reframed the 1995 technology strands into three interrelated but distinct strands - understanding the *Nature of Technology*, *Developing Technological Knowledge* and understanding and undertaking *Technological Practice* (Ministry of Education, 2006). The intent of these strands is to allow students to develop a broad technological literacy that enables them to "participate as informed citizens" (Ministry of Education, 2005, p.1).

To provide senior secondary students (years 11-13) access to NCEA qualifications, Level 1-3 technology achievement standards were implemented beginning 2002[5]. A number of the level 2 and 3 achievement standards require students to analyse the technological practice of a professional technologist(s) as a means to informing the

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[3] *Marautanga* is the māori name for the Curriculum Framework that umbrellas the Essential Learning Areas written in Te Reo Māori – New Zealands indigenous language.

[4] The New Zealand Curriculum Project aims to reframe, refocus and revitalise the New Zealand curriculum by clarify what's important for student to learn in the Essential Learning Areas, placing importance on quality teaching, promoting flexible approaches to curriculum and explaining the curriculum to parents. The project aims to implement its revised curriculum in 2007.

[5] Level 1 – 2002
Level 2 – 2003
Level 3 and scholarship - 2004

development of their own technological outcome(s). They also ask students to analyse technological products developed by professional technologists and the production processes used for their manufacture.

Projects supporting Technology Education

Two initiatives, *Futureintech* and *Growth and Innovation Framework – Technology Education Initiative* (GIF- TEI) have recently been introduced in New Zealand. An expected outcome of Futureintech is to assist and support teachers (and students) to create and maintain links between students and practicing technologists. The GIF – TEI aims to enhance student learning in technology by augmenting teacher practice. One identified mechanism for doing this is to increase the participation of practicing technologists, from the business and the tertiary sectors, in student learning in technology.

Futureintech (FiT) is an initiative of the Institution of Professional Engineers New Zealand (IPENZ). It was instigated in 2003 with funding from the New Zealand Trade and Enterprise (NZTE). The NZTE has guaranteed funding for FiT to 2009. Futureintech employs facilitators that assist teachers to establish and maintain industry links with their teaching programmes. The GIF – TEI was launched in April 2005. The Growth and Innovation Framework (GIF), a fund administered by the Ministry of Economic Development, provided the backing for this project. The Beacon Practice- Technology (BPT) project is the largest project to date to come out of the GIF TEI. This project has identified a group of teachers who have consistently provided opportunity for, or have the potential to allow, students to demonstrate 'best practice' in technology. Teachers in this initiative are provided with facilitated professional development, with an expectation that material will be made available to develop into resources and disseminate to all teachers of technology. I am currently contracted by the New Zealand Ministry of Education to provide facilitator support for teachers involved in the BPT project. A focus of this support is to assist teachers to establish links between practicing technologists and their programmes of learning in technology.

1.3 Rationale for this Research

The idea that students' educational outcomes are enhanced when an expert works alongside them is not new. Learning theories such as Anchored Instruction (Vygotsky, 1978), Apprenticeship Model (Rogoff, 1990) and Expert Knowledge Theory (Bereiter, 1992) advocate that modelling by and interaction with experienced practitioners is key to student learning. The TiNZC (Ministry of Education, 1995) statement (see Section 1.2.2) suggests that student learning in technology is benefited when students are provided with an opportunity to work in authentic contexts, by working with communities of technological practice outside of education. Compton and Jones (1998) and Jones and Carr (1993) support this suggestion when they recommend that teachers need to offer students an opportunity to work in authentic contexts in order to experience practices that lead to the development of technological outcomes. Technology achievement standards at Level 3 of the NCEA, registered on the NZCF in 2006, examine the knowledge students attain from analysing the practices of professional technologist. These standards were written to align with TiNZC (Ministry of Education, 1995) and the belief that it is beneficial to have students working with communities of technological practice outside of education.

While providing students with access to practicing technologists has generally been accepted within the technology education community, there is no New Zealand classroom based research that validates this as being beneficial to the development of students understandings *of* or *about* technology. There is also no international classroom based research available that supports this belief.

This research sets out to specifically identify what impact, if any, practicing technologists have on students' understanding of technology and technology education when they work alongside students to resolve 'authentic' issues. The findings of this research will be of interest to projects involved in establishing educational partnerships between practicing technologists and students, which aim to enhance learning opportunities for students in technology. Findings from the research will also be available to inform future planning and policy making for the delivery and assessment of technology at senior secondary school by the MoE and the NZQA, as well as offer a contribution to the international literature on technology education. These findings may also be of assistance to teachers in helping them to make informed decisions about involving practicing technologists in their planning of technology programme(s) and/or its delivery.

No research has been conducted to date that refutes or supports that having practicing technologists participating in student learning in technology is beneficial to their overall learning in technology. This study therefore seeks to address this gap in the literature.

1.4 Research Aim and Questions

The overall aim of this research is to determine if there is an impact on student understandings *of* and *about* technology when practicing technologist(s) are provided opportunity to work alongside them. The research questions were:

1. what are the initial understanding(s) of technology held by senior secondary school students?
2. what are the initial understanding(s) of the purpose of technology education held by senior secondary school students?
3. do these understandings change after students undertake a programme in technology that involves the participation of a practicing technologist(s)?

1.5 Structure of the Research Report

This chapter (*Chapter One*) provided an introduction and background to the research and introduced the aim and objectives of the research.

Chapter Two provides a review of relevant literature upon which this research is based. This literature review presents an overview of Technology Education in the New Zealand Curriculum (Ministry of Education, 1995) and current initiatives that have been introduced to support its delivery. It also considers international and New Zealand research conducted on student understandings/concepts of technology and technology education. The chapter concludes with a brief review of the literature on the learning theories; Anchored Instruction (Vygotsky, 1978), Apprenticeship Model (Rogoff, 1990) and Expert Knowledge Theory (Bereiter, 1992).

Chapter Three explores the literature concerning methodological approaches and research methods in educational research. This literature establishes a methodological framework for the study. The chapter concludes with a description and justification of the methods used in this research, an overview of the participants and discusses the ethical considerations that underpin the research.

Chapter Four presents the research findings obtained from 27 senior secondary school student research participants on their initial understanding(s) of technology and technology education. Both quantitative and qualitative findings are presented from data that were analysed using both statistical analysis, and a thematic approach. The thematic approach allowed common themes to be drawn from written comments to open-ended questions which were presented in a survey questionnaire and follow-up purposive interviews. This chapter ends with a summary of the findings and answers the first two research questions.

Chapter Five presents research findings obtained from 27 senior secondary school student research participants on their understanding(s) of and about technology and technology education post their working alongside practicing technologist(s). Data from the written questionnaire and follow-up interviews with participants were analysed to establish the findings, which were categorised under the common themes identified in *Chapter Four*. The chapter concludes with a summary of the research findings and answers the third research question.

Chapter Six addresses the overall aim from the research findings and explores these findings in relation to the literature presented in *Chapter Two*. This chapter also discusses the implications this research has on using practicing technologists to enhance student learning in technology and how this may impact on future projects such as FiT and GiF- TEI. The chapter ends with suggestions for future research and a concluding comment.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of the Chapter

This chapter shows that no research has been conducted to date in New Zealand classrooms to determine the impact that a practicing technologist has on senior secondary school student's understandings *of* or *about* technology when they work alongside them. Technology programmes that offer Level 3 technology achievement standards however require students to resolve 'client' issues through analysing the practices of professional technologists. This requirement, which is unique within New Zealand's educational context, has little international literature to draw upon to demonstrate how this impacts on students' understanding in technology. Research however has been conducted in New Zealand, which examined student concepts of technology and technology education and student attitudes towards technology (Burns, 1990; Mather, 1995). The chapter also shows that there is also literature supporting learning theories, which suggest that key to student learning is allowing students to work with experienced practitioners. Literature which articulates the learning theories underpinning *TiNZC* (Ministry of Education, 1995) and how this impacts on the nature of student learning in technology is analysed to identify the issues that need to be considered to ascertain the impact (or not) that practicing technologists have on student understandings *of* or *about* technology.

In Section 2.2 an overview of technology education in New Zealand is presented along with a framework for its delivery in New Zealand classrooms. Also presented is a review of the New Zealand Curriculum and Marautanga Project (*NZCMP*) and a discussion of its potential impact on technology education in New Zealand. The nature of student learning in technology espoused by TiNZC (Ministry of

Education, 1995), and how this relates to learning theory(s) is discussed. Potential changes to these due to the NZCMP, are explored.

Section 2.3 presents a review of prior research that has been conducted in New Zealand classrooms to date, which focuses on identifying student concepts of technology and technology education, and student attitudes towards technology. It also reviews similar international research conducted on these concepts, as well as discusses findings from research currently being conducted in New Zealand, to explore students' general concepts of the purpose of technology.

In Section 2.4 discussion on authentic student learning in technology and the relationship to learning theories such as Anchored Instruction (The Cognition and Technology Group at Vanderbilt, 1990), and Apprenticeship Model (Rogoff, 1990) is presented. It discusses research findings concerning the social construct of learning within a situated learning environment and the potential of this to impact on student understandings in technology education.

Section 2.5 provides an overview of two initiatives: Futureintech and GIF-Technology Education initiative that have been introduced to support teachers to deliver and enhance learning opportunities for students in technology.

Section 2.6 provides a summary of the emergent themes and issues identified from the reviewed literature, and relate these to the aim of this research as presented in Chapter One.

2.2 Technology Education in New Zealand Curriculum

Background

In 1999, *Technology in the New Zealand Curriculum [TiNZC]* (Ministry of Education, 1995) was gazetted as a compulsory learning area in New Zealand's national curriculum for all students from years 1-10 and as an optional subject for study in senior secondary school (years 11-13). Although TiNZC existed as a final curriculum statement (Ministry of Education, 1995) prior to 1999, few secondary schools trialed its potential as a compulsory learning area of school curricula before it was gazetted. At this time however, several design-orientated subjects that were taught in New Zealand secondary schools were considered to be 'technological in nature' (Burns, 1997). These subjects included workshop craft, design and technology, home economics, and textiles and design. Other subjects had also previously introduced aspects of 'technology' as a part of their classroom curricula. For example: sciences had introduced technology as an applied science; social studies presented technology through a technological deterministic lens, and computer studies allowed students to gain an understanding of how computers worked and provided opportunity for students to use them as tools (Compton, 2001). While aspects of technology taught in these subjects were later included in *TiNZC* (Ministry of Education, 1995), they did not provide the construct that was used to develop this curriculum (Compton & Harwood, 2003; Mather, 1995).

Significant catalysts leading up to the development of the *TiNZC* (Ministry of Education, 1995) were the paradigm shifts that occurred within New Zealand's sociological, political, economic and educational climate during the 1980's and 1990's (Compton, 2001; Harwood, 2002; Mawson, 2004). These shifts led to the demise of the 'Department of Education' and the emergence of the 'Ministry of Education', which introduced a national curriculum statement for education - the *New Zealand Curriculum Framework* [*NCF*] (Ministry of Education, 1993a). These shifts encouraged a review of how technology was taught inside New Zealand classrooms and concluded that a national curriculum statement for technology education should be developed. As a result, international developments in technology education were reviewed and critiqued by Ferguson (1991), a senior policy analyst at the New Zealand Ministry of Education. In 1991, Ferguson released a series of discussion papers on Technology Education and followed these up by commissioning policy papers to be written to provide the framework for a draft technology education curriculum statement for New Zealand (Compton, 2001). Jones and Carr (1993) and Guy (1992) were subsequently contracted to write seven policy papers. From these policy papers, *TiNZC* (Ministry of Education, 1995) a new subject for implementation into New Zealand curriculum was developed.

By being included as one of the seven Essential Learning Areas[6] [ELA] identified in the *NCF* (Ministry of Education, 1993a), technology became a compulsory curriculum for all students from years 1-10. As a subject taught in secondary school this shift allowed technology to sit alongside other curricula that had previously been given status as a compulsory subject, due to their traditional academic orientation (Compton, 2001). As such, the introduction of *TiNZC* (Ministry of Education, 1995) required secondary schools to review their delivery of all taught curricula, in order to make technology education accessible to students up to and including year 10.

Technological Practice

The introduction of *TiNZC* (Ministry of Education, 1995) required that students be given opportunity to develop knowledge and skills through actively participating in the development of technological outcomes[7] (products, systems and/or environments). To develop such outcomes, students were expected to undertake technological practice that considered the needs and aspirations of people who:

- could interact with a technological outcome once implemented in their intended environment; and

[6] The seven Essential Learning Areas are: Languages and Language, Science, Social Sciences, Mathematics, Technology, The Arts, and Health and Physical Education (Ministry of Education, 1993a).

[7] Examples of *technological outcomes* include such things as: the development of a product such as a robot (machine) to pick golf balls up off a driving range, with minimal human input; a multimedia electronic book to assist teachers to enhance student reading skills; or a system that efficiently allows students to gain access to and pay for food products at the cafeteria.

- may potentially be affected (both positively and negatively) by the development of a technological outcome.

As such, *technological practice* is defined as an overall descriptor for the thoughts, actions and interactions that occur as part of any technological endeavour, including the development of technological outcomes. This has been described as follows:

> *Many aspects are involved in the determination of the specific nature of the technological practice that is used to develop a technological outcome. These aspects include such things as:*
>
> - *the perspectives of the people involved in the development;*
> - *the capability of the people involved in the development;*
> - *the range of technological knowledge, skills and resources available at the time of the development;*
> - *knowledge and skills from other domains as appropriate;*
> - *the society and environment which impact on the development;*
> - *the society and environment which the development will impact on.*
>
> *(Compton & Harwood 2003, p.3)*

The introduction of *TiNZC* (Ministry of Education, 1995) therefore required students to consider the physical and social environment in which their outcomes were developed and ultimately placed. To do this, it was expected that students would take into account the values, ethics, attitudes and expectations of people (stakeholders) within the community where their practice takes place. *TiNZC* (Ministry of Education, 1995), placed emphasis on the technological practice students undertook to develop quality technological outcomes. However, it measured this not by teacher-predefined criteria based on 'take home value', as with previous technical subjects, but on students' ability to address stakeholder expectations by developing outcomes that were deemed 'fit for purpose'. This change in emphasis meant that teachers from previous technology orientated subjects had to shift their focus from that of solely developing student 'hands-on' technical skills, to encompass broader curriculum outcomes. This change in emphasis presented a challenge to many secondary teachers from traditional technical backgrounds such as home economics, textiles, design and technology, and graphics (Compton & Harwood 2000; Compton & Harwood 2005). Teachers who came from social studies, science and computer studies backgrounds[8] to teach technology, also struggled to adopt 'practice-based learning' pedagogy (Compton & Harwood 2000; Harwood 2002) that allowed students to develop their knowledge of things technological through involvement in practical activity.

As well as subsuming previous technical curricula, *TiNZC* broadened the range of technological areas that could be used as a focus of study (Ministry of Education, 1995). These technological areas, considered to be of significance to New Zealand's successful future included: biotechnology, food technology, information and communications technology, electronics and control technology, production and process technology, structures and mechanisms, and materials technology. Incorporation of these technological areas within the *TiNZC* did allow some of the knowledge, skills and practices that were traditionally aligned to subjects such as science, computer studies and social studies to be introduced in technology education. As such, *TiNZC* provided opportunity for knowledge, once primarily taught by science, computing and social studies, to be learnt by students through undertaking technological practice to develop technological outcomes. *TiNZC* placed no boundaries around the knowledge and skills students had opportunity to interact with and acquire. Rather, it allowed these boundaries to be determined by the nature of the technological practice that students engaged in and the context that this practice was related to. To ensure that students were not limited by the knowledge and skills that they had opportunity to draw upon, a variety of overlapping contexts (such as personal life, home, school, recreation, community, environment, energy, production and supply, business, and industry) were identified within the *TiNZC* (Ministry of Education, 1995), to provide a focus for the development of student technological outcomes.

[8] These subjects had traditionally focused on developing students theoretical understandings of their subject.

Technological Literacy

The overall aim of technology education, as described in *TiNZC* (Ministry of Education, 1995), was to support the development of students' technological literacy. In the 1995 curriculum statement, this is represented through the interlinking of the three defined curriculum strands - Technological Knowledge and Understanding, Technological Capability, and Technology and Society. Such a focus on interlinking the curriculum strands (Ministry of Education, 1995, pp. 31, 35 & 41) provides opportunity for students to increase their level of technological literacy through:

- *undertaking their own technological practice;*
- *examining the cultural and historical development of technologies; and*
- *critically analysing both their own and others' practice*

(Compton & Harwood, 2003, p.2).

The emphasis placed on supporting the development of students' technological literacy, positions technology education in New Zealand within the 'education for citizenship' argument (Beane, 1997; Print, 1998; Zuga, 1989), as opposed to educating students primarily for vocational reasons, in order that they may replicate the ways of practicing technologists (Compton & Harwood, 2003). This emphasis is communicated in the 1995 technology curriculum as:

> *Technology education is a planned process designed to develop students' competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of a technological society (Ministry of Education, 1995, p.7).*

Underpinning the development of student's technological literacy is a philosophy of technology as "a situated human activity that is reliant on, and reflective of the social, cultural, political and environmental location" (Compton & Harwood, 2004, p.2). In support of such a focus, *TiNZC* (Ministry of Education, 1995) has adopted a socio-cultural theoretical stance (Compton, 2001; Compton & Harwood, 2003; Compton & Jones, 2003), that situates learning within settings that are influenced by historical, cultural and institutional factors (Wertsch, 1991). Technology education in New Zealand curricula is therefore seen as a "creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems and environments" (Ministry of Education, 1995, p.6). As such Technology is therefore conceptualised as a "purposeful human activity undertaken to meet a need or realise an opportunity as influenced by, and impacting on, the sociocultural and physical location in which it is undertaken" (Compton & Harwood, 2003, p.3).

As one of the seven compulsory ELA for all students from years 1-10 identified in the *NCF* (Ministry of Education, 1993a), *TiNZC* (Ministry of Education, 1995) is currently being reviewed under the *NZCMP* alongside the six others ELA.

New Zealand Curriculum and Marautanga Project

The *NCF* (Ministry of Education, 1993a) is the umbrella document for all curricula taught in New Zealand schools, from years 1-13. Arguably it is underpinned by a post-modernist view of teaching and learning where curricula are presented as frameworks (Shearer, 1997). Such frameworks enable teachers' to develop classroom programmes that best meet their students' learning needs. The seven interrelated ELAs (Ministry of Education, 1993a) identified in the *NZCF*, therefore do not contain a prescribed set of knowledge and skills that teachers need to deliver to students, but rather present a set of prescribed achievement objectives that describe broad learning goals for teachers to develop classroom programmes. The intent of this approach to curriculum design is to enable teachers to develop 'learner-centred' (Print, 1998) programmes and adopt pedagogical delivery strategies that are focused on the 'learner' and their learning needs, rather than solely on the curriculum itself.

The national curriculum statements for each of the seven ELAs were progressively written and gazzetted from 1994 to 2000 to replace previous curriculum syllabuses.

Although the *NZCF* (Ministry of Education, 1993a) provided the guiding framework upon which each of the seven curriculum statements were written, their design however changed as each was developed. These changes were justified on the basis of the need to align the ELAs with the most contemporary understandings about teaching and learning at the time of their development. This influence meant that there is now a considerable difference found between the first statements developed and those which later followed. For example, the number of achievement objectives written into curriculum statements has reduced dramatically from the first ELA curriculum statement developed for the NZCF (Ministry of Education, 1993a) to the last. This reduction in the number of achievement objectives is highlighted when you compare the Mathematics in the New Zealand Curriculum [*MiNZC*] (Ministry of Education, 1993b) with the The Arts in the New Zealand Curriculum [*TAiNZC*] (Ministry of Education, 2000) which was gazetted seven years later. *MiNZC* (Ministry of Education, 1993b) had 281 achievement objectives that needed to be covered as part of compulsory education in Mathematics while *TAiNZC* (Ministry of Education, 2000) only had four common generic achievement objectives identified that were contextualised within each of the disciplines of the Arts (e.g. visual art, drama, dance and music). Other notable differences were the later gazzetted curriculum statements had a significant decrease in the amount of advice and guidance provided to teachers on how to teach their curriculum, as well as the removal of a section that provided teachers guidance on assessment.

In 2002, to address these differences in the ELA Curriculum Statements and also gauge the effectiveness of their implementation, a Curriculum Stocktake was undertaken by the New Zealand Ministry of Education. The major outcome of this Stocktake was the decision to redefine the *NZCF* (Ministry of Education, 1993a) and develop a curriculum framework called the New Zealand Curriculum and Marautanga [*NZC&M*]. Goals for the redevelopment of the *NCF* included:

- clarifying and refining the intended learning outcomes for each of the ELAs
- placing a focus on quality teaching
- strengthening school ownership of curriculum

- better supporting communication and strengthening partnerships between the education sector, and parents, whānau, and communities.

(Ministry of Education, 2005)

This redevelopment specifically meant that the *NZCF* was re-written to incorporate:

- a one page 'essence statement' that encapsulated the fundamental ideas and important learning outcomes for students for each ELA.
- an eighth ELA called International Languages and rewriting of the previous Language and Languages ELA to only include English and Te Reo Maori
- a removal of the previously identified *Essential Skills*[9] and inclusion of Key Competencies[10].
- a revision of the section on *Attitudes* and *Values*[11] to provide a clearer focus for schools and teachers that promotes a broad set of values identified as important to all New Zealanders.

(Ministry of Education, 1993a)

Copies of the NZCF Draft for Consultation (Ministry of Education, 2006) were released for consultation in August, 2006.

New Zealand Curriculum and Marautanga Project and Technology

The overall aim of allowing students to develop 'technological literacy' through participating in technology education has been retained in the New Zealand

[9] The *Essential Skills* identified in the NZCF (MoE, 1993a) were *Communication, Numeracy, Information, Problem solving, Self-management and Competitive, Social and Cooperative, Physical* and *Work and Study* skills.

[10] *Key Competencies* is a term that describes the desirable competencies all students should aim to attain as a result of participation in learning. This term was first identified in an OECD project called: Definition and Selection of Competencies: Theoretical and Conceptual Foundations (DeSeCo).

[11] *Attitudes* and *Values* were not specifically defined in the NZCF (MoE, 1993a). Rather *Attitudes* were identified as "positive dispositions towards things, ideas or people" and *values* as "internalised beliefs, or principles of behaviour held by individuals or groups" (Ministry of Education 1993a, p.21).

Curriculum Project draft *Technology Curriculum Learning Area Introduction*[12] [TCLAI] statement (Ministry of Education, 2006). The three strands in the *TiNZC* (Ministry of Education, 1995): Technological Knowledge and Understanding, Technological Capability, and Technology and Society have however been re-conceptualised into three new strands. These new strands are:

- Nature of Technology;
- Technological Knowledge; and
- Technological Practice.

This change in strands is reflective of contemporary understandings about technology education that have evolved from ten years of classroom practice and on-going educational research, that have occurred since *TiNZC* (Ministry of Education, 1995) was implemented (Ministry of Education, 2005). A key finding from the research conducted in technology education is the importance of students undertaking technological practice that is informed from their understandings about technological knowledge and the nature of technology (Burns, 1997; Davies, 1998; Compton & Harwood, 2003; Compton & Jones, 2003; Petrina, 2000). This research has also identified the benefits to students of gaining understandings about 'technological knowledge' and the 'nature of technology' outside of their own technological practice (Compton, 2004; Compton & Jones, 2004). In recognition of such findings, the three strands identified in the draft *TCLAI* (Ministry of Education, 2006) are no longer required to be interlinked for each unit of learning in technology, as they were under the 1995 *TiNZC* statement (Ministry of Education, 1995). This has meant that teachers now have the freedom to develop strand orientated learning experiences for students (Ministry of Education, 2005). The overall intent of the 1995 *TiNZC* statement, which focused student learning on the integration of the three strands; *technological knowledge, technological capability* and *technology and society* is however not lost, rather it has been captured within the new strand called *technological practice*.

[12] The Technology Curriculum Learning Area Introduction was initially called the Technology Essence Statement. This name was changed when the NZCF Draft for Consultation (Ministry of Education, 2006) was released for consultation in August, 2006.

The *technological practice* strand provides opportunity for students to undertake practice and examine the practice of others. The draft *TCLAI* (Ministry of Education, 2006) expects teachers to provide students with an opportunity to develop a range of outcomes during a programme of study in technology education. This range could include technological outcomes that are conceptual designs, working models, prototypes, and final outcomes in situ and/or multi-unit productions. The draft *TCLAI* (Ministry of Education, 2006) also suggests that where appropriate, these outcomes could be developed in collaboration with wider stakeholders such as practicing technologists and/or clients who have an issue/need to resolve.

The *Technological Practice* strand offers students the opportunity to undertake technological practice and examine the practice of others. The strand includes:

> *identifying and investigating issues, existing outcomes. This requires consideration of ethics, legal requirements, protocols, codes of practice and the needs of and potential impacts on stakeholders.*
>
> (Ministry of Education, 2006, p.1)

There are three components to the Technological Practice strand – *planning for practice*, *brief development* and, *outcome development and evaluation.*

The *Nature of Technology* strand allows opportunity for students to:

> *develop a philosophical understanding about technology as a domain and how it is differentiated from other forms of human activity. This strand supports the development of a critical understanding of technology and allows informed debate of historical and contemporary issues and future scenarios.*
>
> (Ministry of Education, 2006, p.1)

There are two components to the Nature of Technology strand - *characteristics of technology* and *properties of the technological outcomes.*

The *Technological Knowledge* strand allows opportunity for students to:

> *develop technological knowledge that is generic to all technological endeavours. Key ideas included in this strand are functional modelling and prototyping, material use and development and components of technological systems and how they interact.*
>
> (Ministry of Education, 2006, p.1).

These key ideas are captured within the three components of Technological Knowledge strand - *Technological Systems, Technological Modelling* and *Technological Products.*

The achievement objectives and their corresponding progression statements[13] found in the *TiNZC* (Ministry of Education, 1995) document were written on a 'projected belief' rather than 'absolute knowledge' of what students could achieve in technology education (Compton & Harwood, 2000; Compton & Harwood, 2004; Compton & Harwood, 2005). The reason for this was due to the lack of classroom based research that was available at the time of writing the curriculum statement (Compton & Harwood, 2005). The objectives and progression statements written for technological practice strand in the *TCLAI* (Ministry of Education, 2006) however, are now based on findings from ten years of research conducted inside New Zealand classrooms. This research has focused on developing an understanding of what students in technology can achieve when they are provided opportunity to engage in technological activity (Compton & Harwood, 2004; Compton & Harwood, 2005; Moreland & Jones, 2000; Moreland, Jones & Northover, 2001). Achievement objectives and progression statements have also been written for the *technological knowledge* and *nature of technology* strands.

[13] Statements that describe eight levels of student competency for each achievement objective - Level 1 being the lowest level of competency and level 8 the highest.

These however are yet to be trialled and/or validated within New Zealand classrooms[14]

The *NZCF* identified seven technological areas as important for students to experience within a programme of study in technology education. Classroom practice and research however, has shown that learning in technology often goes across a number of these technological areas (Compton & Harwood, 2003). The specified list of technological areas found in the *TiNZC* (Ministry of Education, 1995) statement has therefore been dropped from the *TCLAI* (Ministry of Education, 2006) and replaced with a list that describes a broad range of related technologies. This list includes control, food, communications, structural, dynamic, and bio-related technologies, along with creative design processes and materials. In developing technological literacy, students are expected to experience and explore a wide range of these technologies in a variety of contexts (Ministry of Education, 2006).

Nature of student learning in technology education

Technology education in New Zealand is often positioned with sociocultural learning theory. Sociocultural learning theory draws from theories based on situated cognition (Brown, Collins & Duguid, 1989), apprenticeship models of human cognition (Rogoff, 1990), and learning through participation in communities of practice (Lave 1993; Lave & Wenger, 1991). Sociocultural theorists "assume human agency in the process of coming to know" and believe, "that meaning derived from interactions is not exclusively a product of the person acting" (Gipps, 1999, p.21). Rather, influences from the community itself also contribute to the establishment of meaning. This belief is currently reflected in *TiNZC* (Ministry of Education, 1995) where technology is conceptualised as:

> *..... a creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems and*

[14] It is the achievement objectives for the *technological practice strand* that are of interest to this research, not those drafted for *nature of technology* and *technological knowledge* strands

> *environments.... Technological practice takes place within, and is influenced by, social contexts*
>
> (Ministry of Education, 1995, p6).

This view of technology is also reflected in the draft *TCLAI* (Ministry of Education, 2006) where it states that:

> *Technology is continually changing. It is influenced by and in turn impacts upon the cultural, ethical, environmental, political, and economic factors of the day, both local and global.*
>
> (Ministry of Education, 2006, p.1)

For students to meet the identified aim for technology education and develop *technological literacy*, they therefore need to be able to competently undertake and understand *technological practice* within the contemporary technological discourse/s in which they are situated (Compton & Harwood, 2003). Alongside this, however, they also need to demonstrate understandings of both the *nature of technology* and *technological knowledge* (Ministry of Education, 2006). In saying this however, it is recognized that there are varying degrees of technological literacy that a person may possess. This degree spans from literacy that is *functional* (Barnett, 1994; Custer, 1995; Layton, 1987) to a literacy that is *liberatory* in nature (Burns, 1997; Davies, 1998; Compton, 2001, Compton & Harwood, 2003; Mather, 1994). A person who possesses a *functional literacy* is seen to create technological outcomes (products, systems or environments) through undertaking technological practice and demonstrating understanding of technological knowledge and the nature of technology from within the boundaries of their current location (Compton, 2004; Compton & France, 2006; Compton & Harwood, 2003). Their outcomes (including their technological practices) most often replicate that which has been done before. A person however who demonstrates a literacy that is *liberatory* in nature, extends beyond the boundaries of their current location and displays an ability to critique and undertake comparative analysis of past and current technological practices. As well, under the constructs of the *TCLAI* (Ministry of Education, 2006), they must also have understandings of technological knowledge and the nature of technology within and across a range of different contexts. These include contexts such as control, food, communications, structural, dynamic, and bio-related technologies. Such literacy, allows people to judge the worth of experts (Compton & Jones, 2004) and make informed projections into "potential future practices that step outside and/or push boundaries of their current practices" (Compton & Harwood, 2003, p.4). As such, a person who possesses a liberatory technological literacy can contribute to determining the direction of our future technological society, through their participation as an informed citizen (Compton & Harwood, 2003; Compton & Harwood, 2005). Allowing opportunity for students to develop a technological literacy that is liberatory in nature, therefore, has inherent implications for the sorts of pedagogical practices that teachers adopt, as well as the learning contexts that they allow students to access.

Implications for teachers' pedagogical practices and learning contexts

To enable students to develop a technological literacy that is liberatory in nature, students need to be provided with a balanced teaching and learning programme that integrates all three strands of the *TCLAI* (Ministry of Education, 2006), as well as introducing specific units of work that focus on one or two of these strands at a time (Ministry of Education, 2006). Essential within such classroom curricula is an opportunity (and teacher encouragement) for students to employ diverse and creative practices that explore a range of values, ethics and attitudes. Teaching and learning programmes in technology also need to provide opportunity for students to participate in individual and group technological activity. Engagement in such activity enables students to gain insight into the "complex relationships involved in such things as developing and combining technological knowledge, skill and resources, assessing risk, accounting for stakeholder interests, ethics and understandings, (and) adapting to current boundary conditions and challenging these when appropriate" (Ministry of Education 2005, p.1).

To align technology education with its sociocultural underpinnings, classroom curricula needs to be based on *learner-centred* and/or *problem-centred* design (Print, 1993). Contexts, on which learning activities are based therefore, should enable students to explore and demonstrate '*process*' that is embedded in learning environments that are both bounded within the classroom, but connected to the world outside (Ministry or Education, 1995). Such contexts provide students opportunity to experience and learn from "problems of living that are both individual and social in nature" (Print, 1993, p.101) that are of interest to them, and relevant to real-world settings (Print, 1993; Shepard, 2000). Such an alignment with real-world settings encourages teachers to provide learning environments that allow technologists to work alongside students. This alignment of student learning with real-world settings is further explored in Section 2.5

2.3 Students' Concepts of Technology

2.3.1 International research on students' understandings of technology and technology education

Much of the contemporary research on student understandings of technology and technology education is based on the Pupils' Attitude Towards Technology (PATT) questionnaire developed by a team working at Eindhoven Technology University (Ratt, deKlerk, Wolters & de Vries, 1987). This questionnaire judged pupils' attitudes towards technology on a five point Likert-type scale. The PATT questionnaire used "pre-chosen characteristics of technology that were later used as a subscale in the analysis, with each characteristic having a number of items attributed to it" (Mather, 1995, p.19). The five original characteristics used in the PATT questionnaire were *Technology is a specifically human activity; Technology influences all aspects of society; Technology and sciences are interrelated; Designing and technical skills play a major part in technology;* and *Three pillars of technology are matter, energy and transformation* (Ratt, deKlerk, Wolters & de Vries, 1987). These five characteristics were later modified following a pilot study to *Human activity and society; Technology and sciences; Designing and technical skills;* and *Matter, energy and transformation* (Ratt, deKlerk, Wolters & de Vries, 1987). The PATT questionnaire, using these modified characteristics, was initially presented to 2500 eighth grade pupils in the Netherlands. Findings from this research concluded that pupils predominantly thought of technology as machines and equipment - girls more so than boys. To gain a wider understanding about pupils' attitudes to technology, an international project that involved 22 countries was initiated using the PATT questionnaire. However as discussed by Mather (1995) at the time of this research, in the majority of participating countries, technology was not a part of their compulsory national curriculum.

Findings from this research concluded that whilst students had a positive attitude towards technology they generally had a limited concept of it. That is, their concepts were "namely one restricted to equipment and machines that does not include the skill of designing and in which the relationship with science is unclear" (Burns, 1990, p.8). Where countries had introduced technology education as a part of their compulsory curricula, students generally scored consistently higher overall than their counterparts in those countries were it was not compulsory. Across all countries, boys recorded higher scores than girls. Rennie and Sillitto (1988) also identified a similar pattern in Australia in their investigation with year 8 students who used the PATT questionnaire format. Rennie and Sillitto concluded that pupils often:

> *related technology solely to computers and electricity. They found that few students considered the diversity or pervasiveness of technology in our society, or had a sense of history and change* (Rennie & Jarvis. 1993, p.3).

Later research conducted in Australia and the United Kingdom by Rennie and Jarvis (1993) who reported on student's attitudes and perceptions of technology, concluded that they "held an enormous variety of ideas about technology, even when they were grouped within the same class" (Rennie & Jarvis. 1993, p.8). The research also identified that even though student views of technology appeared to become more complex and coherent as they became older, their concept of technology was still largely focused on computers and modern appliances (Jarvis, 1998a; Rennie & Jarvis, 1993). A third finding from the Rennie and Jarvis study (1993) identified that student's perceptions about technology mirrored the way in which technology education was offered. In the United Kingdom, students clearly associated their perceptions about technology around their learning about the design cycle and model making, whilst in Australia students virtually ignored this aspect of technology. Rather, Australian student responses indicated that they most often shaped their ideas about technology from "incidental and often out-of-school sources, like family conversations, television and other forms of media" (Rennie & Jarvis. 1993, p.8). When these studies were undertaken, the United Kingdom's technology curriculum placed heavy emphasis on students 'designing and making' projects, while in Australia their curriculum continued to follow a more traditional technical education model, that required students to construct projects to teacher specified plans. Students at this time in the United Kingdom and Australia therefore did not possess concepts of technology that fitted the more generally accepted social understandings of technology - that is, a process(es) that purposefully intervene in the world.

In 1987, Bame and Dugger at Virginia Polytechnic, together with Marc De Vries, adapted the PATT questionnaire for use in the United States (Heywood, 1998). The adapted questionnaire sought student responses to the questions:

- *what is students' attitude toward technology at junior high and middle school?*
- *what is their concept of it?*

The adapted questionnaire asked students to *describe what technology is*. The questionnaire also asked students to provide demographic information about themselves and their families. Alongside this, students were presented with 58 statements that allowed the researchers to assess their attitudes toward technology and a further 31 items that assessed their concepts of technology. The research was conducted in seven States and 10,349 students participated in the research. Technology education/industrial arts classes were predominantly targeted of which 60% were boys. Findings from this research indicated that:

(1) *Boys generally showed a greater interest in technology than girls.*

(2) *The general interest in technology of older students was significantly greater than younger students.*

(3) *When a student's father had a job that was related to technology then this influenced their (the students) interest positively in technology.*

> (4) *When a mothers' job had "anything" to do with technology, then their children had a significantly better attitude toward technology than those children whose mother had "nothing" to do with technology.*
>
> (5) *The technological bent of mothers had a non-linear effect on students' knowledge about technology.*
>
> (6) *Having a personal computer at home had a significant positive effect on students' general interest in technology.*
>
> (7) *Students who think they will choose a technological profession were significantly more likely to have a greater general interest in technology, a more positive attitude toward technology, a better view of the consequences of technology, and a greater knowledge about technology than those who shied away from a technological profession.*
>
> (8) *Taking or having studied technology education/Industrial Arts made a significant difference to student attitudes to technology, as well as the conceptual understanding of technology.* *(Heywood, 1998, p.3)*

While a sizable knowledge base now exists internationally on student concepts of technology and technology education, there has been minimal research undertaken to date in this area in New Zealand. This is chiefly due to New Zealand's relatively recent entry into technology education as a compulsory learning area for all students from years 1-10 (Mather, 1995). Of the research that has been conducted, two studies standout. The first: *Students attitudes towards and concepts of technology education* (Burns, 1989); and the second: *Student concepts of technology and technology education: Implications for practice* (Mather, 1995). These two studies are discussed in detail in the following section.

2.3.2 New Zealand classroom based research

Previous Studies

In 1989 the New Zealand Department of Education commissioned a research study to determine student attitudes towards and concepts of, technology education. This research was commissioned due to the Department's interest in technology education and a desire to respond to trends observed internationally (Burns, 1990; Mather, 1995). This research drew on the PATT questionnaire as its primary research instrument and was administered on a national sample of year 9 (third form) students. In addition to the PATT questionnaire, this study also collected biographical information, data on student ability, and required students to answer "an open-ended question about what they thought technology meant" (Burns, 1992, p.73).

This study was undertaken prior to the implementation of a national curriculum for technology education in New Zealand. Students who participated in the research, therefore, were not able to draw on their experiences from study in technology education. Rather they drew upon their in-school experiences from undertaking studies in technical subjects, which formed part of schools compulsory curricula for year 7 - 10 students at that time and their out of school encounters. These technical subjects included Home Economics, Workshop Craft, and Clothing and Textiles. In a number of schools, students were also able to draw on learning experiences from undertaking a course in Computer Studies, and Graphics/Technical Drawing. These latter subjects were increasingly being made available as optional subjects for students to study at the time (Burns, 1990). Although there was an increasing number of male and female students who chose to cross the traditional boundaries that existed between technical subjects orientated towards females (Home Economics and Clothing and Textiles) and those traditionally focused at males (Workshop Craft – wood and metal) when Burns (1990) study was undertaken, there still existed a significant bias for gender segregation within technical subjects (Harwood, 2002; Mather, 1995). The characteristics used as subscale categories in the PATT questionnaire developed by Raat, de Klerk, Wolters and de Vries (1987) were altered for this New Zealand study. Those that were used as a focus for the study were:

- People and society
- Problem solving or technical process
- Science and change.

Reference to *matter, energy and information* that was a characteristic used for the original PATT study, was dropped for this research (Burns 1990). The researcher offered no explanation for these changes. Moreover, no indication was given of the anticipated differences that Burns (1990) hoped to uncover as a result of making these changes to the research questions. As a result of these changes, Burns (1990) findings offer little opportunity for comparisons to be made with the PATT findings.

Burns (1990) collected data from 641 girls and 592 boys in year 9. Findings showed that "form three students in New Zealand had a limited appreciation of the nature of technology" (Burns, 1990, p.62). A number of students were unable to provide responses to either the open-ended question and closed questions in the adapted PATT questionnaire. Burns (1990) concluded that boys had a 'better concept of technology' than was evident for girls. She went on to suggest that this may be as a consequence of boys' greater confidence in "providing a concept at all" (Burns. 1990, p.62), as opposed to their necessarily having a greater understanding of concepts of technology itself. Girls, Burn's (1990) found, more frequently recorded a 'don't know' response than boys. Burns defined 'better concepts of technology' in this context as being those students who possess a "broader more contemporary" view of technology (Burns, 1992, p.76). In addition, boys were reported to be "slightly more likely to identify a problem solving dimension to technology than girls and that this was probably linked to their experiences in workshop craft"[15] (Burns, 1990, p.63). Notably students were shown to identify that technology impacted on society rather than it being a "determination by society" (Burns, 1990, p.62). These findings mirrored conclusions drawn from the

[15] Workshop Craft, implemented in 1975, as a part compulsory education for all years 7-10 students in of New Zealand, introduced a 'design and make' constructivist ideology to technical education. This was in contrast to a traditional behaviourist ideology that had been used to deliver technical instruction under the previous woodwork and metalwork curricula (Harwood, 2002).

Netherlands study (Raat and DeVries, 1987) and Australian study (Rennie, 1987), showing that students who were not receiving formal instruction in technology education, had poorly formed concepts of technology (Burns, 1990).

However, as opposed to the Rennie (1987) Australian study, Burns found that New Zealand students appeared more aware of the incidence of technology in everyday life than their counterparts in Australia. Burns (1990) also identified that high ability students, as perceived by the teacher of these students, had 'better' concepts of technology than those of lower ability. She also identified that when students grew up in a rural environment, they held better concepts of technology than their counterparts from an urban upbringing. Burn's (1990) speculated that this was due to rural students experiencing technogical processes to develop outcomes as an integral part of their rural upbringing, as opposed to urban students who primarily interact only with the technological outcome(s) itself. No research however has been conducted to date to validate this speculation.

Students in this study also showed a general interest in technology and had a positive disposition to it. They portrayed it to be "not too difficult, appropriate for girls as well as boys, was overall beneficial to society and a good subject for school and careers" (Burns, 1990, p.63). Burns (1990) found that a "significant proportion of students (20% girls and 8% boys) responded to attitudinal statements by saying that they didn't know how they felt" about technology (Burns, 1990, p.63). This finding paralleled those findings from Rennie's (1987) research and was believed to align to students who had poor concepts of technology. As found in other international studies (Raat, de Klerk, Wolters & de Vries, 1987), where students did have good concepts of technology, their attitude towards technology was also positive (Burns, 1990; Burns, 1992).

In 1995, student concepts of technology in New Zealand were once again scrutinised, in research conducted by Mather. Within this research, Mather (1995) explored student concepts of technology and technology education. This research was conducted after the introduction of the draft TiNZC statement (Ministry of Education, 1993c). Schools involved in the research, therefore, had insight into the potential direction for technology education in New Zealand and were able to introduce students to technology, based on this draft document[16]. Mather was also an integral part of the team who had written the draft curriculum statement for technology and was a key contributor to the writing of *Technology in the New Zealand Curriculum* (Ministry of Education, 1995) document. As such Mather had insight into how technology education (as espoused by the draft curriculum) could be interpreted inside the classroom. This enabled Mather to adopt an interventionist research methodology where she worked alongside her research teachers to plan teaching units.

Mather's (1995) research centered on students in three levels of schooling; new entrant (year 1), standards 3 and 4 (years 5 and 6) and forms 1 and 2 (years 7 and 8). Five different classrooms were used in the research and comprised one class of 10 new entrant students; one class of 27 students in standard 3 and 4 classes; and three classes that comprised 34 students, 33 students, and 33 students, in forms 1 and 2. The questions Mather explored in this research were:

- *do the students appear to have determinable concepts of technology, and technology education?*
- *on what do the students appear to base their concepts of technology and technology education?*
- *in what ways do student's concepts of technology, and technology education, and their technological practice, appear to be linked?*
- *are there any differences across levels, classroom and gender?*
- *what are some implications for technology practice in New Zealand schools from all of the above?* *(Mather, 1995, p.3)*

Mather's (1995) research focused on gaining insight from a selected sample of student research participants, whereas Burns (1990) and many of the international studies, gathered her data from a large de-contextualised group of students. Data collected by Mather targeted student's concepts of technology and technology education prior to their engagement in technological activity (initial data) and also following activity (final data). While the technological activities were co-planned

[16] Note there were no significant changes in philosophy and structure between the Draft Technology in the New Zealand Curriculum (Ministry of Education, 1993c) and Technology in the New Zealand Curriculum (Ministry of Education, 1995) documents.

by the classroom teachers and Mather, the teacher delivered them to students. Data collection instruments, including sheets/activity booklets and audiotapes of class discussions, were employed to obtain the initial data. These instruments were selected following explicit consideration of the "class level and/or student ability" of the research participants (Mather, 1995, p.39). Interviews were conducted with 10 students in each class to collect final data. These interviews allowed Mather to illustrate the "interpretive process used in the categorizing of their (students') initial concepts of technology and technology education" (Mather, 1995, p.84). Additional data were obtained during interviews following student participation in a technological activity that allowed students' final concepts of technology and technology education to be explored.

To analyse student data from new entrant students, students in years 3 and 4, and years 7 and 8 classrooms, Mather identified categories for technology and technology education. These categories are presented in Table 1 and Table 2.

Table 1: Factors used in the categorisation of student's concepts of technology

Artefacts: Students were categorised under this heading if their concept of technology were based on an artefact itself. There were two sub categories of *Artefacts – electrical devices* and *tools/machines.*
Inventions: Students were categorised under this heading if their concepts of technology included the process of invention of artefacts, as well as the artefact itself. There were two sub-categories of *Inventions – new/different* and *past/present/future.*
Usefulness: Students were categorised under this heading if their concepts of technology focused on technology as a process designed specifically to be useful to, or for, people. Social factors such as peoples needs were apparent in these student's comments. Artefacts and the process of their invention, design and construction, all appeared to be included as a part of these students concepts of technology. There was only one category under this heading – *Meeting people's needs.*
Other: Students categorised as 'Other', were those who could not be categorised under the previous headings. Students categorized as 'Other' may also include students for whom there was little data available. (The number of subcategories varied for each class).

(Mather, 1995, p.228)

The categories *Artefacts* through to *Usefulness* were considered by Mather to be a "progression from a narrow concept of technology, towards a more broad, inclusive concept of technology" (Mather, 1995, p.228 -229).

Table 2: Factors used in the categorisation of student's concepts of technology education

Making/Understanding: Students were categorised under this heading if their concepts of technology education was based on making or understanding, an artefact, which had already been invented. When focusing on making these, students often referred to using recipe type instructions to recreate some object e.g. the use of 'lego technics'. For those students focusing more on the understanding, this was in terms of understanding the way something worked. Often both of these foci were present together, hence the joint characterisation.
Designing/Inventing: Students were categorised under this heading if their concept of technology education was based on designing or inventing an artefact. In most cases of students being categorised in this group, there appeared to be a strong linkage to science related activities.
Meeting Needs: Students were categorised under this heading if their concepts of technology education focused on being involved in a process designed specifically to meet the needs of people, especially themselves. Social factors were usually apparent in these students' comments.
Other: Students categorised as 'Other' were those who could not be categorised under the previous headings. Students categorized as 'Other' may also include students for whom there was little data available. The number of subcategories varied for each class.

(Mather, 1995, p.229)

The categories *Making/Understanding* through to *Meeting Needs* were considered to be a progression from a narrow to a broader concept of technology education (Mather, 1995).

Findings from this research identified that new entrant students held "consistent and determinable concepts of technology" (Mather, 1995, p.228). Also identified was that these student's concepts of technology were "relatively evenly spread between artefact and process, but all based on people" (Mather, 1995, p.228). Mather also identified that the majority of these students undertook their technological practice in a holistic fashion, which appeared to be linked to an understanding between "design, process and end solution" (Mather, 1995, p.228). For these students, the technological outcome (solution) that they developed addressed (or attempted to address) the problem(s) which they set out to resolve. Mather (1995) concluded that the link between design, process and end solution was an important aspect of a student's concept of technology.

Mather identified that 61% of students in the years 5 and 6 class held an initial concept of technology, prior to their engagement in a technological activity, based on an *artefact*. Two thirds of these students considered the artefact to be an electrical device, and the remainder as a tool or machine. The concept of technology as a *process* was held by 32% of years 5 and 6 students with "approximately two thirds who see this process in terms of inventing something, and one third seeing technology as involving process that is useful to people, or concerned with meeting people's needs" (Mather, 1995, p.230).

Within the students in the years 5 and 6 class, 60% were found to hold an initial concept of technology education, prior to their engagement in a technological activity, based on *making/understanding*. This concept included acknowledgement that technology education involved:

> *..... one or more of the following - making something from a design but not having been involved in the design, testing some artefact, and trying to understand how something works (Mather, 1995, p.230).*

Twenty–six percent of students held concepts of technology education that focused on *designing/inventing* and 7% considered it to be an "activity whereby people meet their needs" (Mather, 1995, p.230).

Mather found that following a technological activity that presented underlying concepts of technology and technology education that were similar to those held by students, there appeared:

> *... to be a level of reinforcement or strengthening of students initial concepts; .... where students concepts were significantly different, there appears to be little change in students initial concepts (Mather, 1995, p.232).*

For teachers to reinforce and strengthen student concepts of technology and/or technology education therefore, they need to understand the concepts held by their students and plan learning activities accordingly.

Across the three classes who participated in the research at year 7 and 8, 53% of students held an initial concept of technology, prior to their engagement in a technological activity, based on an *artefact.* The concept of technology as a *process* was held by 40% of students in the years 7 and 8 classes with 23% of these students "appearing to consider social factors to be relevant to their concept of technology" (Mather, 1995, p.233). A difference noted in the research findings between two of the three classes was that a "higher majority of students favoured a concept of technology based on an *artefact*, and a lower percentage of students appeared to stress the relevance of social factors" (Mather, 1995, p.233). In the third class, students favoured a concept of technology based on a *process,* with only a quarter of the students in this class portraying a concept of technology as an *artefact.*

In year 7 and 8 classes, 55% of students were found to hold an initial concept of technology education, prior to their engagement in a technological activity, based on *making/understanding*. Fifteen percent of the year 7 and 8 students held a concept of technology education based on a "general notion of activities (which were) centred around improving things for people, or *meeting needs*" (Mather, 1995, p.234) and less than 25% held a concept based on *designing/inventing*. Unlike the findings for student concepts of technology these students' concepts of the technology education showed no noticeable difference across the three classrooms.

Changes in student's initial concepts of technology were noted in the year 7 and 8 classes, following technological activity. The findings indicated that now "fifty-one percent of the students held a final concept of technology as based on *process* (an increase of 11%), with (now) twenty-eight percent considering social factors to be important", an increase of 8% (Mather, 1995, p.234). Students concepts of technology based on *artefact* reduced from 37% to 16% of students. Mather (1995) again noted a difference across classes for student concepts of technology; these however were more in terms of a change in pattern - an even distribution of students across the *artefact* and *process* categories in one class and in the other two, an increase in those students who considered *social factors* to be important.

Following technological activity in the year 7 and 8 classes, student concepts of technology education also showed a statistically significant change, with a decrease in those students who held concepts of technology as being *making/understanding* (26% decrease) and *design/inventing* (3% increase) and a 16% increase in concepts based on *meeting needs* (Mather, 1995). Students who were categorised as *other*, predominantly conceptualised technology education as "anything that might be done at school" (Mather, 1995, p.235). Class differences were again noted across the categories for student concepts of technology following the technological activity. The variation of the difference was similar across all three classes in terms of *making/understanding* and *meeting needs*. Difference however was noted between classes who displayed a bias for *designing/inventing* and those categorised as *other*. Mather's findings therefore indicated that student participation in technological activity, and their subsequent learning, was greatly affected by their concept of technology and technology education. Also identified was that those students who possessed a limited concept of technology and technology education were often disinterested and disadvantaged in their learning of technology, whilst those students with sound understandings were enthusiastically engaged in technological activity. Mather (1995, p.253) concluded that student's concepts of technology and technology education are of "major importance to their participation in technological activity and subsequent learning in technology...". Teachers therefore need to place importance on identifying their student's concepts of technology and technology education, and ensure that these concepts are used as the foundations upon which they plan and deliver technological activities inside their classroom. Mather's findings also suggest that technological activities should be socially constructed and taught in environments which openly encourage discussion between teachers and students. The importance of allowing within these environments the opportunity to discuss and critique a range of other people's concepts of technology and technology education, was also highlighted by Mather (1995).

In summary, the literature review thus far has provided an insight into findings from both international and national research relevant to identifying student concepts of technology and technology education and student attitudes towards technology. These studies however, have not looked at the influence that a practicing technologist may or may not have on student understandings as a result of their involvement with a student programme of learning in technology. The New Zealand based research studies that looked at student concepts of technology and technology education (Burns; 1990; Mather, 1995) focused on students up to junior secondary school students (year 9), neither of these studies examined what these concepts (student concepts of technology and technology education) meant for senior secondary students (years 11-13). Research is currently being conducted by Compton (2005) to collect base-line data on student understandings of the purpose for including mathematics, science and technology education in New Zealand school curricula. Details of Compton's preliminary findings from this research are presented under the next heading.

Current research

Compton (2005) has embarked on a two year study (2005-2006) to identify student understandings of mathematics, science and technology in New Zealand. The findings to date have been categorised into seven generic categories which are able to span across all three curricula (mathematics, science and technology) under investigation. The categories Compton has used are:

- Improve life;
- Understand the world;
- A tool for other areas;
- Life skills/personal skills;
- To express the world
- Encourage creativity; and
- No response.

Compton's (2005) data came from year 2 -13 students (students aged 6-17) from three schools (one full primary and two secondary schools) who are involved as case study schools in the Futureintech project. The gender mix of the sample size was 46% female and 54% male with the mean age of students being 13 years (year 8-9 students). The initial sample size for Compton's research was 142 students however, it needs to be noted that 54 students (38%) failed to provide any response to these questions. Compton's (2005) findings to date for the question that asked students to *describe their understanding of technology* are presented in Table 3.

Table 3: Summary of Student Response to Understanding of Technology

Students (n=88)	**Improve Life**	**Understand the world**	**Tool for other areas**	**Life Skills/ personal skills**	**Encourage creativity**
Understanding of Technology	60.0%	15.0%	11.5%	11.5%	2.0%

Of interest is the large number of students who perceived that technology was to *improve life* (60% of respondents) while only 2% of respondents considered that it was to *encourage creativity*. Students who identified that technology was to *improve life* did not exclude the notion technology may also be to *encourage creativity*. However, those students whose preference was that technology was to *encourage creativity* did not perceive that its purpose was also to *improve life*. Whilst Compton's findings do not transpose neatly into student concepts of technology education, as this was not the focus of her research, they do provide some interesting comparisons with Mather's (1995) earlier research on student concepts of technology education. Mather's (1995) research on year 7-8 students' identified that 15% of students held an initial concept of technology education, prior to their engagement in a technological activity. This concept was based on a "general notion of activities centred around improving things for people, or meeting needs" (Mather, 1995, p.234). Although there is no indication in Compton's (2005) baseline findings if the 60% of student respondents who indicated that technology was concerned with improving life had previously engaged in technology education prior to the data being collected, this difference, an increase of 45% of students over Mather's (1995) findings is important.

2.4 Authentic Student Learning in Technology and its Relationship to Learning Theory

The call for student learning to be grounded within authentic contexts is well documented (Brown, Collins & Duguid, 1989; Lave, 1991; Rogoff & Lave, 1984). What constitutes an authentic leaning context, within an educational setting that is "meaningful and useful for students", is not so clearly defined (Turnbull, 2002, p.27). Brown, et. al (1989, p.6) define authentic learning activities "as the ordinary practices of the culture" and propose that such activities need to provide students with an opportunity to access the perspectives of experts within the community, in order to allow student learning to be meaningful and purposeful. Choi and Hannifan (1995; cited in Altalib, 2002) further suggest that authentic learning cannot be simulated within tasks and activities that are usually found in educational settings. Rather, to be classified as 'authentic', student learning needs to be embedded in the actual life activities of experts within a community who are engaged in problem solving situations.

Dick (1991; cited in Ingram & Jackson, 2005) however, challenges this view of authentic learning and raises concerns about placing students into real world contexts when many of them are not ready for such experiences. He purports that the use of simulations is a better means to present students with learning contexts that are reflective of the real world, than embedding them in actual life activities. Simulations, according to Dick (1991), allow teachers to frame problems based on real world contexts, to ensure that students can engage with them at an educational level. As such, simulations according to Dick (1991) provide opportunity for teachers to focus student learning on the deeper understandings of concepts and assist students to recognise the interconnectedness of these concepts, rather than concentrating solely on the resolution of a one-off problem or set of problems. Teachers can also use simulations to emphasise the importance to students of developing skills that aid the transfer of developed understandings of concepts to alternative situations and settings (Ingram & Jackson, 2005).

Shaffer and Resnick (1999) suggest that within educational settings there are four identifiable kinds of authentic learning. These include: learning that is meaningful to the student; learning that relates to the real-world outside of school; learning that provides an opportunity to think in the modes of a particular discipline; and learning where the means of assessment reflect the learning process (Shaffer and Resnick, 1999, p.91). Shaffer and Resnick (1999) also suggest that although each of these kinds of authenticities are different, they are "interdependent and mutually–supporting" and therefore one cannot be achieved without the other.

Medway (1989), however suggests that authentic student learning only occurs at two levels. The first level, the factual level of authentic learning, occurs when the objects and data students interact with within the bounds of the learning context are 'real' in terms of being true to life (Medway, 1989). At this level of authentic learning, Medway (1989) suggests that even though student learning is bound within the confines of a classroom, the information and tools they interact with can still remain authentic. For example, the data students are provided to analyse and draw conclusions about, are those currently used (or previously used) by industry and the data processing tools (database) are also industry compliant. The second level of authentic learning Medway (1989) suggests, is focused on the task(s) students are asked to perform and the degree of authenticity of these tasks. At this level of authenticity, the setting for a project or activity that student learning is centred on is embedded in a true-life context, whilst the task(s) which they are asked to undertake may be engineered to allow for their engagement. Driscoll (2000 – cited Ingram and Jackson, 2005) claims that the focus of authentic learning contexts should be to immerse students in the "culture of the field" so that they may adopt the role of an apprentice who learns from field experts. Through such immersion, students are able to observe experts, model their practices, and receive coaching on how to replicate them. This form of instructional learning is commonly referred to as the 'apprenticeship model' (Rogoff, 1990).

The Apprenticeship Model

The key focus of the apprenticeship model is to develop student competence by exposing them to experts who model effective practices and make their tacit knowledge explicit to them (Rogoff, 1990). As student confidence and abilities increase over time, the modelling and coaching from the expert(s) is gradually withdrawn to the stage where the apprentice eventually becomes the expert. As such, an apprenticeship model of learning aims to enculturate students into authentic practices through activities that engage them in social interactions with experts in the field (Rogoff, 1990). A modified form of Rogoff's *apprenticeship model* of learning is the *cognitive apprenticeship model* (Hennessy, 1993). Unlike the *apprenticeship model* of learning (Rogoff, 1990) that focuses chiefly on developing learner's abilities to perform physical skills, the *cognitive apprenticeship model* (Hennessy, 1993) also places emphasis on enhancing the cognitive skills of the learner. Under a *cognitive apprenticeship model*, student development from an apprentice to an expert is centred on their gaining an increased ability to resolve complex and diverse problems alongside an ability to perform physical skills (Hennessy, 1993). The Cognition and Technology Group at Vanderbilt (1990) argue that cognitive apprenticeship is made feasible and is often enhanced when coupled with anchored instruction.

Anchored Instruction

Anchored instruction is an approach to learning which stresses the importance of learning taking place within meaningful, problem-solving contexts (The Cognition and Technology Group at Vanderbilt, 1990). To do this it uses authentic contexts such as case studies and/or problem situations to 'anchor' learning for students, so that they are not only able to solve problems, but also think about the thought processes involved in their resolution. A major goal of anchored instruction is to allow students to make inert knowledge active, through allowing students to "undertake sustained exploration" in order to "understand the kinds of problems and opportunities that experts ... encounter and the knowledge that these experts use as tools" (The Cognition and Technology Group at Vanderbilt, 1990, p.3).

Anchored instruction, as a learning or instructional theory, is derived from a belief that when an expert is confronted with a new situation they are able to draw on their prior understandings and experiences, to gain insight into the concepts and principles that underpin it. This ability of an expert to identify the relevance of previously learnt understandings to new situations is thought to be due to their being "immersed in phenomena" and being "familiar with how they have been thinking about them" (The Cognition and Technology Group at Vanderbilt, 1990, p.3). Experts, when introduced to new theories concepts and/or practices that have relevance to their own area of experience, are therefore able to make reasoned changes to their own thinking in order to take account of these new ideas. When a novice (student) however, is confronted with new theories concepts and/or practices, they often see these as merely "new facts or mechanical procedures that need to be memorised" (The Cognition and Technology Group at Vanderbilt, 1990, p.3). This is due to their limited experience in being immersed in phenomena that is under investigation, which results in an inability for them to notice and make meaning of new information.

In summary, the use of anchored instruction within education when coupled with a cognitive apprenticeship model provides opportunity for students to develop understandings within authentic contexts. By overtly placing importance on how and why experts use specific skills and knowledge in their practice, students are able to develop insights that can be used to inform their own practice. As discussed earlier, TiNZC (Ministry of Education, 1995) often positions student learning within a sociocultural theoretical stance. As such, it recognises the value of an apprenticeship model for authenticating student learning (Compton, 2001; Compton & Harwood, 2003; Compton & Harwood, 2005). In saying this however, it is also cognisant of the need not to align educational learning outcomes for students solely on the replication of expert practice. For students to develop a technological literacy that is liberatory in nature, they need to be sufficiently skilled (both physically and cognitively) to be able to "judge the worth of an expert(s)" (Compton & Jones, 2004, p.3) in order to identify and examine the knowledge that underpins their practice. Possession of a literacy that is liberatory in nature, allows students to be discerning, in choosing whether or not to adopt or modify others practices into their own future practice (Compton & Harwood, 2004), rather than simply replicating current practices.

2.5 Initiatives that Support the Delivery of Technology Education in New Zealand Classrooms

This section presents an overview of two initiatives: Futureintech and GIF-Technology Education initiatives that have been introduced to support teachers to deliver and enhance learning opportunities for students in technology

2.5.1 Futureintech

Futureintech is a New Zealand Trade and Enterprise (NZTE) funded initiative that is instigated and administrated by the Institution of Professional Engineers New Zealand (IPENZ). This initiative is designed to encourage more school leavers into technology, engineering and science careers, through their having positive school learning experiences (Compton 2005). As a professional body, which has representatives from both practicing and academic engineers, IPENZ has played a very proactive role in supporting the implementation of technology education into schools. This support has been especially prevalent in ensuring that the development of qualifications for technology at senior secondary school align to courses of tertiary study in technology and engineering.

The drive to initiate the Futureintech initiative came from a growing concern that was being expressed by industry and the tertiary education sectors about the lack of people pursuing careers in technology, engineering and science (ICT Taskforce, 2002; Techforce Initiative, 2000 - cited in Compton, 2005). Another reason for initiating Futureintech was the recognition that if the New Zealand economy was to grow, then more talented New Zealanders were required to generate and develop Empowering Intellectual Property (EIP). Findings from the ICT Taskforce (2002) and the Techforce Initiative (2000) had shown that student participation rates in technology, engineering and science-based programmes, that provided starting points for future EIP creation, were low (Christie, 2003). The stated aims for the Futureintech initiative are to:

- raise the profile of careers in technology, engineering and science as being highly desirable
- offer school students realistic technology, engineering and science learning experiences that draw on companies associated with IPENZ partnership programmes
- establish co-operative relationships between industry and education communities.

Futureintech has contracted facilitators to liaise between teachers, tertiary educators and industry personnel in order to assist them to establish professional working relationships (Compton, 2005). The focus of these relationships is to provide positive learning experiences for school students in technology, science and mathematics that are linked to real-world settings. To assist students to have these positive learning experiences, Futureintech has recruited practicing technologists, engineers and scientists to provide expert input into their learning, as part of an Ambassador scheme. The Futureintech Ambassadors are young practitioners who are passionate about their work, who can serve as mentors and/or role models to students. They have been selected because they have an ability to "enhance teacher and students' learning in technology, science and mathematics in terms of knowledge and practice, as well as adding to an understanding of the contemporary nature of the discipline" (Compton, 2005, p.6).

The outcomes of the Futureintech initiative are being researched in terms of students having positive school learning experience in technology, engineering and science careers, due to interactions with Futureintech facilitators and ambassadors (Compton, 2005).

2.5.2 GIF - Technology Education Initiative

The Growth and Innovation Framework - Technology Education Initiative (GIF - TEI) was instigated from funding provided to the Ministry of Education for technology education by the Growth and Innovation Framework (GIF). This Framework is administered for the New Zealand Government by the Ministry of Economic Development (MED). An expectation of the MED in providing this funding to technology education, was that student participation in technology both within and beyond education would increase. Identified as significant to realising this expectation was the need to raise the quality and effectiveness of teaching and learning in senior secondary school technology programmes by building teacher capability.

This stated aim of the GIF - TEI is to support senior secondary technology education through:

- raising the quality and effectiveness of teaching and learning in senior secondary school technology courses
- increasing secondary school student participation in technology education;
- enhancing teacher capability to provide senior secondary school technology courses
- improving alignment between secondary and tertiary technology education
- increasing interaction with business/industry needs/vision.

(Techlink, 2006)

The Ministry of Education contracted a Director to administer the GIF – TEI on their behalf. The Director works with a Reference Group that includes membership from the secondary and tertiary sectors of education, NZQA, and IPENZ. The Reference Group provides guidance on how the GIF –TEI funds should be spent as well as overseeing the outcome from its expenditure. Projects that the GIF - TEI have undertaken to date include: the Beacon Practice - Technology (BPT) project; Head of Department (HOD) technology support; supporting the continued development of a website (http://www.techlink.org.nz) that presents information about the GIF- TEI; and case studies on the practices of technologists within industry and profiles of their career paths.

The BPT is the biggest project to date to come out of the GIF –TEI. The focus of the BPT project is on supporting the delivery of quality teaching, the provision of innovative student centred learning environments, and establishing supportive relationships between teachers, students and community resources. Growing alliances between secondary and tertiary technology education, and encouraging interaction between technology education and the 'enterprise' community, is considered an essential component in establishing these relationships. The BPT project, in 2005, included seven initiatives that involved 13 secondary schools. In 2006, this was increased to include another five initiatives that involved a further ten secondary schools. Schools involved in BPT are provided with two years funding to support their involvement in the project. Some of the schools involved in BPT are working with contributing intermediate and primary schools as part of their BP initiative (Harwood, 2005).

To assist BP teachers to focus on the aims of the BPT project, I was contracted as one of a team of Facilitators to work with them. A facilitated situative professional development model (Borko, 2004) was adopted for this project, to ensure that the professional support provided was appropriate for the community who were the recipients of it. In other words, the professional development was developed to address the needs of teacher and student as identified within their learning environment, and drew upon local resources found within the school and its wider community. These resources included practicing technologists, community groups, material suppliers and people with authentic problems that they wished resolved (Harwood, 2005).

Funding provided BPT teachers with release time to enable them to reflect on their current teaching programmes, examine the pedagogies and resources they used to deliver technological experiences to their students, and critique the resulting student outcomes from these experiences. Important in this reflection was identifying opportunities to develop new and/or enhance existing technology programmes. The development of alliances with practicing technologists, and looking for opportunities for technologists to support the delivery of technology education to students was also explored during release time. Once established, these alliances were used to contribute to the situative professional development programme for the BPT teachers. An intended outcome of these alliances is the broadening of BPT teachers and their students' understandings of the 'practices of a wider society', that is the commercial world of technology.

No research, however, has been conducted to date to identify if this occurred or indeed, if having students interact with practicing technologists influences their understandings of technology in its broadest sense. The questions of this study, and my role as a facilitator for this project therefore provide an ideal opportunity to explore the benefits that may arise out of the BPT project, in terms of gains in student understandings when practicing technologists work alongside them.

2.6 Summary of the Literature

This literature review comprised four sections. The first section sought to present an overview of technology education in New Zealand as defined by the TiNZC (Ministry of Education, 1995) statement. The introduction of *TiNZC* (Ministry of Education, 1995) into New Zealand classrooms required student learning in subjects previously aligned to things technology[17] to move their learning focus from instructing students on craft based, design and make skills, to developing students' technological literacy. For this change to be successful, teachers were required to adopt pedagogical practices that aligned sympathetically with sociocultural learning theory, rather than continuing to adhere to previously applied behaviourist and constructivist teaching approaches (Compton & Harwood, 2003; Compton & Harwood, 2005). Print, (1993) identified that an important feature of all learning within a sociocultural learning paradigm was the connecting of classroom curricula with the world outside. Whilst *TiNZC* (Ministry of Education, 1995) also makes reference to the importance of aligning student learning in technology with the world outside the classroom, it does not explicitly alert teachers (and teacher educators) to the significance of this for developing technologically literate students. The review of *TiNZC* (Ministry of Education, 1995) under the *New Zealand Curriculum and Marautanga Project* however is attempting to make this more overt. The Technology Curriculum Learning Area

[17] Subjects such as: Workshop craft, Design and Technology, Home Economics and Computer Studies.

Introduction statement (Ministry of Education, 2006) is redefining the curriculum strands to focus on *technological practice*; *technological knowledge;* and *technology and society*[18], and defined what a technologically literate student should be able to do. These changes require that students draw on knowledge, skills and practices from a wider perspective than their own experiences, and learning is situated in real world settings that are relevant to their interests. There is, however, little research conducted to date to verify or refute the significance of connecting students' learning experiences in technology education, to the world beyond the classroom. There is also little understanding of how this will influence the development of a student's technological literacy to being that which is liberatory in nature.

The second section of this chapter reviewed literature on student concepts of technology and technology education. The literature revealed that students who had little or no experience in technology education generally had a limited concept of technology and technology education. In contrast however, the literature showed that where students had experienced technology as part of compulsory school curricula, then students consistently held broader, more accepted concepts of technology, than their counterparts in countries where it was not compulsory. Mather's (1995) research revealed that students' understanding of technology could be significantly influenced when they are provided opportunity to participate in technological activities that are underpinned by curricula based on technology education. Like Mather's (1995) research, Compton's (2005) findings were also drawn from classrooms in which students experienced technology as part of their school curricula. Findings from these two research studies therefore provide useful baseline data for further research. Importantly none of the research identified in this literature review has attempted to look at the influence practicing technologists have on student concepts of technology and technology education. There is therefore an important gap between the literature and what senior secondary students are being asked to do – work alongside practicing technologists.

[18] The strands in TiNZC (1995) are *Technological Knowledge and Understanding*; *Technological Capability*; and *Technology and Society*.

The third section of this chapter reviewed the literature surrounding authentic learning in technology and its relationship to learning theory. The literature showed that although there are a range of contemporary views held by researchers and academics on what constitutes an authentic learning context, they all espoused the need for student learning to be grounded in true-to-life settings. As such, the literature in this section supports the need for students in technology education to be provided with opportunity to work alongside experts so that they may gain insight into the practices of a practicing technologist(s). Compton and Harwood (2003; 2005) however, point out that care needs be taken to ensure that such opportunity is not solely focused on developing students who can replicate the practices of experts. Rather, students need to be encouraged and equipped with a literacy that is liberatory in nature, which enables them to critically evaluate any expert practices they experience so that they can be discerning in how they take such practices into their own future practice - if at all.

The last section of this chapter discussed two initiatives that have been introduced to support the delivery of technology education inside New Zealand classrooms. These initiatives are Futureintech (FiT); and Growth and Innovation Framework (GIF) – Technology Education. A key focus of the Futureintech initiative is to ensure that students receive positive learning experiences in technology education. To assist with this, ambassadors (practicing technologists from industry) have been recruited to coach and mentor students in their technological endeavours. These ambassadors provide students with the opportunity to locate their technological practice in real-life contexts and develop their understandings and practices, by drawing upon the practices of experts. The GIF – Technology Education initiative is centred on building teacher capability in technology education, through a focus on improving the alignment between secondary and tertiary technology education; supporting the establishment of innovative learning environments; and encouraging interaction between education and the enterprise community. A key project of the GIF- Technology Education initiative is the Beacon Practice – Technology (BPT) project. The BPT project is focused on supporting teachers to establish relationships with community resources that enhance student learning.

This thesis seeks to determine if students' interactions with practicing technologists influence their understandings of technology and technology education. The research literature presented in this chapter highlights the importance of student learning being embedded in authentic contexts that are informed/influenced by experts (practicing technologists). However, there has been no specific research undertaken to date to identify the influence that practicing technologists have on student concepts of technology and technology education. The literature reviewed in this chapter suggests that student concepts of technology and technology education can be influenced by their classroom experience in technological activity and that a limited understanding of these concepts can be a factor in inhibiting student learning. Exploration of the influence of practicing technologists on students' understandings of technology and technology education thus forms the research questions for this thesis as detailed in Chapter One Section 1.4.

CHAPTER THREE
METHODOLOGY AND RESEARCH METHODS

3.1 Overview of the Chapter

This chapter describes the methodology employed for this research. The chapter begins with a general discussion about educational research and educational research methodology. This is followed by an outline of methods used to collect data in educational settings. Section 3.3 describes and justifies the case study design adopted for this research. An overview of the research participants and their schools is provided in Section 3.4. Section 3.5 explains how the research was conducted, along with a description of measures taken to enhance the validity and reliability of the data gathered, and the relevant ethical considerations. Section 3.6 presents a summary of this chapter.

3.2 Educational Research

3.2.1 Methodological approaches

Research in its broadest sense may take on a variety of meanings and therefore can be employed across a range of contexts. Borg (1963; cited in Cohen, Manion & Morrison, 2002) states that "research is a combination of both experience and reasoning and must be regarded as the most successful approach to the discovery of truth, particularly as far as the natural sciences are concerned" (p.5). Research conducted within the context of education is primarily focused on the identification and clarification of issues and concepts concerned with teaching and learning within educational settings. It is concerned with identifying and understanding learning behaviours from both a normative and/or interpretive perspective (Cohen, Manion & Morrison, 2002). Educational research is conducted in a systematic and scholarly manner, and as such is grounded within research methodology.

Research methodology allows us to understand the process(es) that guide research rather than the products of the research itself (Cohen, Manion & Morrison, 2002). As such, research methodology defines the issue of how we go about proving what we believe we know and/or identifying what we come to understand (Guba & Lincoln, 1989). It is bound within a paradigm, or set of common beliefs and shared agreements that are based on a "community's philosophical assumptions about what the world is made of and how it works", or in other words a "collection of ontological and epistemological assumptions" (Davidson & Tolich, 1999, p.26). Making explicit the paradigm(s) underpinning intended research is important in determining the methodology and research method(s) that is best to employ, in order to gain understanding of the research problem(s)/question(s). Paradigms commonly aligned with educational research include *positivist, interpretive* and *critical social science.*

Positivist Paradigm

Positivists believe that human behaviour is fundamentally governed by a set of universal laws that recognize positive facts and observable objective phenomena (Horton & Hanes, 1993). Educational researchers, who work within a positivist paradigm, adopt an objective observer role to examine events in order to discover relationships that have always been there. A positivist paradigm is based on the premise that there is an objective reality that can be fragmented, compartmentalized, and once understood, predicted and controlled (Horton & Hanes, 1993; Cohen, Manion & Morrison, 2002). As such, a positivist paradigm provides an opportunity to observe social reality, classify relationships and make predictions. The ontology of a positivist paradigm therefore, is based on a belief that the universe is made up of a set of discrete and observable events that can be represented by universal propositions (e.g. high unemployment rate) and regular patterns of events (e.g. unemployment) (Sanghera, 2005a). Therefore, researchers and reality are considered to be separate (Weber, 2004). The epistemology of positivism sees knowledge logically connected to laws, based on facts that are derived from sensory experiences and "concepts and generalisations (e.g. gender relations and state terror) ... (as) ... summaries of particular observations"

(Sanghera, 2005a, p.1). Within a positivist paradigm therefore, objective reality is seen as existing beyond the human mind (Weber, 2004).

A weakness of a positivist paradigm, when used to uncover human behaviour, is that it tends to fragment and compartmentalise what are often intangible qualities that have no order and/or regularity. A positivist paradigm therefore tends to focus on objectivity, rather than valuing processes such as intuition and insight (Cohen, Manion & Morrison, 2002) and often fails to identify tacit knowledge. The value system and beliefs of the researcher are also not seen as impacting on the focus of the study and as such, many moral, ethical, political, and economic implications are not taken into account when a positivist paradigm is employed for human inquiry.

Interpretive Paradigm

An interpretive paradigm is characterised by its concern for the individual. It is focused on gaining understanding of the "subjective world of human experience" (Cohen, Manion & Morrison, 2002, p.22) from within. This is achieved by the researcher making efforts to experience the individual world of the research participants, through working directly with them. Educational researchers that practice within an interpretive paradigm, focus on an individual's actions. They view actions as unique, purposeful and future-orientated (Cohen, Manion & Morrison, 2002). Within an interpretive paradigm, social actions and human activity can be captured by text, from interview or observation for consideration by researchers (Berg, 2004). Analysis of such text enables researchers to identify patterns of human activity and action, and evolve theoretical explanations that are grounded within the research site. The ontology of an interpretivist paradigm therefore, is based on a belief that the researcher and reality are inseparable (Weber, 2004) and an epistemology that knowledge is derived from everyday concepts and meanings (Sanghera, 2005b), and therefore it is "intentionally constituted through a person's (researchers) lived experiences" (Weber, 2004, p.iv).

The challenge for researchers', who use an interpretive paradigm, is to maintain objectivity. To remain true to an interpretive paradigm, they need to 'bracket' their own personal value theories and not introduce their own subjective practices into the research site (Berg, 2004; Cohen, Manion & Morrison, 2002) to ensure that the research remains trustworthy (Lincoln & Guba, 1990). Due to the nature of an interpretive paradigm, multiple realities will often be presented to researchers. It is the researchers' responsibility to emerge theories from such realities which explain the "purposes of those people who are their source" (Cohen, Manion & Morrison, 2002, p.23) by ascertaining/debating their truthfulness or fact.

Critical Social Science Paradigm

A critical social science paradigm is characterised by a belief that research should be conducted in order to "critique and transform social relations" (Neuman, 1997, p.74). As such, critical social science sets out to reveal the underpinning constructs of social relations in order to assist people to change the world. A critical social science researcher is often dissatisfied with the way things are, and sets out to make dramatic improvements through uncovering the myths and hidden 'truths' that are not overtly obvious (Cohen, Manion & Morrison, 2002, Neuman, 1997). Researchers who adopt a critical social science paradigm, tend to ask embarrassing questions that expose inequalities and hypocrisies within social settings, in order to "promote individual freedoms within a democratic society" Cohen, Manion & Morrison, 2002, p.28). The ontology adopted by critical social science shares much in common with an interpretivist paradigm, that is, "social reality is socially constructed" (Sanghera, 2005c, p.1) within a real world and therefore can only be understood within the limitations of our own constructs. What critical social science however goes on to suggest, is that this reality should be examined and empirically tested with the intent of making changes (Cohen, Manion & Morrison, 2002). Researchers who adopt a critical social science paradigm cannot undertake objective observation due to having preconceived assumptions and interests that they bring to the research site. The epistemological stance of critical social science identifies knowledge as a form of self-reflection that requires both an understanding and a theoretical explanation in order to reduce entrapment in systems of domination or dependence. Such understandings and theoretical explanations are also used by critical social science researchers to establish emancipatory knowledge that is free from restrictions and oppression (Cohen, Manion & Morrison, 2002, Neuman, 1997).

Cohen, Manion and Morrison (2002) point out that some research paradigm are more suited to research purposes and questions than others. Therefore any research paradigm that is selected to underpin research needs to be 'fit for purpose'. Similarly the research methods or instruments that are used to gather data and the guidelines by which data are interpreted and explained, also need to be fit for their intended purpose (Cohen, Manion & Morrison, 2002).

3.2.2 Research methods

Research methods are traditionally grouped into two distinct categories, that cover a wide range of approaches and methods, which are used to access data from the research sites. These two categories are labelled *quantitative* and *qualitative* research.

Quantitative research collects data in the form of numbers, to test a theory or hypothesis that comprises variables about social or human problems (Creswell, 1994; Neuman, 1997). In quantitative research, data are analysed using statistical procedures in order to "determine whether the predictive generalisations of the theory hold true" (Creswell, 1994, p.2). As such, quantitative methods are traditionally aligned to positivist research methodology and therefore uphold to an ontology where "reality is objective and singular" and "apart from the researcher" (Creswell, 1994, p.5). As a result, quantitative researchers adopt an independent, valueless distance from the research site with their only influence being to "attempt to control for bias, select a systematic sample and be objective in assessing a situation" (Creswell, 1994, p.6). Many problems studied using a quantitative research method have previously either been selected for study by other researchers, or have had component parts that have been the subject of previous scrutiny. As such, there is often a body of existing literature that can assist in determining variables, and hypotheses for examination in any new quantitative study. Data collection methods most commonly used for quantitative research include experiments and surveys that comprise closed questions, that often demand a multiple-choice or rating scale response.

Qualitative research attempts to understand a social or human problem within a natural setting, by building an 'holistic picture' that is formed by words and reported research participant views (Creswell, 1994). In qualitative research, data are analysed using inductive logic to identify category labels that allow patterns or theories to be derived to help to explain phenomenon (Creswell, 1994; Neuman, 1997; Cohen, Manion & Morrison, 2002). Qualitative methods are traditionally aligned to interpretative research methodology and therefore uphold an ontology where "reality is subjective and multiple and seen by participants in the study" (Creswell, 1994, p.5). Qualitative researchers therefore, assume that the only reality that exists is that which is constructed by the research participant(s). As a result they adopt an interactive, collaborative bond with their research participants in order to minimise the distance between themselves and those being researched (Creswell, 1994). A consideration for qualitative researchers is the need to "acknowledge the value-laden nature" of their study and accurately report their "values and biases, as well as the value nature of the information gathered" (Creswell, 1994, p.6).

Most problems studied using qualitative research methods are exploratory studies with unknown variables, which have little to no existing literature or theory base to draw on. Data collection methods most commonly used for qualitative research include surveys that comprise open-ended questions that demand a written and/or pictorial response; observation and interviews (Neuman, 1997).

Where combinations of quantitative and qualitative methods are used within the same research, it is said to have adopted a *mixed methods approach* to research. A *mixed methods approach* to a single research study can allow:

- data to be triangulated to determine if there is a convergence of results
- an overlapping or differences in the phenomenon under investigation to be identified
- findings from the first method to be used to inform the second method that follows
- the study to expand in order to add breadth and depth where needed

- contradictions found to be viewed from fresh perspectives through use of an alternative method. (Creswell, 1994)

Models for combining research methods include: a *two-phase design* where the researcher conducts a qualitative phase of the study and a separate quantitative phase; the *dominant-less dominant design* where one of the methods is more dominant in use within the study than the other; and the *mixed-methodology design* where both methods are mixed at all or many of the stages undertaken throughout the research (Neuman, 1997).

In light of the above discussion, details of the research methods used for this research are discussed in detail in Section 3.3.

3.3 Approaches used for this Research

3.3.1 Methodological approach

As discussed in Chapter Two, the belief that students' educational outcomes are enhanced when an expert works alongside them has generally been accepted within the technology education community. This belief, embraced by the Beacon Practice - Technology (BPT) Initiative, the Futureintech project, and within senior secondary technology programmes, is under theorised. In my dual role, as the contracted facilitator for the BPT Initiative and researcher, I have the opportunity to become closely connected with students (research participants) who are presented opportunity to work alongside practicing technologists. Whilst being closely associated with the research participants may be seen as a disadvantage to the trustworthiness of the research findings (Lincoln & Gubba, 1990), it can also be beneficial. This is due to the opportunity that the association provides me, as the researcher, to make explicit any beliefs and concepts I may have that may influence the research process (Neuman, 1997). Keeping this in mind therefore, an interpretive paradigm was chosen for this research to allow a close investigation of the research questions. These questions, which initially focused on identifying students' initial concepts of technology and the purpose for technology, later went on to identify if these concepts changed when a practicing technologist(s) worked alongside students.

Justification for Choice of Methodological Approach

An interpretive methodology was determined to be the most appropriate for this research, as it allowed the researcher to work directly with the research students in order to look at the research questions through their eyes. It also provided an appropriate ontological and epistemological base in order to conduct this research. An advantage of an interpretive methodology is that it does not impose a theoretical position on the questions under inquiry, but rather allows theoretical understandings to emerge. This was important as little was known about the influence that practicing technologists had on students' understandings *of* and *about* technology. As outlined in Chapter Two, there had been previous studies undertaken on student concepts of technology (Burns, 1990, Rennie & Sillitto, 1988; Rennie & Jarvis. 1993; Ratt, deKlerk, Wolters & de Vries, 1987) and the purpose of technology education (Mather, 1995). Mather's (1995) research was the only research however, that specifically focused on New Zealand students who were engaged in technological activity. As theoretical understandings emerged from the data from this research, an opportunity existed to analyse these against the category labels identified by Mather (1995). Such analysis allowed for comparisons to be drawn between Mather's research findings and those from this research.

As discussed in Section 3.2, interpretivist methodology recognises the important role that values play in the development of knowledge (understandings), through acknowledging that knowledge is "socially constituted (and) historically embedded" (Lather, 1986, p.259). This orientation to knowledge allowed the researcher to look for emerging themes from the data, and derive "multi-faceted images of human behaviour" (Cohen, Manion & Morrison, 2002, p.23) that were cognisant of the social settings (within and outside the classroom). As such the researcher in this research could look at the interactions between students and practicing technologist, compare student understandings within and across these social settings, and evolve meaning that provided potential insight into understanding the impact that practicing technologists have on students understanding *of* and *about* technology.

3.3.2 Case study design

From within this interpretive framework, both quantitative and qualitative data were gathered using a case study, mixed methods approach that incorporated the use of questionnaires with follow up purposive sampling interviews. An advantage of using case study was that it allowed the researcher to observe both "cause and effect" (Cohen, Manion & Morrison, 2002, p.181) of practicing technologists impact (or not) on student understandings *of* and *about* technology. As such, use of case study, which followed an interpretivist methodology, allowed the researcher to draw theoretical conclusions to situations which were observed though the eyes of the research participants (the students) (Cohen, Manion & Morrison, 2002). An additional advantage of choosing a case study design for this research, was that it enabled the subject of the case (the impact of a practicing technologist(s) on student concepts *of* and *about* technology) to be interpreted and explained within a clearly defined time, space and place bounded system (Burns, 2000). Therefore, by adopting a case study design this research was able to have an 'explicit end in view' as well as a theoretical aim (Berg, 2004). The use of a framework, that was initiated before the research began, was essential for the successful use of a case study approach. Gilham (2000) states that a case study investigates a case (e.g. individual, group, class) "to answer specific research questions (that may be fairly loose to begin with)" through gathering "evidence which is there in the case setting", that can be "abstracted and collated to get the best possible answers to the research question" Gilham, (2000, p.1). By adopting an *intrinsic case study* (Stake, 1995; Berg, 2004) approach for this research, the researcher was able to gain an understanding of the impact (or not) that a practicing technologist(s) had when they worked alongside senior secondary students. This allowed the researcher to define the uniqueness of any impact (or not) through analysing the interactions between practicing technology and students along with the changes in student concepts *of* and *about* technology.

Using an intrinsic case study for this research also meant that the timeframe required for the researcher to establish and maintain a robust rapport with research participants was less than that required by other qualitative research methods (e.g. ethnography). This is due to the 'bounded' nature of case study research, which enables the researcher to focus on a narrow range of research participants within a known situation/place. As such a case study researcher can be more obvious and probing, applying the use of 'how', 'who' or 'why' questions when interviewing participants (Burns, 2000). The danger of this approach however is that participants may end up telling and/or demonstrating to the researcher what they perceive the researcher wants to see or hear. While this situation is not unique to case study, a case study researcher needs to ensure that in their eagerness to collect answers to the research question(s), they do not taint participant responses through using leading questions, or digging too deep to fast, without first ensuring that their rapport with participants allows them to talk and act naturally. While it is acknowledged that it is impossible for the researcher to be completely neutral, constantly validating research participant responses through the use of multiple sources of evidence and allowing for method triangulation, is essential to ensure that any such bias is not entered into the conclusions that are drawn by a case study researcher (Gilham, 2000). Multiple sources of data collection (mixed methods) were therefore used for this research to allow data to be triangulated in order to determine the trustworthiness (Lincoln & Guba, 1990) of the student responses. The mixed methods used in this research included questionnaires, purposive interviews and historical documents (teacher plans).

3.3.3 Data collection tools

Questionnaires

Questionnaires are used as instruments to structure the collection of survey information to enable its analysis to be comparatively straightforward (Cohen, Manion & Morrison, 2002). The design of questionnaires ranges from the highly structured to unstructured; is dependent on the type of data they are seeking to obtain; and the way in which they will be administered to and from research participants. Cohen et al. (2002) point out the need for designers of questionnaires to consider the research participants and their ability to interpret and respond to them. The wording of questions and their layout within questionnaires can have a major influence on the validity and reliability of data they collect. Pre-testing (piloting) questionnaires, prior to their employment as research instruments is therefore a critical step in the development of their design (Cohen, Manion & Morrison, 2002), to ensure that the questionnaire respondents (research participants) can provide valid and reliable data. The resources available to administer the questionnaire within the research environment, including acknowledgement of any religious and/or cultural protocols, also needs to be considered.

The questionnaire employed for this research, was made-up of a series of rating scale questions that were formatted using a semantic differential, and a range of open-ended questions. This mixture of both rating scale questions and open-ended questions provided allowed the researcher to compare research participant responses between the two forms of questions. This format was chosen to make the questionnaire as 'user-friendly' as possible for the research participants (students) whilst still eliciting from them, data that could inform the research. An advantage of including open-ended questions alongside rating scale questions in the questionnaire is that they invite research participants to provide an "honest, personal comment … in addition to ticking numbers and boxes" (Cohen, Manion & Morrison, 2002, p.255). Open-ended questions also firmly place the responsibility for, and ownership of a response (data) in the hands of research participants and as such assist in eliciting data that otherwise may not have been captured (Cohen et al, 2002). The disadvantage of using open-ended questions however, is that they can make it difficult for the researcher to make comparisons between research participant responses, as there is often little in common to compare. To overcome this disadvantage, common themes (Neuman, 1997) were identified in this research across research participant responses. The questions were also framed in a questionnaire following consultation with the research participants' teachers and pre-testing of the questions themselves, to ensure that the student research participants were able to commit their understandings and/or opinions to paper.

By using semantic differential rating scales for some of the questions in the questionnaire the researcher was able to aggregate participant responses to identify the frequency of responses and make correlations between responses. In doing this however, the researcher was aware of the limitations of semantic differential rating scales. Such limitations include: the making of assumptions about there being equal intervals between categories (e.g. a rating of 4 does not necessarily imply that it is twice as powerful as a rating of 2); ability to know if research participants are telling the truth (i.e. indicating a rating that truly reflects their understanding/opinion); lack of an opportunity for research participants to elaborate or justify their response; and human natures' unwillingness to be represented at either extremes of a continuum (e.g. on a 1-5 scale a reluctance to be seen to be rated as a 1 or a 5) (Cohen et al, 2002). To minimise these limitations the researcher ensured that the rating scale questions were complemented with open-ended questions. This allowed the researcher to make comparisons between research participant responses to questions, to gauge such things as truthfulness of their response and research participants' ability to comprehend what the question was asking. Discrepancies identified between responses to the rating scales and open-ended questions were used as one of the triggers to determine the need for a follow-up purposive interview (Patton, 1990).

Interviews

Interviews provide researchers with insight into what is 'inside a person's head', and as such make it possible for researchers to gain an understanding about what a person knows (knowledge or information), what a person likes or dislikes (values and preferences), and what a person thinks (attitudes and beliefs) (Tuckerman, 1972). As such, interviews provide a means for a researcher to interpret the meaning of a person's experiences so that they may understand the world from the participants' point of view. A common characteristic of all interviews is the dialogue that takes place between those seeking information (the researcher or interviewer) and those supplying information (the research participant). Cannell and Kahn (1968; cited in Cohen & Manion, 1994, p.271) defined research interviews as a "two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused by him (sic) on content specified by research objectives of systematic description, prediction, or explanation." To ensure that research-relevant information was obtained through interview in this research, the researcher analysed data collected from the structured questionnaires during Phases One and Two. This analysis identified characteristics in research participant responses that were believed by the researcher to be of potential importance to the research findings and/or required further clarification in order to be categorised validly. From this analysis, research participants were selected for *purposive interview*. For a discussion on the criteria used to determine which students were targeted for purposive interview, refer to Section 3.5.1.

To structure the purposive interviews, a *focused or semi-structured interview* strategy (Cohen & Manion, 1994) was employed by the researcher. Interview guidelines were developed and questions framed, based on the characteristics (variables) that were identified within the Phase One and Two data. The framed questions, whilst not 'set in concrete', provided a focus for the interview and allowed the researcher to probe deep into the research participant's attitudes or opinions about specific aspects of the variables under question (Cohen & Manion, 1994). Such probing allowed the researcher to uncover that which was not disclosed from analysis of the prior research data, in order to substantiate or reject previously formulated assumptions. For an example of the questions asked during the purposive interviews with student research participants, refer to Appendix C.

Interviews are heavily reliant upon social and interpersonal interactions occurring between the interviewer and interviewee (research participant). Interviewers therefore, "must be at pains to conduct the interview carefully and sensitively" and create an environment where the research participant (s) trusts the interviewer to the point that they "feel secure to talk freely" (Cohen, Manion & Morrison, 2002, p.279). Ethical considerations that include: gaining of informed consent, guarantees of confidentiality, and consequence as a result of the interview (e.g. what counts as data and what will remain as 'off the record' information, making transcripts/ interview data available to research participants to alter or retract from further consideration), therefore were clarified with the student research participants before any interviews commenced. Other considerations taken into account when interviews were conducted for this research included the obtrusive nature of audio recording and how this can shut down research participants from responding (Cohen, et al, 2002). The first questions asked by the researcher, therefore were framed to allow student research participants to chat freely about the work (technological practice) they were currently undertaking. Through allowing the research participants to talk about something which was familiar to them, an environment was created where they felt comfortable discussing their attitudes and opinions openly and freely, with the researcher.

3.3.4 Measures taken to enhance trustworthiness

While validity and reliability are a central concern for all researchers, for those involved in social research from an interpretivist paradigm, they often become 'ideals' that should be strived for, rather than 'absolutes', due to constructs in social theory which "are often ambiguous, diffuse, and not directly observable" (Neuman, 1997, p.138).

Validity refers to the "extent to which a (research) question or variable accurately reflects the concept the researcher is actually looking for" (Davidson & Tolich, 1999, p.32). The intent of research is to move the research question(s) from being an abstract theoretical concept, to something which is concrete that can be empirically measured. Validity therefore asks if the research method(s) used to gather data realistically provides data that allow the concept or research question(s) to be answered (Davidson & Tolich, 1999).

Reliability is concerned with the research instrument(s) ability to produce consistent data. For a research instrument (e.g. a questionnaire) to be considered reliable it must provide the same information (data) from a similar group of respondents each time it is used, irrespective of when or where it is used, or who the researcher is that uses it (Davidson & Tolich, 1999; Neuman, 1997).

While research instruments may be considered to be reliable, this does not guarantee their validity (Neuman, 1997). For example even though an instrument consistently produces the same or similar data over multiple measures, the instrument itself may not be valid. This is due to the data it produces not matching a known definition(s) of the construct under investigation. An example of this is a set of scales which are used to the weigh an item - while multiple measures of the same item on the scales provide a consistent reading, the scales themselves if not calibrated to known weights may not provide readings that accurately describe weight, in terms of agreed descriptions of weight. For a research instrument to be considered to have validity however, it must first be shown to be reliable (Davidson & Tolich, 1999; Neuman, 1997).

Measures Taken to Enhance the Validity and Reliability of this Research

The student research participants were selected from schools identified as offering technology programmes that provided opportunity for practicing technologists to work alongside students. To ensure that findings to the research questions could be substantiated by empirical measure (Davidson & Tolich, 1999), the *Phase One* and *Phase Two* data gathered from the semantic differential rating scale questions and open-ended questions in the student questionnaires, were compared to identify commonality and difference. This comparison also enabled the researcher to substantiate, both *theoretically* and *empirically,* if the research method (student questionnaire) was a valid data gathering tool.

The *Phase One* and *Phase Two* findings from the questionnaire along with the purposive sample interview data collected in *Phase Three,* were triangulated to ensure that the research findings had *internal validity*. That is, that the research findings accurately described reality, in terms of any influence that practicing technologists had on student understandings of technology and technology education.

To ensure that the student questionnaire could be acknowledged as providing reliable data, equivalence type questions that measured the same concept were included in the questionnaire. The use of equivalence type questions also allowed the researcher to critique the reliability of student responses. As discussed above, the student research participants who were interviewed were all given a transcript of the interview to confirm its accuracy and that it captured data that could be considered reliable.

3.4 Research Participants

This research was centred in five New Zealand schools. It draws on data gathered over two-years from senior secondary students in years 11-13. The schools chosen to participate in this research were a mixture of state and private schools of co-educational and single-sex gender that offered technology programmes in their senior school. These schools were geographically located in large urban centres in both the North and South Islands of New Zealand. Each school offered technology courses that used technology achievement standards and allowed students' access to the National Certificate of Educational Achievement (NCEA). They were also schools who:

- had either previously indicated a willingness to allow practicing technologists to work alongside their students; or
- who were currently supporting practicing technologists to work alongside their students as an integral part of their senior secondary technology education programme.

3.4.1 Profile of schools and participants

School A

School A was a private single-sex girls' school that provides education for year one to thirteen students. The school is decile 10 and has a roll of approximately 657 students. In years 1-10, technology is taught in topics (years 1-6) or options (years 7-10) as a part of compulsory curriculum, and as an option in years 11-13. In years 9-10 students are provided opportunity to study two 10 week options of technology at each year level and in years 11, 12 and 13 they may undertake a full year of study. Seven students (four students in year 12 and three students in year 13 in

2006) from School A participated in this research. All seven students indicated that a practicing technologist had not been involved in their learning in technology when the baseline data (Phase One) was collected - see Table 4 for details.

Table 4: Students School A

Student	Year level 2006	Gender	Practicing technologist involved in learning
A1	12	Female	No
A2	12	Female	No
A3	12	Female	No
A4	12	Female	No
A5	12	Female	No
A6	13	Female	No
A7	13	Female	No

During this research, students participated in a technology programme that had a material focus predominantly centred on the use of textiles to develop technological products. Other materials that students had the opportunity to work with included pewter casting, plastics, paper and wire.

School B

School B was a private single-sex girls' school that provides education for year one to thirteen students. The school is decile 10 and has a roll of approximately 715 students. In years 1-10 technology is taught in topics (years 1-6) or options (years 7-10) as a part of compulsory curriculum and as an option in years 11-13. In year 9 students are provided opportunity to study two 16 week options of technology, in year 10 two 20 week options, and in years 11, 12 and 13 a full year of study in technology. Five students (one student in year 12 and four students in year 13 in 2006) from School B participated in this research. Four of the students indicated that they had had involvement with a practicing technologist when the baseline data (Phase One) was collected. The students' teacher however verified that none of these students had had opportunity to work alongside a practicing technologist within the technology programme offered at school. Based on the teacher's verification, all five students were considered to be valid research participants - see Table 5 for student research participant details.

Table 5: Students School B

Student	Year level 2006	Gender	Practicing technologist involved in learning
B1	12	Female	No
B2	13	Female	No
B3	13	Female	No
B4	13	Female	No
B5	13	Female	No

During this research, students participated in a technology programme that had a material focus which was predominantly centred on textiles and garment construction.

School C

School C was a state co-educational secondary school that provides education for year nine to thirteen students. The school is decile 9 and has a roll of approximately 1527 students. Technology is taught as a compulsory subject in years 9 -10 and as an option in years 11-13. In years 9-10 students are provided opportunity to study two 10 week options of technology at each year level and in years 11, 12 and 13 they may undertake a full year of study. Five of the students indicated that they had had involvement with a practicing technologist when the baseline data (Phase One) was collected. The students' teacher verified that none of the students had had opportunity to work alongside a practicing technologist within the technology programme offered at school. Based on this the teacher's verification, all seven students were considered to be valid research participants - refer Table 6 for student research participant details.

Table 6: Students School C

Student	Year level 2006	Gender	Practicing technologist involved in learning
C1	12	Male	No
C2	12	Male	No
C3	12	Male	No
C4	12	Male	No
C5	12	Male	No
C6	12	Male	No
C7	12	Male	No

During this research, students participated in a technology course that had an information and communication (ICT) focus which was predominantly centred on use of computers as an ICT tool. The course provided students with the opportunity to learn and incorporate within technological solutions, a range of computer applications and programming skills.

School D

School D was a state co-educational secondary school that provides education for year seven to thirteen students. The school is decile 9 and has a roll of approximately 950 students. Technology is taught as a compulsory subject in years 7 -10 and as an option in years 11-13. In years 7-8 technology is taught as a whole year option, in 9-10 students are provided opportunity to study two 10 week options of technology at each year level, and in years 11, 12 and 13 they may undertake a full year of study. Six students year 12 in 2006 from School D participated in this research - refer Table 7 for student research participant details.

Table 7: Students School D

Student	Year level 2006	Gender	Practicing technologist involved in learning
D1	12	Male	No
D2	12	Female	No
D3	12	Male	No
D4	12	Female	No
D5	12	Male	No
D6	12	Female	No

During this research, students participated in a technology course that had an information and communication (ICT) focus which was predominantly centred on use of computers as an ICT tool. The course provided students with the opportunity to learn and incorporate within technological solutions, a range of computer applications and programming skills.

School E

School E was a state co-educational secondary school that provides education for year nine to thirteen students. The school is decile 9 and has a roll of approximately 1115 students. Technology is taught as a compulsory subject in years 9 -10 and as an option in years 11-13. In years 9-10 students are provided opportunity to study two 10 week options of technology at each year level and in years 11, 12 and 13 they may undertake a full year of study. Two year 12 students in 2006 from School E participated in the research - refer Table 8 for student research participant details.

Table 8: Students School E

Student	Year level 2006	Gender	Practicing technologist involved in learning
E1	13	Female	No
E2	13	Female	No

During this research, students participated in a technology programme that had a material focus which was predominantly centred on textiles and garment construction.

3.5 Data Collection and Analysis Procedure

Data collection consisted of three discrete phases:

PHASE ONE – initiation phase June 2005

- Identification and invitation to schools, teachers and students to participate in this research (see Appendix A: for details of letters and consent forms used for this research)
- Collection of baseline data including:
  - student participant questionnaire (for a copy of the *student questionnaire* used for this research see Appendix B)
  - reviewing teachers' planned lessons to identify the role that practicing technologist may have in supporting student learning over the duration of this research.
- Analysis of baseline data.

PHASE TWO – August 2006

- Further data collection including:
  - student participant questionnaire (for a copy of the *questionnaire* used for this research see Appendix B
  - gathering teachers' planned lessons to identify the role that practicing technologist may have in supporting student learning over the duration of this research.
- Analysis of collected data and comparison with baseline data findings.

PHASE THREE – September 2006

- Collection of endpoint data including:
    - purposive sample interviews of student participants that focused on coverage across the variables identified from questionnaire data, to identify patterns and their meaning from within the data (for an example of *the interview questions* used for this research see Appendix C)
    - Final analysis of all research data and drawing of conclusions.
- Reporting of research findings in thesis report.

3.5.1 Explanation of procedures adopted in each phase

Student Selection and Data Collection: Phase One (2005)

In 2005, students within Beacon Practice - Technology classes at year 11-13, whose teachers enabled them to work alongside a practicing technologist(s) as an integral part of their senior secondary technology education programme, were invited to participate in this research – see Section 3.5.2 for a explanation of the consent procedure adopted for this research. A number of potential student research participants from the Beacon classes had to be omitted from the research however, as they had previously worked alongside a practicing technologist prior to the research commencing in 2005 and/or they indicated that they would not be continuing to study technology in 2006[19]. Where a student indicated that they had previously worked alongside practicing technologist, this was verified with the student's teacher to establish if, in fact, their previous involvement was such that it should omit them from inclusion as research participants. Examples of the involvement of a practicing technologist presented by students included the technologist:

- providing them with an issue (a person who had an issue that offered them an opportunity to undertake technological practice in order to address it)

[19] A large number of potential student research participants in year 12 in 2005 indicated that they would not be continuing their studies in technology in 2006 due to Technology not then being on the Cannon of Subjects approved for university entrance. In 2006, Technology was placed on the Cannon of approved subjects for university entrance.

- providing them with a target market to design their product for (a retail shop owner who had a need for a new product)
- the teacher who guided their learning was considered to be a technologist
- using a script/parts of a computer programme obtained from the web that was written by a professional computer programmer
- use of textbooks to learn specific programming skills.

In all of these cases the involvement of a technologist as described by students and verified by the teacher, was such that it did not exclude them from being a trustworthy research participant.

Baseline data were collected from the research participants in Phase One using the questionnaire (see Appendix B for a copy of the Student Questionnaire). The questionnaire was provided to the teachers, who administered the completion of the questionnaire by the student research participants. Providing the questionnaires to the teachers, rather than directly to the students, allowed the teacher to determine the opportune time to have students fill them in, to ensure least disruption to their learning and the learning of other students within the classroom. Giving the questionnaire to teachers to administer also meant that the student responses collected at Phase One, were obtained prior to the students working alongside practicing technologist in their technology class in 2005. To maintain anonymity, the students were asked to place filled in questionnaires in a self-addressed, postage-paid envelope that was supplied with the questionnaire and return it back to the researcher. This meant that information provided by the student research participants did not have the potential to be scrutinised by their teachers. Both the questionnaire and the envelope were coded with a letter and a number – the letter to indicate the student's school and the number to differentiate between students. This allowed subsequent student responses to the questionnaire and data gathered from interview to be analysed against the baseline data presented by students.

An initial analysis of the baseline data collected using the questionnaire for the first research question[20] was undertaken, to identify if the *category labels* used by Mather (1995) to categorise student concepts of technology, were valid labels to categorise data for this research. Mather's (1995) category labels and their subcategories were:

- artefact;
    - *electrical device*
    - *tool/machine*
- Invention;
    - *new/different*
    - *past/present/future*
- process (useful);
    - *meeting people's needs*
- other.

For an explanation of these labels refer to Chapter Two: Table 1.

From this analysis it was found that an additional sub-category for 'process', titled *way of developing new products/systems* needed to be included to sit alongside Mather's (1995) sub-category under 'process'. This allowed students who conceptualised technology to be a process of creating products and/or systems to be categorised. For examples of student responses and how these were categorised under these category/sub-category labels refer to Chapter Four, Section 4.2.1.

An initial analysis of the baseline data for the second research question[21] was also undertaken to identify if the *category labels* used by Mather (1995) to categorise student concepts about the purpose of technology, were also valid category labels for this research. The category labels identified by Mather (1995) were:

- making understanding

[20] The first research question was: *what were the initial understanding(s) of technology held by senior secondary school students?*

[21] The second research question was: *what were the initial understanding(s) of the purpose of technology education held by senior secondary school students?*

- designing and inventing
- meeting needs opening
- other.

For an explanation of these labels refer to Chapter Two: Table 2.

The category label *opening career opportunities* and *life skills* were added to Mather's list of labels to capture understandings identified from the baseline data that were not encapsulated by Mather's (1995) categories. For an explanation of how student responses were categorised under these category labels refer to Chapter Four, Section 4.2.2.

Data Collection: Phase Two (2006)

In 2006, the teachers of the student research participants who completed the questionnaire in 2005 were asked to verify that these students were still studying technology. Of the 30 students who completed questionnaires in 2005, three (10%) indicated in Phase One that they had experienced technologists working alongside them to support their learning. Teachers of these three students were asked to verify that a practicing technologist(s) had previously worked alongside the student prior to the Phase One data being collected. Where it was confirmed that a practicing technologist had previously worked alongside students in technology, either in a prior technology class or outside of the classroom, then those students were omitted from further participation in the research.

The questionnaire was once again sent out to the student research participant teachers. Students were asked to complete it after they had finished a technology unit where they had worked alongside a practicing technologist(s) – for details of practicing technologists working alongside students refer to Chapter Five, Section 5.2.

An analysis of the Phase Two data was completed using the category labels identified in Phase One. Comparisons were drawn between the findings of the Phase One and Phase Two findings in order to answer the third research question:

> do these understandings (students initial concepts of technology and understanding of the purpose of technology education) change after students undertake a programme in technology that involves the participation of a practicing technologist(s)?

Data Collection: Phase Three (2006)

The findings from comparing student questionnaire responses between Phases One and Two were used to identify student research participants whose responses required further clarification. These responses included participant responses that were believed by the researcher to be of potential importance to the research findings, particularly those students whose data indicated a significant change in its categorisation between Phases One and Two. Criteria used to determine responses that also needed to be explored further, through the use of purposive interviews included:

- participants whose responses were significantly different from their peers which were not isolated (i.e. where two or more students presented similar data)
- participant responses where there was a need for further clarification around a variable in order to ensure data integrity and that the data could be categorised accurately.

The purposive interviews with the selected student research participants were audio-taped and transcribed by a private secretarial service. Interview times with the student research participants were negotiated between the researcher and the teachers of the student research participants. Times were selected in order to minimise disruption to these students' learning. For an example of the Interview Questions and the Interview Schedule please refer to Appendix C.

3.5.2 Ethics

Ethical issues for educational and social researchers are the concerns, dilemmas, and conflicts that arise over the proper way to conduct their research. As such, "ethics define what it is or is not legitimate to do, or what moral research procedure is" (Neuman, 1997, p.443). For the researcher, there are no ethical absolutes as most issues involve trade-offs between competing values and depend on the specific situation that is under investigation. In saying this however, there are a set of agreed principles that govern the way that educational and social researchers should follow, when engaged in research. These principles are primarily focused on ensuring that a balance remains between "the pursuit of scientific knowledge and the rights of research participants or of others in society" (Neuman, 1997, p.443). Researchers therefore, need to ensure that the rights of research participants to be protected from potential harm, including a loss of privacy, dignity, self-esteem and/or democratic freedom, is weighed up against the potential benefits that can be gained from the research. Such potential benefits include advancing society's understandings about social life, improvements for future decision making and/or helping the research participant(s) themselves. Strategies used in this research to minimise potential harm to student research participants included the seeking of informed consent, the use of pseudonyms (to preserve confidentiality) and the right of participants to withdraw from the research at any stage during its undertaking. (Berg, 2004; Punch, 2000).

Board of Trustees (BoT) of the schools who had potential student research participants were first approached and invited to participate in the research. A letter was sent to the Chairperson of the BoT that explained this research project, and the voluntary nature of having students from their school participate in the study along with a consent form for them to sign. For further explanation see Appendix B.

Once a schools' BoT agreed to the research being conducted in their school, potential student research participants were sent an information letter and a consent form to participate in the research. The letter explained the research project and the voluntary nature of their participation. The letter also outlined how confidentiality and anonymity would be addressed for this research project and the likely benefits to themselves and the wider technology education community that their participation in the research offered. For further explanation see Appendix B.

The letter to student research participants and the BoT of participating schools also made them aware that they had the opportunity to ask questions of the researcher. It also informed them of their right to withdraw from the study at any stage prior to any data gathered being analysed.

This research was undertaken within the guidelines and procedures as outlined by the Massey University Human Ethics Committee for Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. Ethical approval was gained from this committee for this research to be undertaken – see Appendix D.

3.5 Summary

Chapter Three justified the use of an interpretive methodology as being the most appropriate framework for use in this research. The aim of this research was to establish students' concepts of technology and technology education and if these concepts changed in a natural setting. This is in keeping with the primary goal of interpretive methodology with its practical orientation (Cohen, Manion & Morrison, 2002). Use of an interpretive methodology allows the researcher to work directly with the student research participants in order to enable theoretical understandings to come out of the research data. This chapter also argued that semi-structured interviews, along with a questionnaire that used complementary semantic differential rating scale and opened-end questions, allowed the researcher to gain an insight into the concepts of technology and the purpose of technology held by the student research participants.

The chapter discussed how data were gathered from the student research participants and the research process (phases) that were adopted for this research. The category labels employed by Mather (1995) were argued as providing an appropriate means for categorising student research participant responses to the first two research questions. An initial analysis of these responses however, identified the need for further sub-categories to be included in order to validly capture the concepts expressed in the student research participant baseline data. These sub-categories, along with Mather's (1995) categories, were subsequently used to tabulate and analyse the data in order to identify trends specific to the research questions.

In Chapter Four, the findings from the Phase One date are presented and discussed.

CHAPTER FOUR
RESEARCH FINDINGS: PHASE ONE

4.1 Overview of the Chapter

This chapter focuses on the Phase One data (baseline data) that were collected using the structured questionnaire developed to identify the students' initial understandings *of* and *about* technology. Data were gathered from 27 students in five schools that participated in the project. In 2006, 18 of these students were in year 12 and twelve in year 13. This chapter presents findings in relation to students' *concepts of technology* and understandings of the *purpose for technology education* prior to a practicing technologist(s) working alongside them. Section 4.2 discusses the category labels that were identified as a result of qualitative data analysis of the open-ended questions in the structured questionnaire. Section 4.3 presents the findings on a school by school basis. Section 4.4 discusses combined school data and Section 4.5 provides a summary of the findings and answers the first two research questions:

1. what are the initial understanding(s) of technology held by senior secondary school students?
2. what are the initial understanding(s) of the purpose of technology education held by senior secondary school students?

4.2 Data Analysis

Initial data collected from the structured questionnaire used for Phase One of this research were collated for quantitative analysis and categorised for qualitative analysis, based on the researcher's interpretations of the students' data. This allowed an exploration of the trends within individual schools concerning student initial understandings *of* and *about* technology to be undertaken.

4.2.1 Students' concepts of technology

In this section, data collected from students within individual schools have been analysed qualitatively, categorised and tabulated. The category labels used for the qualitative analysis, which reflect the core of each student's concepts of technology, are presented in Chapter Three, Section 3.5.1.

Student responses about their *concepts of technology* for Phase One and how these were categorised are illustrated in Table 9.

Table 9: Categorisation of student responses: Concepts of technology

Student	Response	Category
A1	*The process of decision making and evaluating to reach an outcome.*	Process: a way of developing new products/ systems
A2	*Technology is the development of new ways to do things, or new products to make peoples life and work more easy and efficient*	Process: meeting people's needs
A3	*...learn how to use materials, how to use machinery, learn how to write briefs and skills needed to succeed in a job like designers and advertisers*	Other
A4	*Using skills to design and construct ideas and inspirations*	Process: a way of developing new products/ systems

A5	*The practice of designing and creating. It is using creative ability. Can be anything from woodwork to fabric technology.*	Process: a way of developing new products/ Systems
A6	*Technology is the practice of developing different technologies*	Process: a way of developing new products/ systems
A7	*Using different kinds of equipment to make/create a product*	Invention: new /different
B1	*Developing and testing new things. Expanding the possibilities of existing objects*	Process: a way of developing new products/ systems
B2	*Technology is the process which allows us to develop an efficient solution to a need or opportunity.*	Process: meeting people's needs
B3	*Working with stakeholder, developing a brief and undertaking tech practice*	Process: meeting people's needs
B4	*Process followed to produce and construct a object/item to fit a purpose or*	Process: meeting people's needs
B5	*Technology is the design and creation of something to be used by someone for a specific use*	Process: meeting people's needs
C1	*Technology is the physical form of ideas that have been made*	Process: a way of developing new products/ systems
C2	*Technology is a way that help human life easier*	Process: meeting people's needs
C3	*Technology is a means of empowering ourselves in this knowledge economy with essential skills that allow transitions (for individuals) across different types of job opportunities in a number of industries*	Process: meeting people's needs
C4	*....to help improve human life and to also make human life easier*	Process: meeting people's needs
C5	*Technology means things used in everyday life. Like how wood technology makes furniture - furniture is used in everyday life*	Artefact: tools/machines
C6	*Technology is anything that a person uses to achieve a goal – this can be from complicated machinery to something simple like a hammer*	Artefact: tools/machines
C7	*Technology is inventions that have always happened*	Inventions: past/ present/future
D1	*Everything we use is a result of technology advances i.e. TV, computer, phones, cars etc.*	Artefact: tools/machines

D2	*Technology is the process in which outcomes are developed to address people issues*	Process: meeting people's needs
D3	*A method of doing things*	Process: a way of developing new products/ systems
D4	*Technology is hard to describe – computers definitely pops into mind and other things which have been created like cars, TV, radio*	Inventions: past/ present/future
D5	*Things to help people and are always being improved e.g. machines tools*	Process: meeting people's needs
D6	*Technology is all about gathering information and learning to use skill to develop new things*	Process: a way of developing new products/ systems
E1	*Technology is the process of designing, researching, creating and evaluating a product. Adding originality into items and creating things that are different and better than other existing solution*	Process: a way of developing new products/ systems
E2	*Creating and applying technological processes to meet everyday needs*	Process: meeting people's needs

4.2.2 Student understandings of purpose of technology education

In this section, data collected from students within individual schools have been analysed qualitatively, and categorised and tabulated. The category labels used for the qualitative analysis, which reflect the core of each student's concepts about the purpose of technology education, are presented in Chapter Three, Section 3.5.1

Examples of student responses about their understanding about the *purpose of technology* education and how these were categorised are shown in Table 10.

Table 10: Categorisation of student responses: Purpose of technology education

Student	Response	Category
A1	*Learning skills that can be later used or applied to life in more than one way*	Life skills
A2	*Broadening our knowledge in ways to make things, developing our technological skills*	Designing/inventing
A3	*To broaden our knowledge of using materials to give you skills to be able to own your own clothing business*	Opening career opportunities
A4	*If you want to do it as a career in the future*	Opening career opportunities
A5	*For me materials, I study it because I love designing ... is a chance for my creative side*	Designing/inventing
A6	*The purpose of studying technology at school is to teach us the fundamental practices like pattern making, designing, sketching, sewing to create garments*	Designing/inventing
A7	*To teach students practical things such as sewing, building etc. and skills they can use in life*	Life skills
B1	*To learn how to develop and test new things. How to expand the possibilities of existing objects*	Designing/inventing
B2	*To help develop creativity in students and give us a firm grounding in problem solving and researching and the reasoning involved in exploring and creating solutions*	Designing/inventing
B3	*To broaden design skills and enhance logical and technological thinking to make things*	Designing/inventing
B4	*Is a good process to know in the technological industry*	Opening career opportunities
B5	*To help your creative skills grow and your use of planning and developing an idea to a product. I have learnt many sewing skill, broadened my range of technique.*	Designing/inventing
C1	*To understand how scientific ideas are used in the real world as well as how they can be manipulated*	Making understanding
C2	*To update ourselves since now we are in the 21st century, technology is used around the world*	Making understanding

C3	*Technology is a good subject at school because it teaches us organisational skill and time management as well as knowledge of software and hardware which allows us to take jobs in the IT industry, as well as compliment other jobs*	Opening career opportunities
C4	*To help students understand more about the evolving world around us, and how the technologies we use work*	Making understanding
C5	*To get ready for the business world*	Opening career opportunities
C6	*To be able to learn what it is, how to use it, and use it to benefit us*	Making understanding
C7	*To learn these skills early in life – programming, making games*	Designing/inventing
D1	*To give us skills so that we can carry on making technological advances*	Designing/inventing
D2	*To gain a better understanding of technology and its place in society – how it effects everything*	Meeting needs
D3	*So that there are new technologists and so people do not have to be trained as much*	Opening career opportunities
D4	*So that we can apply our skills towards whatever career we may have in the future, as most of the jobs will involve technology*	Opening career opportunities
D5	*Technology is an important part of life*	Other
D6	*To help students learn the skills needed to perform everyday tasks*	Life skills
E1	*Gives people understandings of what processes to use and what things have to be considered when solving problems*	Life skills
E2	*To teach us how to make garments and how to make them to suit weather conditions by looking at different fabrics*	Designing/inventing

4.3 Phase One Findings

Introduction

Students were asked in the structured questionnaire to respond to open-ended questions about their *concepts of technology* and what they understood to be the *purpose of technology education*. Responses (as exemplified in Tables 9 & 10) to these questions were subsequently tabulated for analysis. The questionnaire also asked students to identify their *confidence* in describing their understandings (concept of) about technology and how *important* it is to have technology included as a subject within a school's curriculum. Students were asked to indicate their *confidence/importance* on a 1-5 rating scale with 1 being *not confident/not important* and 5 *very confident/very important*. These data are presented below for each participating school. Although this research used a small number of research participants', findings from the baseline data are presented and discussed as percentages to allow comparisons to later be draw across the five research schools.

4.3.1 Findings by school

School A

Seven students (4 students in year 12 and 3 students in year 13 in 2006) from School A participated in the research. Table 11 presents Phase One data for this school.

Table 11: School A: Phase One Data

n = 7	Artefact		Invention		Process		Other
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 1)*	0	0	1	0	4	1	1
%			**14.3%**		**57.1%**	**14.3%**	**14.3%**

Confidence to explain technology *(Phase 1)*	**Not confident** **1**	**2**	**3**	**4**	**Very confident** **5**
	0	0	2	4	1
%			**28.6%**	**57.1%**	**14.3%**

Purpose of technology education *(Phase 1)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	3	0	2	2	0
%		**42.8%**		**28.6%**	**28.6%**	

Importance of technology education *(Phase 1*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	1	6	0
%			**14.3%**	**85.7%**	

Students in School A held initial concepts of technology that were either focused on technology being an *Invention: new/different* (14.3%) or a *Process: a way of developing new products/systems* (57.1%) and *Process: meeting people's needs* (14.3%). One student (14.3%) was categorized as *other* as their data could not be tabulated into a category. The majority of students (57.1%) indicated that they were a 4 on the rating scale in terms of *confidence* to explain their concept of technology with one student (14.3%) indicating they were *very confident*. Two students (28.6%) indicated they were a 3 in their *confidence* to explain their concept of technology.

Three students (42.8%) indicated that the purpose of technology education was to increase their abilities in *designing/inventing*. The others either identified that it was to *open career opportunities* (28.6%) for their future or provided them with *life* *skills* (28.6%). Students in School A either rated technology education as being a 4 (85.7%) or a 5 (14.3%) on the rating scale for *importance* of technology education.

School B

Five students (1 student in year 12 and 4 students in year 13 in 2006) from School B participated in the research. Table 12 presents Phase One data for this school.

Table 12: School B: Phase One Data

***n* = 5**	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 1)*	0	0	0	0	1	4	0
%					**20%**	**80%**	

Confidence to explain technology *(Phase 1)*	**Not confident 1**	**2**	**3**	**4**	**Very confident 5**
	0	1	3	1	0
%		**20%**	**60%**	**20%**	

Purpose of technology education *(Phase 1)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	4	0	1	0	0
%		**80%**		**20%**		

Importance of technology education *(Phase 1*	**Not important 1**	**2**	**3**	**4**	**Very important 5**
	0	0	1	3	1
%			**20%**	**60%**	**20%**

All students in School B held initial concepts of technology that was focused on technology being a *Process* - one student *Process: a way of developing new products/systems* (20%) and four students *Process: meeting people's needs* (80%). Three students (60%) indicated that they were a 3 on the rating scale in terms of *confidence* to explain their concept of technology, one student (20%) indicated they were a 5 and *very confident,* and the remaining one student indicated they were a 2 on the scale.

Four students (80%) indicated that the purpose of technology education was to increase their abilities in *designing/inventing.* The other one student (20%) identified that it was to *open career opportunities.* Three students in School B either rated technology education as being a 4 (60%) on the rating scale for *importance* of technology education and the remaining two students a 3 and a 5 respectively.

School C

Seven year 12 students from School C participated in the research. Table 13 presents Phase One data for this school.

Table 13: School C: Phase One Data

***n* = 7**	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 1)*	0	2	0	1	1	3	0
%		**28.6%**		**14.3%**	**14.3%**	**42.8%**	

Confidence to explain technology *(Phase 1*	**Not confident** **1**	**2**	**3**	**4**	**Very confident** **5**
	0	0	4	1	2
%			**57.1%**	**14.3%**	**28.6%**

Purpose of technology education *(Phase 1)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	4	1	0	2	0	0
%	**57.1%**	**14.3%**		**28.6%**		

Importance of technology education *(Phase 1*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	0	2	5
%				**28.6%**	**71.4%**

Students in School C held initial concepts of technology that were either focused on technology being an *Artefact: tool/machine* (28.6%), *Invention: past/present/future* (14.3%), a *Process: a way of developing new products/systems* (14.3%) or *Process: meeting people's needs* (42.8%). Four students (57.1%) indicated that they were a 3 on the rating scale in terms of *confidence* to explain their concept of technology, while one student (14.3%) indicated they were a 4, and the remaining two students (28.6%) indicated they were a 5 and *very confident*.

Four students (57.1%) indicated that the purpose of technology education was to increase their abilities in *making understanding*. The others either identified that it was for *designing/inventing* (14.3%) or to *open career opportunities* (28.6%). Students in School C either rated technology education as being a 4 (28.6%) or a 5 (71.4%) on the rating scale for *importance* of technology education.

School D

Eight students (6 students in year 12 and 2 students in year 13 in 2006) from School D participated in the research. Table 14 presents Phase One data for this school.

Table 14: School D: Phase One Data

***n* = 6**	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 1)*	0	1	0	1	2	2	0
%		**16.7%**		**16.7%**	**33.3%**	**33.3%**	

Confidence to explain technology *(Phase 1*	**Not confident 1**	**2**	**3**	**4**	**Very confident 5**
	0	1	2	2	1
%		**16.6%**	**33.4%**	**33.4%**	**16.6%**

Purpose of technology education *(Phase 1)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	1	1	2	1	1
%		**16.6%**	**16.6%**	**33.4%**	**16.6%**	**16.6%**

Importance of technology education *(Phase 1*	Not important 1	2	3	4	Very important 5
	0	0	0	2	4
%				33.4%	66.6%

Students in School D held initial concepts of technology that were either focused on technology being an *Artefact: tool/machine* (16.7%), *Invention: past/present/future* (16.7%), *Process: a way of developing new products/systems* (33.3%) or a *Process: meeting people's needs* (33.3%). One student (16.6%) indicated they were a 2 on the rating scale of *confidence* to explain their concept of technology, two students (33.4%) indicating they were a 3 and two students (33.4%) a 4. The remaining one student (16.6%) indicated that they were a 5 and *very confident* in explaining their concept of technology.

One student (16.6%) indicated that the purpose of technology education was to increase their abilities in *designing/inventing* and one (16.6%) that it was *meeting needs*. Two students (33.4%) responded that the purpose was to *open career opportunities* and one (16.6%) that it was to gather *life skills*. One student response (16.6%) was categorized as *other* as their data could not be tabulated into a category. Students in School D either rated technology education as being a 4 (33.4%) or a 5 (66.6%) on the rating scale for *importance* of technology education.

School E

Three year 13 students from School E participated in the research. Table 15 presents Phase One data for this school.

Table 15: School E: Phase One Data

***n* = 2**	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 1)*	0	0	0	0	1	1	0
%					**50%**	**50%**	

Confidence to explain technology *(Phase 1*	**Not confident 1**	**2**	**3**	**4**	**Very confident 5**
	0	0	0	2	0
%				**100%**	

Purpose of technology education *(Phase 1)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	1	0	0	1	0
%		**50%**			**50%**	

Importance of technology education *(Phase 1)*	**Not important 1**	**2**	**3**	**4**	**Very important 5**
	0	0	0	2	0
%				**100%**	

Students in School E held initial concepts of technology that were either focused on technology being a *Process: a way of developing new products/systems* (50.0%) or *Process: meeting people's needs* (50.0%). Both students (100%) indicated they were a 4 on the rating scale of *confidence* to explain their concept of technology.

One student (50%) indicated that the purpose of technology education was to increase their abilities in *designing/inventing* and the other (50%) that it was to develop *life skills*. Both students (100%) indicated they were a 4 on the rating scale for *importance* of technology education.

4.3.1 Findings across schools

An identifiable trend in data from all schools was that the majority of responding students possessed a concept of technology as *Process*. Students in Schools B and E only indicated a concept of technology as being a *Process* with none of them indicating it to be an *Artefact* or *Invention.* While students in these two schools held concepts of technology that may well reflect the nature of the technology programme they have received in the past/or are currently receiving, both of these schools provided the smallest number of student participants to the research (n=2 and n=5) so this information while interesting, is considered not to be sufficiently statistically reliable to indicate a trend. The majority of students in School A who held concepts of technology which was categorised as a *Process* also understood the process to be a *way of developing new products/systems*. In Schools B and C the majority of students categorised under *Process* understood the process to be a means of *meeting people's needs.* Students in School D and E who identified their concept of technology to be a process were evenly distributed between a *way of developing new products/systems* and *meeting people's needs.*

Students in Schools B and D ranged from a 2 to a 4 on the 1-5 rating scale in indicating their confidence to explain their concept of technology. In Schools A and C students ranged from 2-5 on the rating scale and in School E both students indicated 4 for their confidence to explain technology.

School D had the only student who identified that the purpose of technology education was to increase their abilities in *meeting people's needs.* The majority of students in School C identified that the purpose was for *making understanding* and in School B the majority indicated that it was about *designing/inventing*. Students in Schools C, D and E all indicated that they were a 4 or a 5 on the rating scale in indicating the *importance* of the purpose of technology education. In each of Schools A and B one student indicated the *importance* of the purpose of technology education as being a 3 on the rating scale.

The trend of students rating technology education as an *important* subject to study, higher on the 1-5 rating scale than their ability to explain technology, was apparent in each of the individual schools set of data, with the exception of School E.

However School E's participant numbers were too small (n=2) to be able to indicate a valid trend in student responses to these questions.

Due to the number of student research participants in individual schools being low (ranging from n=2 to n=7) any further data analysis and its subsequent discussion will be focused on the data as one aggregated set, where n = 27, in order to identify trends (or not) within the research data.

4.4 Combined School Data – Phase One

4.4.1 Combined student data

The findings from the combined student participant responses to the questionnaire are presented in Table 16.

Table 16: Combined school student responses

n = 27	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 1)*	0	3	1	2	9	11	1
%		**11.2%**	**3.7%**	**7.4%**	**33.3%**	**40.7%**	**3.7%**

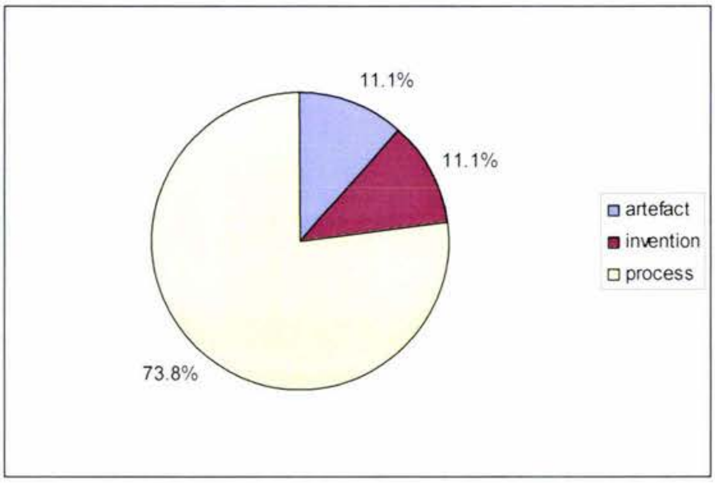
Confidence to explain technology *(Phase 1)*	**Not confident 1**	**2**	**3**	**4**	**Very confident 5**
	0	2	11	10	4
%		**7.4%**	**40.8%**	**37.0%**	**14.8%**

Purpose of technology education *(Phase 1)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	4	10	1	7	4	1
%	**14.8%**	**37.0%**	**3.7%**	**26.0%**	**14.8%**	**3.7%**

Importance of technology education *(Phase 1*	**Not important 1**	**2**	**3**	**4**	**Very important 5**
	0	0	2	15	10
%			**7.4%**	**55.6%**	**37.0%**

Twenty students (73.8%) held a concept of technology that focused on technology as a *Process*, three students (11.1%) viewed technology as an *Invention* and a further three (11.1%) as an *Artefact* – see Figure 1.

Figure 1: Student initial concepts of technology

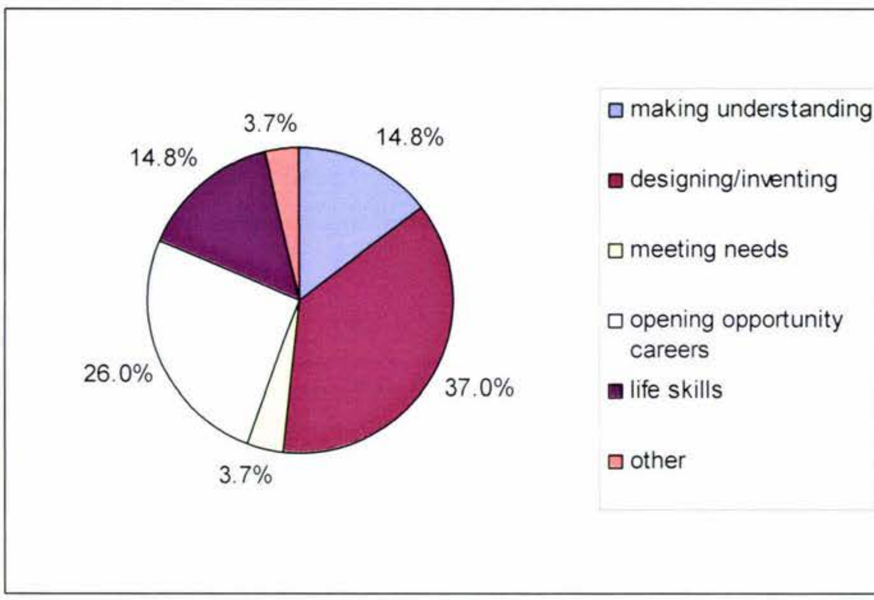


Of the twenty students who identified with a concept of technology as a *Process*, 11 students (40.7%) indicated that the process was for *meeting people's needs* and nine students (33.3%) indicated that the process was a *way of developing new products/systems*. The latter students indicated no awareness of the significance of social factors within the process. As described in Section 4.2.1 social factors identified by students could have included such factors as: meeting stakeholder needs; addressing potential and/or intended user needs; addressing client and/or intended user issues etc. When such factors were included students were categorised under *process*: *meeting people's needs*.

Two students (7.4%) identified that they were a 2 on the 1-5 rating scale in *confidence* to explain what technology was, eleven students (40.8%) gave themselves a rating of 3 and ten students (37.0%) a rating of 4. Four students (14.8%) considered themselves to be *very confident* in explaining what technology was and rated themselves 5 on the scale.

Four students (14.8%) identified that the purpose of technology education was for *making understanding*. Ten students (37.0%) believed it was to provide them skills in *designing/inventing* and one student (3.7%) *meeting needs*. Seven students (26.0%) believed technology education was for *opening career opportunities* and four students (14.8%) to develop *life skills*. Data from one student (3.7%) could not be tabulated against the categories for purpose of technology and was therefore placed in the *other* category – see Figure 2.

Figure 2: Student initial understandings of purpose of technology



When the ten students (37.0%) who identified that the purpose of technology education was to provide them skills in *designing/inventing* were analysed by year group, four of these students (40.0%) were in year 12 in 2006 and six (60.0%) in year 13. However, when the seven students (26.0%) who indicated that the purpose of technology was to *open an opportunity to potential careers* were analysed by year group, two (28.6%) were in year 12 in 2006 while five (71.4%) were in year 13. The differences between year groups could not be considered to be significant for either of the categories *designing/inventing* and *opening career opportunities* due to the low number of student research participants. The difference in percentage between the year groups for *opening career opportunities* may however be due to the stage that these students are at in their secondary schooling (i.e. the year 13 students beginning to think about likely future opportunities post secondary education). This will be explored again when looking at the impact that a practicing technologist has on student understandings following involvement in their learning.

No students indicated a 1 or 2 on the 1-5 rating scale for the *importance* of technology education. Two students (7.4%) indicated a 3 and 15 students (55.6%) rated it as a 4. Ten students (37.0%) indicated that technology education was *very important* by indicating a 5 on the rating scale. The remaining 25 students (92.6%) indicated the *importance* of technology education at a 4 or 5 on the rating scale.

4.4.2 Match between student confidence to explain technology and their understandings of technology

Table 17 portrays the link between student concepts of technology and their confidence to explain the concept.

Table 17: Students' concept of technology and their confidence to explain the nature of the concept

n = 27		**Confidence to explain concept of technology** *Not confident*				*Very confident*
		1	**2**	**3**	**4**	**5**
Artefact	*Electrical device*					
	Tool/ machine		1	1	1	
Invention	*New /different*				1	
	Past/ present/ future			1		1
Process	*A way of developing new products/ systems*		1	2	5	1
	Meeting people's needs			7	2	2
Other					1	
TOTAL		**0**	**2**	**11**	**10**	**4**

No students indicated a one on the 1-5 rating scale for *confidence* to explain their concept of technology. Of the two students (7.4%) who indicated that they were a 2 on the rating scale in their *confidence* to explain their concept of technology, one identified in the subsequent open ended questions that technology was about an *Artefact*: *tool/machine* and the other that it was a *Process*: *a way of developing new products/systems.*

From the 11 students who indicated their *confidence* as a 3 on the 1-5 rating, seven (63.6%) identified technology as a *Process*: *meeting people's needs*, two (18.8%) as a *Process*: *a way of developing new products/systems* and the remaining two (18.8%) as an *Artefact*: *tool/machine*, and *Invention: new different* and *past/present/future.*

Five (50.0%) of the 10 students who indicated their confidence as a 4 on the 1-5 rating scale identified technology in subsequent open ended questions as a *Process*: *a way of developing new products/systems.* Two students (20.0%) identified technology as a *Process*: *meeting people's needs*, one (10.0%) as an *Invention: new/different* and one (10.0%) as an *Artefact: tool/machine.* One student (10.0%) was tabulated as *other.*

Two of the four students (50.0%) who indicated a 5 on the 1-5 rating scale identified technology in subsequent open ended questions as a *Process*: *meeting people's needs.* One student (25.0%) identified technology as a *Process*: *a way of developing new products/systems* and the other *Invention: new different.*

Of the 14 students who identified a rating of 4 and 5 in their *confidence* to explain their concept of technology, only four students (28.6%) held a concept of technology that was categorised under *Process*: *meeting people's needs.* This compared to 7 students (63.3%) who indicated a 3 on the rating scale holding this concept of technology. It would therefore appear that students who rated themselves as 4 or a 5 on the 1-5 rating scale, generally held a less inclusive concept of technology than those students who rated themselves a 3. Ten of the 14 students (71.4%) who identified a rating of 4 and 5 in their *confidence* to explain their concept of technology did however identify their concept of technology to be a *Process*, compared to nine (81.8%) of 11 students who rated themselves a 3. No other trends were discernable from this analysis.

4.4.3 Match between student identifying technology education as important and what they think it is important for

Table 18 portrays the link between student concepts of the importance of technology education and what they think its purpose is.

Table 18: Students' understandings of the purpose of technology and how important it is

n = 27	Importance of technology *Not important* 1	2	3	4	*Very important* 5
Making understanding				2	2
Designing/ Inventing			2	7	1
Meeting needs (social factors mentioned)					1
Opening career opportunities				3	4
Life skills				3	1
Other					1
TOTAL			**2**	**15**	**10**

No students identified the importance of technology on the 1-5 rating scale as being a 1 or 2. The two students (7.4%) who rated a 3 identified in a subsequent open ended question that the purpose of technology education was for *designing/inventing*.

From the 15 students who indicated that they were a 4 on the 1-5 rating, seven (46.6%) identified the purpose of technology education was for *designing/inventing*, three (20.0%) for *opening career opportunities*, three (20.0%) for *life skills* and two students (13.3%) for *making understanding*.

Four (40.0%) of the 10 students who indicated a 5 on the 1-5 rating scale identified the purpose of technology education for *opening career opportunities*, two (20.0%) for *making understanding*. The remaining four students identified technology as being concerned with *designing/inventing, life skills, meeting needs* and *other*.

Twenty five students (95.6%) rating technology education a 4 or 5 as being an *important* subject in a schools curriculum on the 1-5 rating scale. The reasons they provided in the open-ended question for this, were distributed across all six categories with eight students (32.0%) being tabulated as *designing/inventing*, seven students (28.0%) as *opening career opportunities*, four students (16.0%) as *making understanding*, four students (16.0%) as *life skills* and one (4.0%) as *meeting needs*. One student was tabulated as *other*. No other trends were again discernable from this analysis.

4.5 Summary on Findings

The first research question sought to identify the initial understanding(s) of technology held by senior secondary school students. Students presented responses to the open-ended questions in the structured questionnaire that ranged from a very narrow concept of technology, seen as an *Artefact: tool or a machine* to a broader inclusive concept focused on technology as a *Process: meeting people's needs*.

While 20 students (74.1%) involved in this research, possessed a concept of technology that focused on *Process*, only 11 (55.0%) of these students identified the process to be about *meeting people's needs*. The other nine students (45.0%) identified the process as being *a way to develop new products/systems*. It was apparent in these later student responses to the open ended questions that they did not consider social factors such as stakeholder feedback, client and/or end user needs as being a part of technology as a process. Three students (11.2%) possessed a concept of technology that focused on *Artefact: tool/machine* and the remaining three students focused on *Invention* – two students (7.4%) *past/present/future* and one student (3.7%) *new/different.*

Initial understanding(s) of technology held by senior secondary school students involved in this research cover a range of concepts of technology. However, the most common understanding is focused on *Process*, with just under half the students (40.7%) saying it is concerned with *meeting people's needs* and the remaining students (33.3%) who identified technology as a process saying it is *a way to develop new products/systems*. Students also indicated a range of *confidences* (2-5) on the rating scale in being able to explain their concept of technology. Those students who expressed *confidence* in their ability to explain technology (rating themselves as 4 or 5 on the 1-5 rating scale), generally held a less inclusive concept of technology than those students who rated themselves less highly (rating of 3). This *confidence* will be explored again when looking at the impact that a practicing technologist has on student understandings following their involvement in students' learning.

The second research question sought to identify the initial understanding(s) of the purpose of technology education held by senior secondary school students. Students presented responses to the open-ended questions that ranged from a very narrow understanding of the purpose of technology education: *making/understanding* to a broader inclusive understanding of purpose based on: *meeting needs* where social factors such as interacting with stakeholders and clients, resolving people and/or environmental problems/issues were evident in student responses. Four students *(14.8%*) understood technology education to be about *making understanding*, 10 students (37%) about *designing/inventing* and one student (3.7%) that it was about *meeting needs*. Seven students (26.0%) believed it to be concerned with *opening career opportunities* and four students (14.8%) about *life skills*.

Initial understanding(s) of the purpose of technology held by senior secondary school students involved in this research covered a range of purposes. However, the most common were focused on *designing/inventing* (37%) and *opening career opportunities* (26.0%). Students rated technology education as being of importance on the 1-5 rating scale with the majority of students rating it a 4 or 5 (92.6%).

Further analysis of the Phase One data will be undertaken alongside the Phase Two and Three data, once student research participants have worked alongside a practicing technologist and presented in Chapter Five.

CHAPTER FIVE

RESEARCH FINDINGS: PHASE TWO

5.1 Overview of Chapter

Following participation of a practicing technologist(s) in the students' technology programme, the questionnaire was re-administered to students to collect the phase two data as described in Chapter Three. The questionnaire data were again taken from the 27 students in the five schools who participated in the research Where student research participants questionnaire responses needed further clarification, and/or where their responses were markedly different from their peers, but not isolated (i.e. where two or more students presented similar data), then these students were selected for a follow up interview..

This chapter presents findings in relation to students' concepts of technology and understandings of the purpose for technology education following a practicing technologist(s) working alongside them. Section 5.2 presents the student data by individual school and provides a comparison of these findings with those found in Phase One. Section 5.3 discusses the combined data from students in all five schools and Section 5.4 provides a summary of the findings and answers the third research question:

- do students' initial concepts of technology and understanding of the purpose of technology education change after they undertake a programme in technology that involves the participation of a practicing technologist(s)?

5.2 Findings: Phase One and Two

Data collected from the structured questionnaire and interviews during Phase Two were collated for quantitative analysis and categorised for qualitative analysis. This analysis allowed an exploration of the trends concerning both student understandings *of* and *about* technology within individual schools and across schools, to be undertaken.

5.2.1 Individual school and student: comparison with Phase One findings

Student data from Phase Two for each school were analysed and findings compared to those identified from the Phase One data.

School A

All seven students (4 students in year 12 and 3 students in year 13 in 2006) from School A completed the questionnaire for Phase Two of this research. They all indicated that a practicing technologist had been involved in their learning in technology when the data were collected. The teacher confirmed that this involvement for year 13 students was centred on them working alongside practicing technologists, who could provide specific input into the client based issue they were addressing. Examples of practicing technologists who worked with the year 13 students included: a window display designer, screen printers, an electronics expert, and a wearable art designer. All students in year 13 visited and interviewed a fashion designer. The purpose of this visit was for students to gain an understanding of key aspects of her technological practice. Aspects focused on included: how she worked with her clients and how she accessed materials to ensure that her designs were contemporary. An embroidery tutor also visited the classroom to show the students how she went about developing design ideas and the techniques she used.

The practicing technologist case studies on www.techlink.org.nz were analysed by the students to identify aspects of technological practice that were key to the technologists developing outcomes which were 'fit for purpose'. School A student data for Phase Two from the questionnaire are presented in Table 19.

Table 19: School A: Phase Two Data

***n* = 7**	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase2)*	0	0	0	0	6	1	0
%					**85.7%**	**14.3%**	

Confidence to explain technology *(Phase 2)*	**Not confident** **1**	**2**	**3**	**4**	**Very confident** **5**
	0	0	1	5	1
%			9.3%	71.4%	9.3%

Purpose of technology education *(Phase 2)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	0	0	2	5	0
%				**18.6%**	**71.4%**	

Importance of technology education *(Phase 2)*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	0	2	5
%				**18.6%**	**71.4%**

All students in Phase Two indicated in the open-ended question that they considered technology to be a process. This process was identified as either being a *Process*: *way of developing new products/systems* (85.7% of students) or one that was focused on *meeting people's needs* (14.3% of students). No students indicated that technology was concerned with the development of an *Artefact* or *Invention* or provided an answer that could not be categorised as occurred in Phase One. Table

20 provides a comparison of concepts of technology held by individual students at Phases One and Two.

Table 20: School A: Individual student responses - concept of technology Phases One (P1) and Two (P2)

$n = 7$		Student													
		A1		A2		A3		A4		A5		A6		A7	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Artefact	*Electrical device*														
	Tool machine														
Invention	*New different*														
	Past present future														
Process	*A way of developing new products systems*				From questionnaire data				From questionnaire data						
	Meeting people's needs				Following interview				Following interview						
Other															

When Student A4 was interviewed to clarify her questionnaire response for Phase Two the student stated that:

> *By working with practicing technologists this year I have received a lot more examples and knowledge about technology ……I have learnt a lot more about the meaning of technology - its really about making things for other people that meets what they need.* (A4)

As a consequence of this statement, Student A4's concept of technology was re-categorised for Phase Two from *Process: a way of developing new products/systems* to *Process: meeting people's needs*

When Student A2 was questioned about her change from *Process: meeting people's needs* in Phase One to *Process: a way of developing new products/systems* in Phase Two her response was:

> *I feel that technology is definitely about meeting people's needs through using technological practice and that this could be any number of ways – including making new products, but not necessarily.* (A2)

Student A2's concept of technology was also therefore re-categorised for Phase Two as being *Process: meeting people's needs.*

Students A1, A2, A5 & A6 (57.1% of students) presented data that showed no difference between Phases One and Two. Student A7 changed her response from *Invention: new/different* in Phase One to *Process: a way of developing new products/systems* in Phase Two. Student A3 data was categorised under *Other* in Phase One and in Phase Two *Process: meeting people's needs* while Student A4 moved from *Process: a way of developing new products/systems* in Phase One to in Phase Two *Process: meeting people's needs*.

On comparing the Phase Two findings focused on student *confidence* to explain their understandings about (concept of) technology to the Phase One findings, there were no overall differences identified between student responses to the 1-5 rating question. There were however individual students who indicated a difference in their response between the two phases. For example, Student A1 identified in Phase One a rating of 3 and in Phase Two a rating of 4 while Student A7 identified in Phase One a rating of 4 and in Phase Two a rating of 5. Student A4 moved from a 5 in Phase One to a rating of 4 in Phase Two – see Table 21. Due to the small overall number of participant students (n=27) the significance of these individual student differences were not tested in this research.

Table 21: *School A: Comparison between Phase One and Phase Two data - confidence in describing understandings (concept of) about technology*

n = 7	Student													
	A1		A2		A3		A4		A5		A6		A7	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1														
2														
3	■		■	■										
4		■			■	■		■	■	■	■	■	■	
5							■							■

When questioned about the increase in her *confidence* to explain the concept of technology between Phases One and Two Student A7 stated that:

> *.......last year I could say anything about last years topic because it was straightforward .... as you go on the technology gets so much harder and the skills you use more complicated – you have to work outside the square, you have to actually push yourself but I know more (A7).*

While this better understanding of technology resulted in an increase in *confidence* to explain technology for Student A7 the reverse happened for Student A4. For this student (Student A4) her *confidence* decreased between the two phases. She felt that as a result of knowing more about technology than she had in previous years, it had become more difficult to explain.

> *Probably sort of comes down to the fact that technology is not just making a dress, but actually looking at all the different needs, looking at the clients, looking at the stakeholders, looking at the implication the garment has. I have a better understanding of this now – to explain this to someone else would be way difficult (A4).*

Students in Phase Two either considered that the purpose of technology education was for *opening career opportunities* (28.6% of students) or to *develop life skills* (71.4% of students) – see Table 22

Table 22: School A: Individual student responses - purpose of technology education Phases One (P1) and Two (P2)

n = 7	Student													
	A1		A2		A3		A4		A5		A6		A7	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Making understanding														
Designing/ Inventing														
Meeting needs (social factors mentioned)														
Opening career opportunities														
Life skills														
Other														

This compared to 28.6% of students identifying with each of these two categories in Phase One and a further 42.8% of students considering *designing/inventing* to be the purpose for technology education.

Students A2, A5 and A6 changed their response in Phase Two to *Life skills* from *Designing/inventing* in Phase One. When questioned about reasons for this change Student A6 stated that it was because:

> *.... I was interested more in creating new things and letting my imagination run wild. Now this year it was focused more on the client interaction and I learnt client skills that I haven't approached until this year level before. (A6)*

When student responses for both their 'concept of technology' and the 'purpose of technology education' were compared across the year levels (year 12 and 13) there were no noticeable trends identified. Students in each year group presented data that classified them for the 'purpose of technology education', that aligned with both the *life skills* and *designing/inventing* categories and for 'concept of technology' *Process: meeting people's needs* and *Process: a way of developing new products/systems*. Only one student (Student A3 from Year 13) held a concept of technology as being concerned with *Process: meeting people's needs.*

When students were asked to identify the *importance* of technology education on a 1-5 rating scale there was a noticeable difference identified in student responses between Phases One and Two – see Table 23. The majority of students (57.1%) changed their ratings up one point. For example Students A3, A4, A6 and A7 identified in Phase One a rating of 4 and in Phase Two a rating of 5. Student A5 moved their rating up two points from a 3 to a 5 rating while Students A1 and A2 remained the same.

Table 23: *School A: Comparison between Phase One and Phase Two data - importance of technology education*

n = 7	**Student**													
	A1		**A2**		**A3**		**A4**		**A5**		**A6**		**A7**	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1														
2														
3														
4														
5														

When questioned about why they changed their rating on the *importance* of technology education between Phases One and Two, Student A3 stated that:

> *xxx was another practicing technologist I worked with during the project. She is a window display designer at zzz and also happened to be one of my clients. She taught me about the elements that go into a successful window display*

> *such as shape, colour and I applied her advice in the early stages of the design process ... it (working with a practicing technologist) has made me a lot more aware of what working in technological practice in the real world outside of school would be like.* (A3)

She also stated that:

> *I worked with a client, which I believe is of huge importance in terms of what happens in the workplace in the real world, and materials(technology) is the only subject which allows you to work with a client. (A3)*

Both of these statements allude to a practicing technologist having influence on the student's understanding of the *importance* of technology education.

School B

All five students (one student in year 12 and four students in year 13 in 2006) from School B completed the questionnaire for Phase Two of this research. They all indicated that a practicing technologist had been involved in their learning in technology. The teacher confirmed that this involvement for year 13 students included an opportunity for them to interview a shirt designer about her technological practice and the training she undertook to develop her own label and retail outlet. The teacher also directed the year 13 students to magazine articles and case studies on practicing technologists/fashion designers that described the practices they undertook to develop products. Students were expected to thoroughly analyse each of these articles/case studies to identify the nature of the technological practice undertaken by the technologists.

Year 12 students worked in conjunction with a retail outlet to design and manufacture a bag that suited the outlet's client market. This involved the students in identifying the target market through an interview with the outlet owner. The students also analysed the technological practice that the designer for the Air New Zealand uniform undertook to transform a raw product (sheep wool) into garments that were suitable for intended use – a uniform that met the needs of Air New

Zealand employees. School B student data for Phase Two from the questionnaire are presented in Table 24.

Table 24: School B: Phase Two Data

n = 5	Artefact		Invention		Process		Other
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 2)*	0	0	0	0	0	5	0
%						100%	

Confidence to explain technology *(Phase 2)*	Not confident 1	2	3	4	Very confident 5
	0	0	1	3	1
%			20%	60%	20%

Purpose of technology education *(Phase 2)*	Making understanding	Designing/ Inventing	Meeting needs (social factors mentioned)	Opening career opportunities	Life skills	Other
	0	2	3	0	0	0
%		40%	60%			

Importance of technology education *(Phase 2)*	Not important 1	2	3	4	Very important 5
	0	0	1	1	3
%			20%	20%	60%

All students in Phase One indicated in the open-ended question in the questionnaire that they considered technology to be a process – either *Process: developing new products/systems (20%)* or *meeting people's needs (80%)*. In Phase Two all students (100%) in School B identified the process to be focused on a *Process: meeting people's needs.* Table 25 provides a comparison of concepts of technology held by individual students at Phases One and Two.

Table 25: School B: Individual student responses - concept of technology Phases One (P1) and Two (P2)

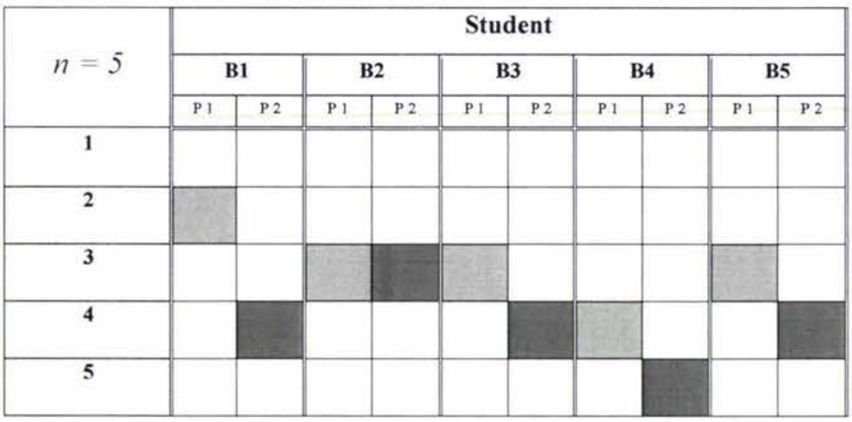
n = 5		Student									
		B1		B2		B3		B4		B5	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Artefact	*Electrical device*										
	Tool/ machine										
Invention	*New /different*										
	Past/ present/ future										
Process	*A way of developing new products/ systems*										
	Meeting people's needs										
Other											

When Student B1 was interviewed to clarify why her concept of technology had changed from *Process: developing new products* to *meeting people's needs* following interactions with practicing technologists, she stated that:

> *You have to put their needs before your own because if you get carried away on your own taste it is not going to happen, but then you have to also bring your own taste in to and make it look like your own (design), in a way that doesn't override other peoples needs. (B1)*

When the findings related to students' *confidence* to explain their understandings about technology were compared to the Phase One findings, there was a notable shift in rating in the student responses – see Table 26. This shift for the majority of students meant a shift up one point on the rating scale between Phases One and Two (i.e. a move from a rating of 3 to a 4 or a 4 to a 5). One student however (Student B1) moved her ratings from a 2 to a 4.

Table 26: *School B: Comparison between Phase One and Phase Two data - confidence in describing understandings (concept of) about technology*



When students were questioned about what contributed to their increase in *confidence* between Phase One and Two their responses focused on how working alongside practicing technologists had allowed them to see more possibilities, go deeper into their technological practice and gain better understandings.

> *I have a broader understanding of what it is now because I have encountered more situations involving technology. Also talking to practising technologists has opened my eyes to more possibilities (B5).*

> *... this year we have been able to go into more depth in all areas it's been more challenging ... looking at what technologists do helped my understanding and what to consider in technology (B4).*

There was a shift in student understandings for the purpose of technology education between Phase One and Two – see Table 27. Although student responses to the open-ended questions in Phase Two again fell into two categories, one of these categories changed between Phases One and Two - from *opening opportunities for careers* to *meeting needs*. The number of students identifying that the purpose of technology education was *designing and inventing* also reduced from four students to two students between Phases One and Two. Two students (Students B3 and B5) did not change their response to the open-ended question, keeping it as *designing and inventing*. Students B1 and B2 *changed from designing and inventing* to *meeting needs* while Student B4 changed from *opening opportunities for careers* to *meeting needs*.

Table 27: School B: Individual student responses - purpose of technology education Phases One (P1) and Two (P2)

n = 5	Student									
	B1		B2		B3		B4		B5	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Making understanding										
Designing/ Inventing	■		■		■	■			■	■
Meeting needs (social factors mentioned)		■		■				■		
Opening career opportunities							■			
Life skills										
Other										

When Student B2 was interviewed she identified how the shift in designing technological outcomes for a client this year (2006) as opposed to designing them for herself, as happened in previous years, contributed to her change from *designing/inventing* to *meeting people's needs*. She stated that:

> *The whole client base thing is very important also, whatever business you go into you have to be listening to your market and doing research and that is something that technology has taught me this year. Last year we did designing for ourselves, we did not go into those things. It has taught me that you have to distance yourself from your own opinions a bit and your own style and own choices, and look at the market and look at your client more, those are the main things (B2).*

> *I don't know that I will go on with fashion specifically but I think the foundation of the process coming up with an idea and then tapping into your market and researching that, that can really apply to any job you get into if you are doing something creative (B2).*

When students were asked to identify the *importance* of technology on a 1-5 rating scale, again there were differences identified in student responses between Phases One and Two. Student B3 reduced their rating from a 4 to a 3; Student B5 moved up one rating; Student B1 moved up 2 ratings; while 2 students kept their ratings the same as in Phase One – Student B2 at 4 and Student B4 at 5 – see Table 28.

Table 28: *School B: Comparison between Phase One and Phase Two data - importance of technology education*

n = 5	Student									
	B1		B2		B3		B4		B5	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1										
2										
3										
4										
5										

Student B5, when questioned about what contributed to her increasing her rating of the *importance* of technology between Phase One and Two stated that:

> *[I] think it is essential for the development of your understanding of how things work and function (B5).*

Student B3 when questioned why her rating went down from a 4 to a 3 stated that:

> *I am not going to study technology when I leave school this year (B3)*

School C

All seven students from School C completed the questionnaire for Phase Two of this research. They all indicated that a practicing technologist had been involved in their learning in technology when the data were collected. The teacher confirmed that students had researched and analysed the practice of technologists to identify key factors that contributed to the success of their technological outcomes (computer games). Key factors identified by students included the recognition of who the games stakeholders were (including target audience); what the common design constructs were for the games they developed (e.g. real time, challenge, reward, sense of progress, penalties, resources), animation techniques (e.g. storyboarding, use of jumpcuts and continuity to create an affects/illusions) and project management techniques they used. In an interview conducted with a practicing technologist, students had the opportunity to discuss how modelling was used to check a programme's logic before being developed into 'mission critical' software. Individual students were also mentored by software developers on specific aspects of their technological practice as well. School C student data for Phase Two from the questionnaire are presented in Table 29.

Table 29: School C: Phase Two Data

***n* = 7**	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 2)*	0	0	0	0	1	6	0
%					**14.2%**	**75.8%**	

Confidence to explain technology *(Phase 2)*	**Not confident** **1**	**2**	**3**	**4**	**Very confident** **5**
	0	1	2	2	2
%		**14.2%**	**28.6%**	**28.6%**	**28.6%**

Purpose of technology education *(Phase 2)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	0	3	1	3	0
%			**42.9%**	**14.2%**	**42.9%**	

Importance of technology education *(Phase 2)*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	0	2	5
%				**28.6%**	**71.4%**

All students in Phase Two indicated in the open-ended questions that they considered technology to be a *Process: either developing new products* (14.2%) or *meeting people's needs* (75.8%). In Phase One however, only 58% of students in School C identified that technology was a *Process: meeting people's needs* and *developing new products* with the remaining students identifying it as being concerned with *Artefact: tools/machines* (28%) and *Invention: past/present/future* (14%). Table 30 provides a comparison of concepts of technology held by individual students at Phases One and Two.

Table 30: School C: Individual student responses - concept of technology Phases One (P1) and Two (P2)

n = 7		**Student**													
		C1		**C2**		**C3**		**C4**		**C5**		**C6**		**C7**	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Artefact	*Electrical device*														
	Tool/ machine														
Invention	*New /different*														
	Past/ present/ future														
Process	*A way of developing new products/ systems*														
	Meeting people's needs														
Other															

When students were interviewed to clarify why their concept of technology had changed from a *Process: developing new products* to *meeting people's needs* following interactions with practicing technologists, Student C1 stated that:

> *My understanding is that technology is about having a need and finding a way to work through that need to solve it. The readings she (the teacher) gave us had information in them such as, purpose, usability ... how technology actually affects people.* (C1)

Similarly Student C7 explained the reason for this change as being due to:

> *Talking to (the teacher) about my project, being given tasks to do in my technology lessons, even thinking about how this (my project) related to the things that technologists do such as planning, programming stuff.* (C7)

When the findings related to students' *confidence* to explain their understandings about technology were compared with the Phase One findings there were shifts in student responses identified. For Student C1 and C5 this shift was a move down one point on the rating scale between their Phase One and Phase Two response. Students C2 and C6 showed a one point increase in their response and Students C3, C4 and C7 indicated no change in their rating point response between the two phases of the research – see Table 31.

Table 31: *School C: Comparison between Phase One and Phase Two data - confidence in describing understandings (concept of) about technology*

n = 7	**Student**													
	C1		**C2**		**C3**		**C4**		**C5**		**C6**		**C7**	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1														
2		■												
3	■		■				■	■		■	■			
4				■					■			■		
5					■	■							■	■

When student C1 was interviewed to clarify why his *confidence* to describe his understandings of technology had declined he stated that:

> *Technology is not just a small thing it is huge, with technology the more you know the less you can actually know. In technology you have to look everywhere, towards people, information area, research and stuff.* (C1)

Student C7 when interviewed also referred to being less *confident* in his ability to describe technology than he had previously, due to now having a better understanding of what technology involved.

> *Technology involves heaps of things, its not just about knowing how things work and making things which I once thought it was. I don't know it's hard to explain.* (C7)

Other students commented that since working with practicing technologists, they now have a better understanding of what technology is about and therefore more able to explain it. Student C2 explained that:

> *Looking at resources such as videos of technologists at work - like how they do stuff, helped me to understand what technology is.* (C2)

There was also a shift in student understandings for the purpose of technology education between Phase One and Two. In Phase One 58% of student responses to the open-ended questions indicated that the purpose of technology was *making/understanding.* No students in Phase Two however, identified with this as the purpose for technology. Of those students whose responses changed from this category (*making/understanding*), three students (Students C1, C2, and C4) changed their response in Phase Two to *meeting needs* while Student C6 changed his response to *life skills.* Student C5 changed his response from *career* to *life skills* and Student C7 from *designing/inventing* to *life skills* – see Table 32.

Table 32: School C: Individual student responses - purpose of technology education Phases One (P1) and Two (P2)

n = 7	**Student**													
	C1		**C2**		**C3**		**C4**		**C5**		**C6**		**C7**	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Making understanding														
Designing/ Inventing														
Meeting needs (social factors mentioned)														
Opening career opportunities														
Life skills														
Other														

When students were interviewed to clarify why their concept of technology had changed from *making understanding* to *meeting needs* following interaction(s) with practicing technologists, Student C2 stated that:

> *The first time I answered the question the way I did I think was because I had not touched technology much. I think technology is something always ahead of us, which is helping us in a way. Technology helps people. I think the purpose for studying technology is mainly about seeing how people think and looking at what they do.* (C2)

Student C4 identified that the practicing technologists had assisted him to develop his understanding of technology and had influenced his own undertaking of technological practice.

> *Xxxx (the technologist) helped me a lot, he taught me not to waste too much time on one area – how to plan to use my time efficiently. Also how important it is to talk to stakeholders.* (C4)

Student C7 who changed his response from *designing/inventing* in Phase One to *life skills* in Phase Two stated that the reason for this change was:

> *……… because if you study IT you can just pick out IT skills, like planning skills I picked up and the storyboarding skills - you can apply that to anything you do. It is not just in IT.* (C7)

Student C6 indicated that his concept of technology was also changed by interaction with a practicing technologist. He stated that:

> *Firstly they (the technologists) taught me about the use of technology, how to use it for practical purposes, and how to use it to help me solve problems or needs. They also taught me time management which I use in all aspects of school and life.* (C6)

When students were asked to identify the *importance* of technology on a 1-5 rating scale there were differences identified in student responses between Phases One and Two. Student C1 increased his rating from a 4-5; Student C5 reduced his rating by one from a 5 to a 4 and all of the other students maintained their Phase One rating response (Students C3, C4, C5 & C7 rating a 5 and Student C2 a rating of 4) – see Table 33.

Table 33: *School C: Comparison between Phase One and Phase Two data - importance of technology education*

n = 7	**Student**													
	C1		**C2**		**C3**		**C4**		**C5**		**C6**		**C7**	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1														
2														
3														
4	■		■	■						■				
5		■			■	■	■	■	■		■	■	■	■

When questioned about why they changed their rating on the *importance* of technology education between Phases One and Two Student C1 stated that:

> *I have learnt more about technology, what it means to have it and search for it and solve it ..... the people that came in from University and explained their process, how a simple programme works, all helped me to see the purpose for technology was more than just explaining things, more than just building things, its also about and how things are built.* (C1)

Student C5 stated that the reason he thought technology was less important than he first thought was:

> *Because I now see it as helping me to develop life skill – not setting me up for a career – I guess I think life skills are not as important as getting a career is.* (C5)

When Student C5 was further questioned about this statement (above) he indicated that was currently looking for a job and that this had influenced his response to this question. He also indicated that he was looking outside of technology related industries as a potential career pathway.

School D

Only six year 12 students from School D completed the questionnaire for Phase Two of this research due to two year 13 students' data being identified as invalid during Phase One– refer to Chapter Three Section 3.4.1 for details. These six students all indicated that a practicing technologist had been involved in their learning in technology when these data were collected. The teacher confirmed that involvement by practicing technologists provided opportunity for students to gain an insight into how the practicing technologist undertook their own technological practice. It also allowed students to gain technical assistance when they were designing their websites. School D student data for Phase Two from the questionnaire are presented in Table 34.

Table 34: School D: Phase Two Data

n = 6	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 2)*	2	1	0	0	0	3	0
%	**33.3%**	**16.7%**				**50%**	

Confidence to explain technology *(Phase 2)*	**Not confident** **1**	**2**	**3**	**4**	**Very confident** **5**
	0	1	2	2	1
%		**16.7%**	**33.3%**	**33.3%**	**16.7%**

Purpose of technology education *(Phase 2)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	0	0	0	5	1
%					**83.3%**	**16.7%**

Importance of technology education *(Phase 2)*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	0	1	5
%				**16.7%**	**83.3%**

Only two categories of concepts of technology (*Artefact*, and *Process*) were identified by students in Phase Two in the open-ended questions. This compared to all three categories (*Artefact*, *Invention* and *Process*) being identified by students in Phase One. Students D3, D4 and D6 identified technology to still be a *Process* but changed their Phase One response from *a way of developing new products/systems* to *meeting people's needs* in Phase Two. In Phase One, Student D4 identified technology to be concerned with *Invention: past/present/future* and changed in Phase Two to *Process: meeting people's needs.* Students D2 and D5 changed from a *Process* in Phase One to *Artefact* in Phase Two (Student D2 from *Process: meeting people's needs* to *Artefact: electrical device* and Student D5 from *Process: meeting people's needs* to *Artefact: tools/machines).* Student D1 kept his response as an *Artefact* but changed the category from *Artefact: tools/machines* in Phase One to *electrical devices* in Phase Two. Table 35 provides a comparison of concepts of technology held by individual students at Phases One and Two.

Table 35: School D: Individual student responses - concept of technology Phases One (P1) and Two (P2)

n = 6		Student											
		D1		D2		D3		D4		D5		D6	
		P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2
Artefact	*Electrical device*				From questionnaire data								
	Tool machine										From questionnaire data		
Invention	*New different*												
	Past present future												
Process	*A way of developing new products systems*												
	Meeting people's needs				Following interview						Following interview		
Other													

When Student D3 was interviewed to clarify why his concept of technology had changed from a *Process: a way of developing new products/systems* to *meeting people's needs* following interactions with practicing technologists, he stated that:

> *Technology is making jobs and things easier for people – saving time technology is finding out what people want and evolving something for them.*
>
> *(This year there is) a lot more stakeholder things in technology (than) last year. (Last year) it would have been mainly teachers', they would have been the main stakeholders. This time there is a lot more – you actually go up and look at an issue then try to find a solution for it. I have worked with real stakeholders, clients.* (D3)

For student D4, the change from holding a concept of technology as being focused on *Invention: past present future* to *Process: meeting people's needs* was due to her now working with authentic clients who have identifiable issues that need resolution, rather than solely working to address personal needs. Student C4 stated that:

> *Last year I thought Technology was about making things. I never thought of it as a process. I did think it was more practical, like making things but now I think about it being more about making things to help people, solve their needs.* (D4)

Analysis of student D5 responses to the questionnaires indicated a change from holding a concept of technology in Phase One focused on *Process: meeting people's needs* to *Artefact: tools machine* at Phase Two. When questioned further on the reason for this change, Student D5 discussed technology as being about things which are high tech - computers and calculators. He also indicated that it was about advancement – for everyone's use and it being about a process.

> *I changed over the year purely because – probably when – my project was just about due. Technology means advancing/making things more useful and easier to use – like computers, calculators, a lot of changes and advancement – for everyone's use, different types for different people, a lot more high tech. I see technology as being a process.* (D5)

Similarly Student D2, when interviewed, clearly aligned his concept of technology to being a *Process: meeting people's needs* rather than an *Artefact: electrical device* as was categorised from his response to the Phase Two questionnaire.

> *I am seeing (technology) as being more of a process in terms of helping people's lives. Helps re computers, building a tool in technology – example – making a – CD - teaching how to make a basketball. Yes I see this as technology; it's about developing outcomes.* (D2)

These two students (D5 and D2) were the only students whose Phase Two questionnaire response about their concept of technology changed categories when they were asked for explanation during interview. In both cases the information they provided in their questionnaire responses was very brief. For example, Student D5 wrote that technology was:

> *A tool that helps people do their job. (D5)*

Similarly Student D2 wrote that technology was:

> *Advanced computerised information. High tech stuff.* (D2)

All students interviewed indicated that the practicing technologists influenced their understandings about technology and the way they undertook their own technological practice. Examples of this impact were Student D4 stating:

> *He made me realize there was so much work involved in technology – I guess it made me think more in detail – really thinking about every little thing to solve a client problem.* (D4)

Student D5 stated that:

> *It gave you an insight into how things worked, how to plan my work, use storyboards, basically it helped me to understand technology, know how to work with other people to look at their needs, how to solve problems.* (D5)

When the findings related to students' *confidence* to explain their understandings of technology were compared to the Phase One findings, only Student D3 shifted his response between Phases One and Two. This student shifted his rating from 4 in Phase One to 2 in Phase Two – see Table 36.

Table 36: *School D: Comparison between Phase One and Phase Two data - confidence in describing understandings (concept of) about technology*

$n = 6$	Student											
	D1		D2		D3		D4		D5		D6	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1												
2	□	■				From questionnaire data						
3							□	■	□	■		
4					□	Following interview					□	■
5			□	■								

When questioned about this change Student D3 stated:

> *No I am not sure why that would be, I would still feel it should be about a 4 at the present time so that should probably be changed (D3)*

As a consequence of this statement, Student D3's confidence rating for Phase Two was changed to 4.

There was a significant shift in student understandings in School D for the purpose of technology education between Phase One and Two. Unlike Phase One, where student responses to the open-ended questions were spread across all six categories, in Phase Two their responses were either categorised into *life skills* (50% of students) or *meeting needs* (50% of students). Student D6 response was categorised as *life skills* for both Phase One and Two. Students D3 and D4 changed categories from opening *career opportunities* in Phase One to *meeting needs* in Phase Two. Student D1 changed from *designing/inventing* to *life skills* and Student D2's category changed from *meeting needs* to *life skills.* Student D5's response changed from *other* in Phase One to *Process: meeting people's needs* in Phase Two – see Table 37.

Table 37: School D: Individual student responses - purpose of technology education Phases One (P1) and Two (P2)

n = 6	Student											
	D1		D2		D3		D4		D5		D6	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Making understanding												
Designing/ Inventing												
Meeting needs (social factors mentioned)												
Opening career opportunities												
Life skills												
Other												

When questioned about the purpose of technology being focused on *meeting needs* students stated that:

> *Basically finding solutions to problems was the main thing because that is not just technology but it's what you do in life.* (D3)

> *It's (technology) a good process to follow – planning is definitely important as a life skill, as is meeting people's needs.* (D4)

When students were asked to identify the *importance* of technology on a 1-5 rating scale only one student (Student D4) changed her response between Phases One and Two. This student increased her rating from a 4 to a 5 – see Table 38.

Table 38: School D: Comparison between Phase One and Phase Two data - importance of technology education

n = 6	Student											
	D1		**D2**		**D3**		**D4**		**D5**		**D6**	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
1												
2												
3												
4												
5												

When questioned specifically why her response had changed, Student D4 responded that:

> *Technology helped me a lot in the development and processes to follow – not just for the subject technology but also in many other areas such as drama …… it has taught me how to solve problems* (D4)

This response aligned with Student D4's response when questioned about what she thought the purpose of technology education was and her belief that it was about *meeting needs.*

School E

The two students who provided valid data in Phase One from School E completed the questionnaire for Phase Two of this research. They both indicated that a practicing technologist had been involved in their learning in technology when these data were collected. The teacher confirmed that the involvement by practicing technologists provided these students with an opportunity to understand the manufacturing (production) process, used in a textiles industry. It also allowed them to gain an appreciation of the importance of technological practice to a fashion designer. Students learnt that things such as planning, understanding client needs and identity (including cultural identity), were key factors that needed to be understood in order to ensure that manufactured garments met client expectations.

Students also analysed the technological practice that was undertaken to develop theatre costumes to a directors' brief, in order to identify how this differed from the practices they used to create garments for streetwear. School E student data for Phase Two from the questionnaire are presented in Table 39.

Table 39: School E: Phase Two Data

n = 7	**Artefact**		**Invention**		**Process**		**Other**
	Electrical device	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
Concept of technology *(Phase 2)*	0	0	0	0	0	2	0
%						**100%**	

Confidence to explain technology *(Phase 2)*	**Not confident** **1**	**2**	**3**	**4**	**Very confident** **5**
	0	0	0	2	0
%				**100%**	

Purpose of technology education *(Phase 2)*	**Making understanding**	**Designing/ Inventing**	**Meeting needs (social factors mentioned)**	**Opening career opportunities**	**Life skills**	**Other**
	0	1	0	1	0	0
%		**50%**		**50%**		

Importance of technology education *(Phase 2)*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	0	0	2
%					**100%**

Both students in Phase One indicated in the open-ended questions that they considered technology to be a *Process* - Student E1 indicated *Process: a way of developing new products/systems* and Student E2 *Process*: *meeting people's needs.* In Phase Two however, both students identified that technology was a *Process* concerned with *meeting people's needs.* Table 40 provides a comparison of concepts of technology held by individual students at Phases One and Two.

Table 40: School E: Individual student responses - concept of technology Phases One (P1) and Two (P2)

n = 2		Student			
		E1		**E2**	
		P1	P2	P1	P2
Artefact	*Electrical device*				
	Tool/ machine				
Invention	*New /different*				
	Past/ present/ future				
Process	*A way of developing new products/ systems*				
	Meeting people's needs				
Other					

When Student E1 was interviewed to clarify why her concept of technology had changed from a *Process: a way of developing new products/systems* to *meeting people's needs* following interactions with practicing technologists, she stated that:

> *This year I had to design a garment for a client (director of Opera) who had given our class a brief and requirements that we had to design a garment for – I had to think about what the director wanted for the garments, what the garments would look like on stage and also what sort of garments would be required for the larger actors that we were designing for – in the end it was all about developing a garment that met the directors needs but I also had to be satisfied that it was ok too.* (E1)

Student E2 also stated that the practicing technologists had helped her to understand technology as a process and the importance of planning, quality control use of themes for inspiration. She also stated that:

> *The practicing technologists enhanced my understanding about what technology was about. I was able to see what they thought of designs and styles and where they got their inspiration from.* (E2)

When the findings related to students' *confidence* to explain their understandings of technology were compared to the Phase One findings, there were no shifts in student responses identified in the data – see Table 41.

Table 41: School E: Comparison between Phase One and Phase Two data - confidence in describing understandings (concept of) about technology

n = 2	Student			
	E1		E2	
	P1	P2	P1	P2
1				
2				
3				
4				
5				

There was a shift in student understandings for the purpose of technology education between Phase One and Two. Student E1 identified that the purpose of technology in both Phases One was for *life skills* and in Phase Two changed this to *opening career opportunities* . Student E2 provided the same response in Phases One and Two identifying technology as *designing/inventing* – see Table 42.

Table 42: School E: Individual student responses - purpose of technology education Phases One (P1) and Two (P2)

n = 2	Student			
	E1		E2	
	P1	P2	P1	P2
Making understanding				
Designing/ Inventing				
Meeting needs (social factors mentioned)				
Opening career opportunities				
Life skills				
Other				

When interviewed about the change in response between Phases One and Two, Student E1 stated that she was aiming to undertake tertiary study in design in 2007, with the aim of making a career out of it. This helps to explain why her responses were focused on identifying technology as a career. Student E2 also indicated that she had an interest in pursuing further study in design at a tertiary level.

When students were asked to identify the *importance* of technology on a 1-5 rating scale the two students changed their response between Phases One and Two from a 4 to a 5 rating – see Table 43.

Table 43: *School E: Comparison between Phase One and Phase Two data - importance of technology education*

n = 2	**Student**			
	E1		**E2**	
	P1	P2	P1	P2
1				
2				
3				
4	■		■	
5		■		■

This response, seeing technology being an important subject to study at school, again reflects these students' intentions to follow a technology pathway in future tertiary study.

5.3 Combined School Data: Phases One and Two

5.3.1 Combined school data: comparison with Phase One findings

Concept of Technology

The student research participant finding from all schools on *concepts of technology* is presented in Table 44.

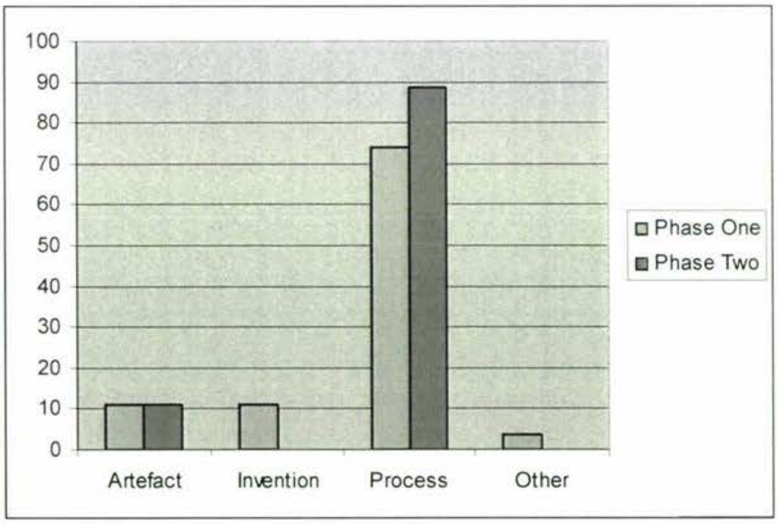
Table 44: Combined Schools: Student responses - concept of technology education

N=27	Artefact				Invention				Process				Other	
	Electrical device		*Tool machine*		*New different*		*Past present future*		*A way of developing new products systems*		*Meeting people's needs*		*Electrical device*	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
STUDENTS A1														
A2														
A3														
A4														
A5														
A6														
A7														
B1														
B2														
B3														
B4														
B5														
C1														
C2														
C3														
C4														
C5														
C6														
C7														
D1														
D2														
D3														
D4														
D5														
D6														
E1														
E2														
TOTAL STUDENTS	0	2	3	1	1	0	2	0	9	5	11	19	1	0
%	0	7.4	11.1	3.7	3.7	0	7.4	0	33.3	18.5	40.8	70.4	3.7	0

In Phase One 74.1% of students held a concept of technology as a *Process*. By the end of Phase Two the majority of students (89.4%) held a *concept of technology* that focused on technology as a *Process*. This indicated a 15.3% increase from the Phase One findings in students who held a concept of technology that focused on *Process*. No students in Phase Two identified that their concept of technology was *Invention* while 11.1% still thought it was concerned with *Artefact* – for a comparison between Phase One and Phase Two overall student concepts of technology see Figure 3.

In Phase Two students in Schools A, B, C and E all identified their concept of technology to be a *Process*. In School D however, 50% of the students (3 students) indicated their concept of technology to be an *Artefact*. As discussed in Chapter Three, Section 3.5 School D's technology programme centred on the use of computers as a tool within information and communications technology. It was therefore not unexpected that students may hold a concept of technology that focused on the technology as an *Invention*: *tool/machine*.

Figure 3: Combined schools: Comparison between Phase One and Phase Two data - student concepts of technology



Of the 24 students who identified with a concept of technology as a *Process*, 19 students (79.2%) indicated that the *Process* was *meeting people's needs* and five students (20.8%) indicated that the *process* was a *way of developing new products/systems*. The latter students indicated no awareness of the significance of social factors on the process they described.

Unlike Phase One findings, where no students held the concept of technology as *Artefact: electrical device*, in Phase Two, two students (7.4%) held this concept. Both of these students came from School D. The only other student to possess a concept of technology as an *Artefact: tool/machine* also came from School D.

Purpose of Technology Education

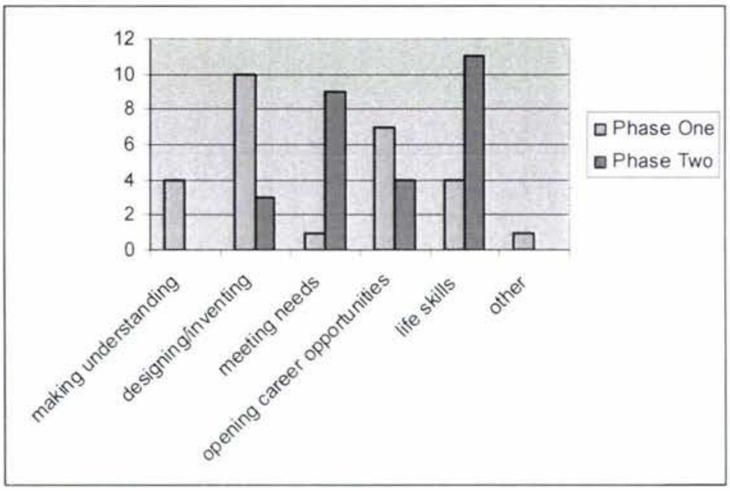
The student research participant finding from all schools on understandings about the *purpose of technology education* is presented in Table 45.

Table 45: Combined Schools: Student responses - purpose for studying technology at school

N=27		Making/ understanding		Designing/ Inventing		Meeting needs (social factors mentioned)		Opening career opportunities		Life skills		Other	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
STUDENTS	A1								■	■			
	A2			■							■		
	A3							■	■				
	A4							■			■		
	A5			■							■		
	A6			■							■		
	A7									■	■		
	B1			■			■						
	B2			■			■						
	B3			■	■								
	B4						■	■					
	B5			■	■								
	C1	■					■						
	C2	■					■						
	C3							■	■				
	C4	■					■						
	C5							■			■		
	C6	■									■		
	C7			■							■		
	D1			■							■		
	D2					■					■		
	D3						■	■					
	D4						■	■					
	D5						■					■	
	D6									■	■		
	E1								■	■			
	E2			■	■								
TOTAL STUDENTS		4	0	10	3	1	9	7	4	4	11	1	0
%		14.8	0	37.1	11.1	3.7	33.3	25.9	14.8	14.8	40.8	3.7	0

In Phase Two, no students identified that the *purpose of technology education* was for *making understanding*, three students (11.1%) identified that it was to enable them to learn how to *design/invent* and nine students (33.3%) identified the purpose of technology was *meeting needs*. Four students (14.8%) identified the purpose of technology was to open *opportunity to potential careers* and 11 students (40.8%) considered it to be about *life skills*. No students were categorised as *other*. For a comparison between Phase One and Phase Two student understandings of the purpose for studying technology at school see Figure 4.

Figure 4: Combined schools: Comparison between Phase One and Phase Two data - purpose for studying technology at school from all student participants



The number of students who identified the *purpose of technology education* was *meeting needs* increased by 29.6% (eight students) between Phases One and Two. Of the eight students who changed their understanding for the purpose of technology being about *meeting needs*, three students identified in Phase One that the purpose for technology was *making understanding*, two students *designing/inventing* and three *opening career opportunities*. The next greatest change between Phases One and Two was students who identified that the purpose of technology education was for *life skills*. This change represented an increase of 26% or seven students. The categories which recorded a reduction in students being tabulated to them between the two phases were: *making understanding* (reduction of four students), *opening career opportunities* (reduction of three students) and *designing/inventing* (reduction of seven students).

Confidence to describe their understanding of technology and importance of technology education

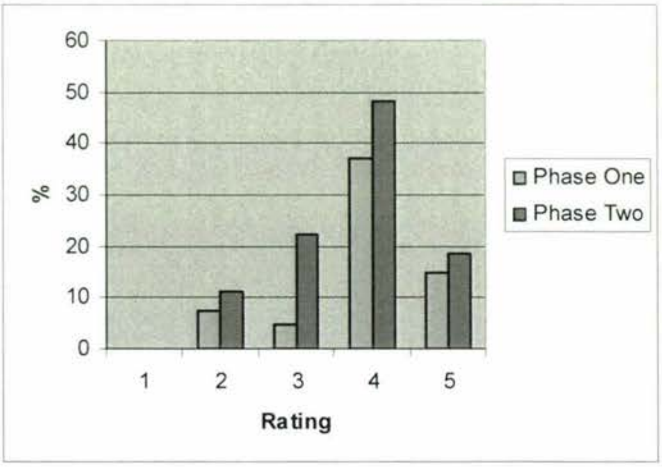
The combined student participant response for Phase Two, from all five schools for their *confidence* to describe their understandings about (concept of) technology is presented in Table 46.

Table 46: Combined Schools: Student confidence to describe understanding (concept of) about technology – Phase Two

Confidence to explain technology *(Phase 2)*	Not confident 1	2	3	4	Very confident 5
	0	3	6	13	5
%		**11.1%**	**22.2%**	**48.2%**	**18.5%**

In Phase Two, 66.7% of students indicated a *strong confidence* (indicating 4 or 5 on the rating scale), that they could explain their understandings of technology. This percentage was an increase from the Phase One findings where only 51.8% of students (an increase of 14.9% of students) indicated a *strong confidence* to explain their understandings of technology - see Figure 5.

Figure 5: Combined Schools: Comparison between Phase One and Phase Two data - confidence to describe understandings (concept of) about technology



Students in all schools presented findings that indicated that student *confidence* to explain technology had increased between Phases One and Two (showing an increase in the number of students indicating a 4 or 5 on the rating scale as compared to a 1-3 rating).

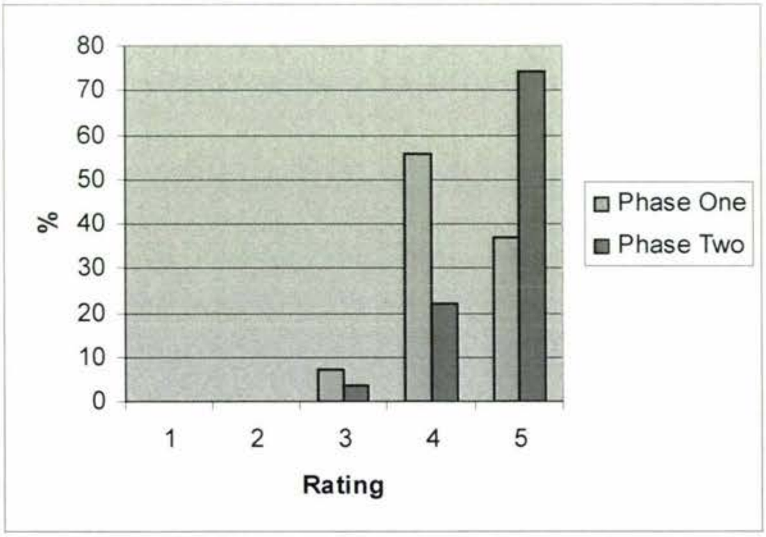
The combined student participant responses for Phase Two from all five schools about the *importance* of technology education included as a subject in a school's curriculum for Phase Two are presented in Table 47.

Table 47: Combined Schools: Importance of technology education - Phase Two

Importance of technology education *(Phase 2)*	**Not important** **1**	**2**	**3**	**4**	**Very important** **5**
	0	0	1	6	20
%			**3.7%**	**22.3%**	**74.0%**

One student (3.7% of students) continued to rate the *importance* of technology education at a 3 on the rating scale in Phases Two, six students rated it at a 4 and twenty students rated it as a 5. When these data were compared to the Phase One data the number of students who rated technology education as *very important* (as a 5) doubled between the two phases. Correspondingly the number of students who rated it at 3 and 4 decreased between Phases One and Two – see Figure 6.

Figure 6: Combined schools: Comparison between Phase One and Phase Two data- importance of technology education



Eighteen students (66.7%) indicated a higher rating (on the 1-5 scale) for technology being an *important* subject to study at school, than their rating for their *confidence* to explain technology. One student (3.7%) rated the *importance* of technology education lower than their *confidence* to explain it and eight (29.6%) rated it the same. Of those students who indicated a higher rating for technology education being an *important* subject to study at school, 13 students (72.2%) rated it one point higher, three students (16.7%) rated it two points higher and two students (11.1%) three points higher. Students rating technology as an important subject to study, higher on the rating scale than their ability to explain technology, was a trend also apparent in Phase One (with the exception of school E - see section 4.3.1 for further explanation).

5.3.2 Match between student confidence to explain technology and their understandings of technology

It would appear from the findings that there is a strong relationship between student *confidence* to explain their understandings of technology and their ability to do so. Eighteen of the 24 students (75%) who demonstrated an inclusive concept of technology by describing technology as a *Process* rated their confidence to explain technology as a 4 or 5 on the 1-5 rating scale. Of the remaining six students (25%) who indicated that technology was a *Process*, one student (4.2%) indicated a confidence rating of 2 and five students (20.8%) indicated a rating of 3 in their confidence to explain technology.

Of the three students who indicated that they were a 2 on the 1-5 rating scale in their *confidence* to explain technology, two students identified in the subsequent open ended questions that technology was about *Process*: *meeting people's needs*, and the other student that it was an *Artefact*: *electrical devices*.

From the six students who indicated that they were a 3 on the 1-5 rating, four (66.7%) identified technology as a *Process*: *meeting people's needs*, one (16.6%) as a *Process*: *a way of developing new products/systems* and the remaining one student (16.6%) as an *Artefact*: *tool/machine*.

All fourteen students who indicated a 4 on the 1-5 rating scale identified technology in subsequent open ended questions as a *Process*. Three of these students (23.1%) identified it as a *Process: a way of developing new products/systems* and the remaining ten (76.9%) as a *Process: meeting people's needs*.

Three of the five students (60%) who indicated a 5 on the 1-5 rating scale identified technology in subsequent open ended questions as a *Process: meeting people's needs*, one student (20%) as a *Process: a way of developing new products/systems* and the remaining student *Artefact: electrical device*. This student came from School D – see earlier discussion in Chapter Five, Section 5.3.1 on this schools' focus on using computers in information and communications technology.

Of the nineteen students who identified a rating of 4 and 5 in their *confidence* to explain technology, eighteen students (94.7%) identified it as a *Process*. Fourteen of these students (77.7%) held a concept of technology that was categorised under *Process: meeting people's needs*. This was an increase of 77.3% of students from those who indicated a 4 and 5 in their confidence to explain their concept of technology in Phase One and identified with technology being a *Process: meeting people's needs*. These findings do not align with the Phase One findings, which found that students who rated themselves as a 4 or 5 on the rating scale, possessed a less inclusive concept of technology than those who rated themselves less highly (at a rating of 3 or below). As such, the Phase Two findings indicate a significant shift in alignment in student confidence to explain their concept of technology and what technology is considered to encapsulate – a process designed specifically for *meeting people's needs*.

5.3.3 Match between student identifying technology education as important and what they think it is important for

The one student who identified they were a 3 on the 1-5 rating scale (to indicate the importance of technology education as a subject at school), identified in a subsequent open ended question that the purpose of technology education was for *designing/inventing*.

Of the six students who indicated the importance of technology as 4 on the 1-5 rating scale, three (50%) identified the purpose of technology education for *life skills*, two students (33.3%) for *meeting needs* and one student (16.7%) for *opening an opportunity to potential career(s)*.

Eight of the 20 students (40%) who indicated a 5 on the 1-5 rating scale identified the purpose of technology education for *life skills*, seven students (35%) *meeting needs*, three (15%) *opening career opportunities* and two (10%) for *designing/inventing*.

Twenty-six students (92.6%) identified technology education as being important as a subject in a school's curriculum on a rating of 4 or 5. The reasons they provided in the open-ended question for this being so, were distributed across five of the six categories with 11 of the students (42.6%) identifying its importance as being focused on developing *life skills*. In Phase One, 25 students identified technology education as being *important* as a subject in a schools curriculum on a rating of 4 or 5 (95.6% of students). The most common reason given for this was *designing/inventing* (8 students or 32%).

5.4 Summary on Findings

The first research question sought to identify the *concept(s) of technology* held by senior secondary school students following opportunity for a practicing technologist to work alongside them. Students in all five schools demonstrated a shift in their understandings of technology following interaction with a practicing technologist – see Table 48.

With the exception of one student, all others indicated that technology was focused on a *Process* and for the majority of these students (84.6% of students) that this process was focused on *meeting people's needs*. Possessing a concept of technology as a *Process* that is centred on *meeting people's needs* represents a broad and inclusive concept of technology – see earlier discussion in Chapter Two, Section 2.3.2.

Table 48: Findings by School: concept of technology - Phase Two

	Artefact		**Invention**		**Process**		**Other**
School A *n = 7*	*Electrical device*	*Tool/ machine*	*New /different*	*Past/ present/ future*	*A way of developing new products/ systems*	*Meeting people's needs*	
(Phase 1)	0	0	2	0	3	1	1
(Phase 2)	0	0	0	0	4	3*	0
School B *n = 5*							
(Phase 1)	0	0	0	0	3	2	0
(Phase 2)	0	0	0	0	0	5	0
School C *n = 7*							
(Phase 1)	0	2	0	1	1	3	0
(Phase 2)	0	0	0	0	1	6	0
School D *n = 6*							
(Phase 1)	0	1	0	1	3	1	0
(Phase 2)	1*	0	0	0	0	5*	0
School E *n = 2*							
(Phase 1)	0	0	0	0	1	1	0
(Phase 2)	0	0	0	0	0	2	0

The second research question sought to identify the understanding(s) of the *purpose of technology education* held by senior secondary school students following opportunity for a practicing technologist to work alongside them. All students in four of the five schools demonstrated a shift in their understandings of the purpose for technology education following interaction with a practicing technologist. – see Table 49.

* Note: This number includes the two students who were re-categorised following interview.

Table 49: Findings by School: purpose of technology education – Phase Two

School A *n = 7*	**Making/ Understandin g**	**Designing/ Inventing**	**Opening career opportunities**	**Life skills**	**Meeting needs (social factors mentioned)**	**Other**
(Phase 1)	0	3	2	2	0	0
(Phase 2)	0	0	2	5	0	0
School B *n = 5*						
(Phase 1)	0	4	1	0	0	0
(Phase 2)	0	2	0	0	3	0
School C *n = 7*						
(Phase 1)	4	1	1	0	1	0
(Phase 2)	0	0	1	3	3	0
School D *n = 6*						
(Phase 1)	0	1	2	2	0	1
(Phase 2)	0	0	0	5	0	1
School E *n = 2*						
(Phase 1)	0	1	1	0	0	0
(Phase 2)	0	1	1	0	0	0

This finding represented a general shift by students along the continuum from their holding a narrow understanding of the purpose of technology education: *designing/inventing* towards a broader, more inclusive understanding based on the purpose of technology education being centred on their developing an understanding about: *meeting needs – see* earlier discussion in Chapter Two. As discussed earlier, the two students from School E who participated in this research were intent on pursuing technology as a career/at tertiary study. This intent may explain why their understanding of the purpose of technology education remained centred on *designing/inventing* and *opening career opportunities*.

The research findings also indicated a shift in student ability to explain their concept of technology and the purpose of technology. This ability was connected to their possessing a broad and inclusive understanding of technology as a process. It is also connected to their understanding that the purpose of technology education is to develop their skills and knowledge (including awareness) of how it meets needs.

The findings of this research, suggest that student concepts of technology and their understandings of the purpose of technology education shift when they undertake a programme in technology that involves the participation of a practicing technologist. Students shift towards development of a broader and more inclusive understanding of technology and technology education, and having greater *confidence* to explain it. The research also demonstrated that students perceive technology education to be of greater *importance* when they interact with practicing technologists, as part of their technology education programme.

In Chapter Six, the findings from this research are discussed further in relation to the literature that was presented in Chapter Two. Implications identified by this research for using practicing technologists to enhance student learning in technology will also be discussed.

CHAPTER SIX

DISCUSSION AND IMPLICATIONS

6.1 Overview of Chapter

This chapter summarises and discusses the research, and addresses its overall aim; that of determining if there is an impact on student understandings *of* and *about* technology when practicing technologists work alongside them. The chapter begins with a summary and discussion of the findings from the research questions set out in Chapter One. The implications of the research findings are next discussed, and the chapter concludes with suggestions for future research.

6.2 Initial Understanding(s) of Technology held by Senior Secondary School Students

The findings from this research for Question One, that focused on identifying the initial understanding(s) of technology held by senior secondary school students showed that they held concepts of technology that ranged from a very narrow concept of technology, seen as an *Artefact: tool or a machine* (11.1%) to a broader more contemporary concept focused on technology as a *Process: meeting people's needs* (66.6%). No students possessed a concept of technology that was focused on technology being an *Artefact: electrical device*. This differed from the findings of Mather (1995) where 42% of year 3-4 students identified technology as being an *Artefact: electrical device*. It is also interesting to note in Ratt, deKlerk, Wolters & de Vries (1987) research with year 8 students, that they predominantly thought of technology as machines and equipment. The difference between findings from this study, and Mather, (1995) and Ratt, deKlerk, Wolters & de Vries (1987) research may largely be explained by Jarvis (1998b), and Rennie and Jarvis (1993) research findings, which concluded that student views of technology appeared to be become more complex and coherent, as they became older.

Even though 66.6% of students in this study possessed an initial concept of technology which focused on it being a *Process*, only 55% of these students identified the process to be about *meeting people's needs* with the remaining students (45%) identifying the process as being a way to *develop new products and/or systems*. As argued by Burns (1990), identifying technology as a way to *develop new products and/or systems* without due consideration of society's needs and influences (i.e. *addressing peoples' needs*), omits to consider technology as determined by society (Burns, 1990).

6.3 Initial Understanding(s) of the Purpose of Technology Education held by Senior Secondary School Students

The findings from this research for Question Two, showed that senior secondary school students' initial understanding(s) of the purpose of technology ranged from a very narrow understanding of its purpose: *making/understanding* to a broader inclusive understanding of purpose based on: *meeting needs*. The majority of students however, identified technology to be concerned with *making/understanding* (14.8%), *designing/inventing* (37%) and *opening career opportunities*. The one student (4%), whose initial understanding of the purpose of technology education was *meeting people's needs* articulated the importance of listening to stakeholder and client opinion when resolving people and/or environmental problems.

The reason for students understanding the purpose of technology education to be to prepare themselves for later *career opportunities*, was initially thought to be due to their concern for their future employment and/or further study post secondary education. Analysis of the research data by year group however, showed that this could not be argued as a justification as both year 12 and 13 students presented data which was categorised into *career opportunities* (40% of the ten students in year 12 and 60% of the students in year 13). Given the small number of students who participated in this research, the difference of 20% identified between year groups for this category cannot be considered to be statistically significant.

Compton's (2005) baseline data on student concepts of technology indicated that 60% of students in her study held concepts of technology that centred on *improving things for people*, or *meeting needs*. Of interest in this research is the fact that students, at the time that the baseline data were collected, were not necessarily studying technology, either due to the timing of their learning programme or they had not selected it as a subject for further study at senior secondary school. Rennie and Jarvis (1993) research found that student's perceptions of technology often mirrored their experiences in technology education and these varied even when they were grouped within the same class. Rennie and Jarvis (1993) findings may therefore, provide some insight into the differences found between Compton's (2005) research findings and those found in the initial data collected from this research. All students who participated in this research were undertaking a programme of learning in technology Differences identified in students' initial understanding(s) of the purpose of technology may therefore be attributed to the nature of the technology programme they were experiencing.

6.4 Impact of Practicing Technologist(s) on Senior Secondary Students' Concepts of Technology and Purpose of Technology

The findings from this research for the first part of Question Three, which focused on identifying if student understanding(s) of technology changed after they undertook a programme of study in technology that involved the participation of a practicing technologist(s), demonstrated that there was an increase in the number of students (22% increase) who understood technology to be a *Process* focused on *meeting peoples' needs*. This increase meant that fewer students held a concept of technology that was based on it being an *Artefact* and/or an *Invention* following interaction with a practicing technologist(s). Mather (1995) also identified that student's concept of technology became broader and more contemporary following engagement in technological activity. The findings from this research therefore provide additional evidence, that student concepts of technology are influenced and shaped as a direct result of their experiences in participating in a programme of technology education. This contrasts with Rennie and Jarvis (1993) findings, which identified that Australian students most often shaped their ideas about technology from "incidental and often out-of-school sources, like family conversations, television and other forms of media" (p.8). In saying this however, not all students in the Rennie and Javis (1993) research were engaged in technology education at the time that their research was conducted. Rather, the subjects they were studying had them either 'designing or making' projects (United Kingdom) or following a more traditional technical education model that required them to construct projects to teacher specified plans (Australia).

The findings, that student concepts of technology and their understanding of the purpose of technology are enhanced through interacting with practicing technologists, supports the learning theories underpinning Technology in the New Zealand Curriculum (Ministry of Education, 1995) and the draft *Technology Curriculum Learning Area Introduction* (Ministry of Education, 2006). That is, the socio-cultural and constructivist stance which underpins technology education in New Zealand (Compton, 2001; Compton & Harwood, 2003; Compton & Jones, 2003; Jones, 2001). Socio-cultural learning theory identifies learning as a "situated human activity that is reliant on, and reflective of the social, cultural, political and environmental location" (Compton & Harwood, 2004, p.2). As such, it allows 'experts' to be involved in the education of students, in order to connect their learning to human activity which is purposeful and connected to real-life contexts. Providing students' opportunity to access practicing technologists therefore, allows any associated learning to be grounded in real-life contexts where social, cultural, political and environmental considerations need to be examined.

The technological activities students undertook during this research, that provided an opportunity for them to access practicing technologists, were all centred on real-life contexts. This allowed the practicing technologists to provide students with authentic insight into:

- the problems/issues they face
- the ways they go about resolving them
- the knowledge that they draw upon to do so.

As such, student learning, in technology was supported within an *apprenticeship* model of learning (Rogoff, 1990).

Due to the overall aim of technology in New Zealand being to develop students who possess a technological literacy that is liberatory in nature, understandings students gain through working alongside practicing technologists need to go beyond simple replication of their practice(s) and/or reapplication of their knowledge. Instead they need to be critical of practices which are selected and applied by the technologists. Technology education is better positioned within an *anchored instruction* approach to learning (The Cognition and Technology Group at Vanderbilt, 1990), rather than being solely aligned to an *apprenticeship* and/or *cognitive apprenticeship* model (Hennessy, 1993). In this research where the relationship between the practicing technologists and students was founded on an *anchored instruction* model of learning, the impact on student's understandings tended to be greater. This was exemplified to be the case with Schools A, B, C and E. In School D where the student/practicing technologist(s) relationship was more aligned to an apprenticeship model less of an impact on student understandings was noted.

Assisting students to develop a concept of technology focused on technology as a *Process,* by working alongside practicing technologists, supports their understanding of how technologists intervene in the world, as well as giving them insight into the purpose of technology education. When students are also empowered to critique the interventions that technologists' make in the world, this supports the overall aim of technology education - to develop students who possess a technological literacy that is *liberatory* in nature (Compton & Harwood, 2003; Compton & Harwood, 2004). Students who possess such a literacy are seen to be able to critique and undertake comparative analysis of past and current technological practices, and make informed projections into "potential future practices that step outside and/or push boundaries of their current practices"

(Compton & Harwood, 2003, p.4). Encouraging students to critically work alongside practicing technologists therefore, provides an opportunity to not only enhance their concepts of technology and technology education, towards understandings that are broader and more inclusive (Mather, 1995), it also allows them to make "judge(ments about) the worth of an expert" (Compton & Jones, 2004, p.3).

Enabling students to develop a concept of technology and understanding of the purpose of technology education that is broad and inclusive is also in keeping with Print's (1993) view of the importance of *learner-centred* and *problem-centred* curriculum design. These 'centred' designs suggest that students need to explore and demonstrate '*process*' that is embedded within learning environments bounded in the classroom, but connected to the world outside. Such connections provide opportunity to increase the authenticity of learning experience through offering students access to the perspectives of experts (practicing technologists) within the community (Brown, Collins & Duguid, 1989; Choi & Hannifan, 1995 - cited in Altalib, 2002; Driscoll, 2000 – cited Ingram & Jackson, 2005). They also enable students to observe and critique the practices of experts and draw comparisons between the practices undertaken by technologists and those espoused within technology education. This assists students in their overall development of a technological literacy that is liberatory in nature as it provides a medium for allowing them to compare and contrast their concepts of technology, and understandings of the purpose of technology education, with others.

Enabling students to connect their learning to the world outside the classroom endorses the desirability for technological activities presented to students to be grounded in real-life contexts. Brown, Collins and Duguid (1989) claim that such connections allow student learning to be purposeful and meaningful. Activities used in this research were embedded in real-life contexts and the findings would suggest this was a key factor in student's demonstrating a broadened understanding of technology.

6.5 Factors that influenced the Impact that Practicing Technologists on Senior Secondary School Students

The findings from this study identified that the technological tasks and activities presented to students may influence the impact that a practicing technologist(s) has on their concept of technology. In this study this was evident when a technological activity was focused on the design and development of a computer programme. For one student, working alongside practicing technologists resulted in their concept of technology becoming narrower and less inclusive, with him moving from holding a concept of technology based on *Artefact: tool/machine* to *Artefact: electrical device.* For two other students there was a noticeable confusion in their concept of technology following interaction with a practicing technologist, between what they understood technology to be from their studies in technology and the understandings they gained from the practicing technologist. While these differences in understanding were not pursued in this research, the reason for some students narrowing their concept of technology following interaction with a practicing technologist(s) may have been due to the nature of the interaction that occurred. The interactions these students had with their practicing technologist(s) appeared to focus solely on resolving programming/scripting problems which they were experiencing. Critically analysing the technological practice that the technologist(s) called upon to resolve such programming issues was therefore not seen as a priority for these students. As such, it appeared that an apprenticeship (Rogoff, 1990) relationship existed between the practicing technologist(s) and the students. This relationship seemed to centre on students mimicking the practice of the technologists, by either using script that they had previously written and/or developing script alongside them. Students' critiquing the technologists practice for its potential value to their own future technological endeavours was not apparent in these students' practice.

Where teachers prepared their students and practicing technologist(s) to work alongside one another, they possessed a shared understanding of why they were being asked to interact with one another. As such the relationships that were established between them, the students and the practicing technologist(s), were focused on an *anchored instruction* model (The Cognition and Technology Group at Vanderbilt, 1990) of learning. Students were provided with frameworks and skills to not only critically analyse the practices that technologist(s) used to resolve a problem(s) but were also made aware of the thought processes the technologist used in their resolution. Technologists were also made fully aware of the role they were playing in the students' overall learning in technology and the underpinning philosophy of technology education. They were therefore able to ensure that their relationship with students allowed them to question 'why' they did things the way they did, without expectation that students would simply mimic their practices. Where teachers used case studies and/or activities, to emphasise to students the importance of developing skills to critique the practice and outcomes of practicing technologist(s), this aided students to transfer their developed understandings to problem situations and settings in which they later engaged.

Where students were offered opportunity to critically analyse the practices of practicing technologists who worked in contexts that were similar but not the same as their own, they were compelled to assess the worth of any understandings they gained for their potential to inform their own future practice. In contrast, where students worked alongside practicing technologists in the same context to a resolve a common problem(s) this sometimes led to students deferring to the expertise of the technologist and adopting their practices without critiquing it on its merits or appropriateness. Whilst the former situation (working alongside practicing technologists in contexts similar to, but not the same as the students) aided students' development of a technological literacy that was liberatory in nature, the latter (working alongside practicing technologists in the same context) was seen to be a limiting factor as it tended to lead to students towards developing a technological literacy that was more functional in nature.

6.6 Implications of the Research

The findings of this research highlight the benefit of technology education being grounded in authentic real-life contexts that provide students an opportunity to crucially analyse the practices and outcomes of practicing technologists. It also confirms the importance of students being provided opportunity to undertake such analysis in contexts that are similar, but not necessarily the same, as those in which they undertake their own technological practice in order to enhance the opportunity for students to develop a technological literacy that is liberatory in nature. Teachers therefore, should allow space within their technology programmes to provide students opportunity to interact with practicing technologists. In saying this however, teachers need to ensure that they establish the foundations upon which these interactions occur. These include:

- establishing a shared understanding by both the student(s) and practicing technologist(s) of why they are being asked to interact with one another
- ensuring students have the skill set to interact with, and critique the practices and outcomes of the practicing technologist
- informing practicing technologists about the educational learning that the teacher hopes the students will gain as a result of their interacting with them
- assisting practicing technologists to understand the overall aim of and philosophy underpinning technology education and how this differs from subjects they may have studied at school[22].

It was outside the framework of this research to explore if students' understandings of the *technological knowledge* and *nature of technology* strands, defined in the draft *Technology Learning Area Introduction* (Ministry of Education, 2006) were enhanced through their working alongside practicing technologists. In saying this however, these two strands encourage students to analyse and critique the perspectives of others, outside of their current location, so that they may develop understandings *of* and *about* technology that contribute to their developing an

[22] For the majority of current practicing technologists their experience in studying technology related subjects at senior secondary school is founded on earlier workshop and design based technical curricula.

overall technological literacy that is *broad, deep and critical* in nature (Compton & France, 2006, Harwood, 2006). Encouraging students to work alongside practicing technologists in activities that are grounded in authentic real-life contexts may well assist them to gain an appreciation of things such as:

- the ways in which individual and group beliefs, values, and ethics can constrain or encourage technological development
- the way things work individually and together in the development and overall function of a technological outcome
- the ethics, legal requirements, protocols that need to be considered and/or adhered to in developing and using technological outcomes
- the needs of and impacts on potential stakeholders due to the development of a technological outcome, including the site where it is developed and finally located
- the characteristics of technological knowledge
- how knowledge is integrated and transformed in the course of technological development
- the social, technical, and environmental impacts of historical and contemporary technological developments.

(Ministry of Education, 2006)

The broader and more contemporary understanding of the purpose of technology education that the majority of students who participated in this research gained as a result of working alongside practicing technologist(s), provide justification for the continuance of initiatives such as Futureintech and Beacon Practice – Technology. These initiatives which promote the establishment of co-operative relationships between industry and education communities provide a mechanism which assists teachers (and practicing technologists) to connect student learning in technology, to the world outside the classroom, so that it may be grounded in authentic real-life contexts. Case studies developed within the Beacon Practice – Technology Initiative present examples of how teachers (and students) may go about establishing meaningful relationships between students and practicing technologists. Futureintech case studies provide accounts of the practices undertaken by technologists in developing technological solutions that address genuine people(s) needs. These case studies provide students (and teachers) with an opportunity to gain insight into the learning environment, which needs to be established to ensure that students can inform their own practice through critically analysing the practice of experts.

Limitation of research

The findings of this research have been limited by the small sample size of research participants who took part in the research. While this did not prevent the study from identifying if (or not) practicing technologists impacted on student understandings *of* and *about* technology, the findings of this research would have been more defendable had the research sample been greater. The variability in the number research participants within schools (e.g. School A had 7 research participants while School E had 2) also meant that it was not valid to draw comparisons between individual school findings, but rather the participants needed to be treated as a single cohort.

An attempt to negate any bias towards research findings and conclusions, due to my involvement as a facilitator in the Beacon Practice – Technology initiative, has been made throughout this research to ensure that the research findings are trustworthy. To do this, through my close connections to the research participants (students and their teachers), I have made explicit to them any beliefs and concepts I had that could have influenced the research process (Neuman, 1997) and/or its findings.

6.7 Suggestions for Future Research

This research has focused specifically on developing an understanding of whether there was an impact on student understandings *of* and *about* technology, when they worked alongside practicing technologists. Technological activities used in this research have been based on real-life contexts. These have allowed students to inform their own undertaking of technological practice from the understandings they have gained through critiquing the practices of practicing technologists. This research has demonstrated that most student's concepts of technology and understandings of the purpose of technology were enhanced when provided with the opportunity to work alongside practicing technologists. It has also highlighted opportunity for further research to be undertaken as a follow-up to the findings of this study. The Technology in the New Zealand Curriculum (Ministry of Education, 1995) is however presently undergoing a significant overhaul as a result of the *NZCMP*. Any further research therefore, would best be focused on the *Technology Learning Area Introduction* and its *achievement objectives* which are still to be gazetted. The achievement objectives for *technological practice* currently presented in the draft *Technology Learning Area Introduction* (Ministry of Education, 2006) are underpinned by research conducted inside New Zealand classrooms (Compton & Harwood, 2003; Compton & Harwood, 2005; Moreland & Jones, 2000; Moreland, Jones & Northover, 2001). The *technological knowledge* and the *nature of technology* achievement objectives however have yet to be validated within the classroom (Compton and France, 2006). Ideas for future research, that would provide further insight into how best to support student learning in technology include:

- identifying the variety of ways in which practicing technologists work alongside students (including the nature of the interactions they have with students). This would allow an analysis to be undertaken to identify those which are most effective in enhancing student's overall development of a technological literacy that is *broad, deep and critical* in nature.

- an examination of learning contexts, used in technology (including the learning environment which supports technology education), to identify those which support students' to develop a technological literacy that is that is *broad, deep and critical* in nature.

- research to identify the effect on students working alongside practicing technologists and their understandings of the *technological knowledge* and *nature of technology* strands are enhanced.

6.8 Conclusion

Not withstanding the limitations of this research, sufficient evidence has been provided to conclude that the involvement of practicing technologists in technology education learning opportunities offers the potential to enhance student technological practice and their learning in technology generally. From undertaking this research, I have confidence that when students work alongside technologists to resolve problems embedded within real-life contexts, this interaction provides the potential to enhance their concepts of what technology is and its purpose. That is, *of* and *about* technology, which are key aspects underpinning the new technology curriculum strand: *Nature of Technology* (Ministry of Education, 2006). To ensure this potential is met, the importance of establishing a mutually inclusive working environment that allows all parties (students, teachers and practicing technologists) to share and critique any understandings gained can not be underestimated. In this way, bringing technologists in to technology programmes, to work alongside students, can provide another mechanism for teachers to support their students to develop a liberatory technological literacy which is *broader, deeper* and *more critical* in nature.

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APPENDIX

APPENDIX A

Information Sheet for Research Participants

Student Research Participants/Board of Trustees/Principal

Consent Form

Board of Trustees

Student Research Participants

Massey University
COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Centre for Educational Development
Private Bag 11 222
PALMERSTON NORTH
New Zealand

Website:
http://ced.massey.ac.nz

Phone: 06 350 9269
Fax: 06 350 9288

TECHNOLOGISTS ALONGSIDE: IMPACT ON STUDENT UNDERSTANDINGS IN TECHNOLOGY

INFORMATION SHEET

(Participant Teachers/BOT/Principal)

Researcher Introduction

A research study to identify if *practising technologists' involvement in student learning, influences students understanding of/attitudes to technology education* is to be conducted by Cliff Harwood. This research called *Technologists' alongside: Impact on student understandings in technology* is part of Cliff's study towards a Masters Degree in Education at Massey University. Cliff's research is being supervised by Dr Mark Brown: Senior Lecturer, Department of Learning and Teaching, Massey University College of Education and Dr Jenny Poskitt: Director, Institute for Professional Development and Educational Research, Massey University College of Education.

Cliff is employed as the Secondary Inservice Coordinator for the Centre for Educational Development at Massey University College of Education and is currently the principal Professional Development Facilitator for the Ministry of Education national contract called *Technology - Beacon Practice Project*. This project is being conducted in 13 New Zealand secondary schools and is aimed at building teacher capability in technology education (as defined by *Technology in the New Zealand Curriculum*).

Technology in the New Zealand Curriculum (Ministry of Education, 1995) has now been taught in New Zealand schools as a compulsory learning area for ten years. As of 2004, students were able to sit qualifications in technology, under the National Certificate of Educational Assessment (NCEA) at Levels 1, 2 and 3, and Scholarship. Level 3 and scholarship examinations for the NCEA in technology currently assess students understanding of the practices of technologists from business and industry, through how they use their understandings to inform their own technological endeavours.

Two projects - *Technology Beacon Practice Project (TBPP)* and *Futureintech (FiT)* are currently being conducted in New Zealand schools. The primary aim of the *FiT* project is to increase practising technologists from business and industry's participation in student learning in technology. This aim has also been adopted by the *TBPP* that you/your school is currently involved in. The benefit to student learning of involving practising technologists in student learning in senior secondary schools to date has not been researched. The influence that such involvement has on students' understanding of technology and the purpose of technology, education in school curricula are also unexplored.

This research study sets out to identify if there are indeed benefits in having *practising technologists working alongside senior secondary school students* and if so, the influence this has on *students' understandings of technology and the purpose of technology education in school curricula*.

Participant Recruitment

Teachers who are involved in the *Technology - Beacon Practice Project* and are:

- teaching technology at years 11and 12 in 2005; and
- are likely to teach the same students in 2006;
-

are invited to participate in this research study.

Ten student participants from these teacher's technology classes will also be invited to participate in the research. The researcher will work with the teacher participants to identify students who are likely to continue to take technology in 2006. The identified students will be invited to participate in the research study by the researcher. Only those teachers and students who complete the Consent Form will be included in the research study as participants.

The researcher will work with the teacher participants to ensure that this research study does not interfere with student participants (or other students in the technology classes) overall learning in technology and in their other school subjects.

Project Procedures

Permission to conduct the research study will be obtained from school management/Boards of Trustees, participant teachers and students prior to the study commencing.

The main method of collecting research data from student participants will be via a questionnaire. It is however anticipated that in order to clarify some student responses, individual student interviews may also be required. Students will be asked to complete the questionnaire on three separate occasions during the 16 months that this research study is conducted (August 2005 to December 2006).

Planned teaching lessons/programmes from the teacher participants will be analysed alongside observation of the pedagogical practices they use with their technology classes to identify how practising technologists are encouraged to interact with their senior secondary school students.

It is acknowledged that due to only those teachers from the *Technology - Beacon Practice Project* being invited to participate in this research study, that anonymity of the research participant and their schools cannot be absolutely guaranteed by the researcher. Names of all participants and data that associate participants with a particular school, will therefore be removed from all research data. All individual participants' data will be aggregated and this will be used to support any reported research results, so that readers cannot identify individual participants.

Participant involvement

Teacher participants will be asked to:

- provide the researcher access to their planned teaching lessons for technology (programme);
- allow the researcher to observe their technology lessons when student participants and practising technologists are present;
- allow opportunity for the student participants to complete the questionnaire (at three separate occasions over 18 months that the research study is being conducted);
- allow opportunity for the researcher to interview student participants, if required, to clarify their responses to questions within the questionnaire.

Student participants will be asked to:

- complete the student questionnaires on three separate occasions over the 16 months that the research study is being conducted;
- allow the researcher to interview them in order to clarify their responses to questions within the questionnaire if required.

It is anticipated that the research study will require approximately four hours of each participants' time during the 18 months that the research study will being conducted. A unique identifier (e.g. number and/or letter) will be placed on all participant research data so that the individual identity of participants and their school is kept anonymous.

Due to an action research methodology being adopted for this research study, opportunity exists for identified research findings/trends to be reported back to research participants during the undertaking of this study. Such reporting may assist teachers and students to improve how practising technologists are utilised in the delivery of technology education at senior secondary. In doing this, the reported research findings/trends if acted upon could strengthen the teaching and delivery of the technology programme for all students in the class, not just those who are participating in the research study. Research data will at no stage *during* the research study be reported back to the Ministry of Education or other potentially interested parties (i.e. New Zealand Qualifications Authority, TEBP or FiT projects). Findings at the *conclusion* of this research study will however be offered to interested parties to allow them insight into its outcomes.

Participants' Rights

Teacher and student participants are under no obligation to accept this invitation to participate in the research study. If you decide to participate, you have the right to:

- decline to answer any particular question asked by the researcher;
- withdraw from the research study at any stage during the one and half years that the study is being conducted,
- ask the researcher or his supervisors any questions about the research study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- be given access to a summary of the research study findings when it is concluded.

Project Contacts

If you have any further questions concerning this research study please do not hesitate to contact either:

The Researcher

Cliff Harwood
Centre for Educational Development
Massey University College of Education

Work Phone:	06 350 9286
Cell Phone:	0274 303 324
Email:	c.d.harwood@massey.ac.nz

or Cliff's supervisors

Dr Mark Brown

Work Phone:	06 350 9099
Email:	m.e.brown@massey.ac.nz

Dr Jenny Poskitt

Work Phone:	06 350 9293
Email:	J.M.Poskitt@massey.ac.nz

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee, PN Application 05/57. If you have any concerns about the conduct of this research, please contact Dr John O'Neill, Chair, Massey University Campus Human Ethics Committee: Palmerston North, telephone 06 350 5799 x8635, email humanethicspn@massey.ac.nz.

Massey University
COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Centre for Educational Development
Private Bag 11 222
PALMERSTON NORTH
New Zealand

Website:
http://ced.massey.ac.nz

Phone: 06 350 9269
Fax: 06 350 9288

AN ACTION RESEARCH STUDY OF THE IMPACT OF

'TECHNOLOGISTS' ALONGSIDE: IMPACT ON STUDENT UNDERSTANDINGS IN TECHNOLOGY

BOARD OF TRUSTEES
CONSENT FORM

This consent from will be held for a period of five (5) years

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name (printed)
Designation ....

Massey University
COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Centre for Educational Development
Private Bag 11 222
PALMERSTON NORTH
New Zealand

Website:
http://ced.massey.ac.nz

Phone: 06 350 9269
Fax: 06 350 9288

RESEARCH STUDY OF THE IMPACT OF

'TECHNOLOGISTS' ALONGSIDE: IMPACT ON STUDENT UNDERSTANDINGS IN TECHNOLOGY

STUDENT PARTICIPANT CONSENT FORM

This consent from will be held for a period of five (5) years

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name (printed)

Designation Student – xxxxx College

APPENDIX B

Student Questionnaire

Massey University
COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Centre for Educational Development
Private Bag 11 222
PALMERSTON NORTH
New Zealand

Website:
http://ced.massey.ac.nz

Phone: 06 350 9269
Fax: 06 350 9288

Technologists' alongside: Impact on student understandings in technology

2006

PHASE TWO
Student Questionnaire

Name: ________________ School: ____________________ Year Level:______

Please circle
Gender: M / F

A. How many years have you studied technology at school? ☐

B. Have you had a practicing technologist provide support to your learning in technology yes ☐ no ☐

If you answered **yes** please state the:

Year Level you were in when this occurred	and	describe the type of the support they provided you

*C. On a scale of 1-5 (**1** being **strongly disagree** - **5** being **strongly agree**) indicate your response to the following statements by placing a tick in the box that best represents your answer*

	1	2	3	4	5
C.1 I think technology is an **important** subject for students to study at school.	☐	☐	☐	☐	☐
C.2 I am **confident** that I can explain my understandings about what technology is.	☐	☐	☐	☐	☐
C.3 Working alongside a practicing technologist **would have a positive impact** on my learning in technology.	☐	☐	☐	☐	☐

D. Explain your understanding of 'technology'
E. What do you think the purpose is for studying technology at school?
F What have you learnt this year in technology?
G. What do you want to learn in technology this year?
H. What aspects of technology do you find most challenging?
I. What aspects of technology do you find most rewarding?

APPENDIX C

Interview Questions – SAMPLE

INTERVIEW QUESTIONS – SAMPLE

Introductory Questions – all research participants

1. *Tell me about the technological practice you undertook to develop your last technological solution?*

2. *Explain the technological practice undertaken by a practicing technologist that you have worked with or studied this year?*

3. *What did you learn from this technologist that informed the way you approached your technological practice?*

4. *What experiences or learning do you see technology education offering you that other subjects you currently study don't?*

5. *What was it about technology education that made you decide to study it as a subject through to year …….?*

Focus Questions - designed to address specific issues/points of clarification identified in the Phase One/Two data

a. *Your 1st response to the question: what is technology about? was 'meeting people's needs'*

   your 2nd response also described it as being about 'meeting people's needs'

   – can you explain what you mean by this?

b. *What influence did the practicing technologists have on your understandings of technology?*

c. *Your 1st response to the question: what is purpose of technology education in schools? was*

   it would 'provide opportunities to gain an understanding about how things are invented/made.

   Your 2nd response was also about

   'gaining an understanding about how things are invented/made'

   can you explain what you mean by this?

APPENDIX D

Letter from Ethics Committee: Massey University

Massey University

OFFICE OF THE ASSISTANT
TO THE VICE-CHANCELLOR
(ETHICS & EQUITY)
Private Bag 11 222
Palmerston North
New Zealand
T 64 6 350 5573
F 64 6 350 5622
humanethics@massey.ac.nz
www.massey.ac.nz

25 July 2005

Cliff Harwood
Centre for Educational Development
PN915

Dear Cliff

Re: HEC: PN Application – 05/57
An action research study of the impact of "Technologists" alongside: Impact on student understandings in technology (TAISUT)

Thank you for your letter.

On behalf of the Massey University Human Ethics Committee: Palmerston North I am pleased to advise you that the ethics of your application are approved. Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

> **A reminder to include the following statement on all public documents:** *"This project has been reviewed and approved by the Massey University Human Ethics Committee, Palmerston North Application 05/57. If you have any concerns about the ethics of this research, please contact Dr John G O'Neill, Chair, Massey University Campus Human Ethics Committee: PN telephone 06 350 5799 x 8635, email humanethicspn@massey.ac.nz".*

Yours sincerely

Dr John G O'Neill, Chair
Massey University Campus Human Ethics Committee: Palmerston North

cc Dr Mark Brown
Dept of Learning & Teaching
PN900

Dr Jenny Poskitt
IPDER
PN900

Ms Caroline Teague
Graduate School of Education
PN900

Professor Bill Tunmer, HoD
Dept of Learning & Teaching
PN900