Science and Mathematics Education Centre

Developing a Framework to Optimize Teaching and Learning in Computing Education: A Study in Technical Institutes and Polytechnics in New Zealand

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Declaration

To the best of my knowledge this thesis contains no material previously published by any other person or which has been accepted for the award of any other degree or diploma in any university or any other institution, except by way of background information and duly acknowledged in this thesis.

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ABSTRACT

This thesis describes research investigating the computer learning environments of students undertaking their computer studies in New Zealand Technical Institutes and Polytechnics. The main focus of this study was to understand the perceptions and opinions of students learning computer courses in technology-rich learning environments and also their attitudes towards the computers and computer courses they studied. The investigations also involved students' perceptions of the actual practices that take place in the computer class rooms and the preferences of how they wish these practices should take place in their class rooms. This study further investigated influences that lead to students' perceptions and beliefs of these practices taking place in their learning environments and how these beliefs influenced their learning.

The literature review presented in this thesis explores New Zealand education and the changes that have been taking place for the past 50 years, with an emphasis on tertiary computer education. The introduction of tertiary computer programmes in technical institutes and polytechnics was investigated. A review of the literature examined various learning theories, learning environments including technology rich learning environments and online learning environments where computer courses are delivered. Also the literature review investigated various teaching models, all of which aimed towards arriving at the research questions.

A mixed methods approach was adapted as the methodology for this study. It involved quantitative approach and qualitative for collecting data, where the quantitative phase preceded the qualitative phase. The quantitative phase involved three instruments which had been previously developed and tested for validity and reliability in similar learning environments. The instruments used were, Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI), the Attitudes Questionnaire and Attitude towards Computers and Computer Courses (ACCC) questionnaire. The questionnaires were further validated against the New Zealand environments where the research was conducted and proved valid. The qualitative phase involved open-ended semi-structured interviews with volunteering students who had already answered the quantitative questionnaires. The qualitative data thus gathered provided a deeper and richer understanding of the quantitative data

gathered. Also, novel thoughts towards what was expected from the study that were not covered in the quantitative questionnaires were attained in the qualitative phase. The findings of the quantitative and qualitative analysis of this study were used to respond to the research questions of this study.

The study synthesised results from these multiple sources within seven tertiary institutes in New Zealand. A total of 325 volunteering students from levels 5, 6 and 7 computer courses in these institutes participated in the quantitative surveys and 325 students participated in the interviews. Quantitative data were analysed using SPSS statistics software. Thematic content analysis was performed with the qualitative data and the findings were subsequently merged with that of the quantitative data.

Overall, the findings of the study provided a perspective on the strategic view of teaching and learning computer courses, in computer learning environments. The findings of the study revealed that student perceptions of their learning environments played an important role towards achieving goals and their academic efficacy. Students always had their preferred learning environment to the actually perceived environment. An important outcome of the findings was the paradigm shift of the teacher, from the traditional teaching methods towards technology-based teaching methods, which requires training in technology and up-skilling teachers' technological backgrounds periodically. The study also examined various aspects that existed in these learning environments with regards to gender differences, institute differences and level differences.

Information gathered from the literature review blended with the findings gave insight to suggest a framework to optimise teaching and learning computer courses in the specified tertiary sector.

Furthermore, the study generated recommendations which could help tertiary computer educators optimise teaching practices within computer laboratory learning environments. This study is expected to benefit future researchers who are interested in doing further research in this area.

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This thesis is dedicated to the memory of

my parents

Martin Weerasena and Tulin Weerasena

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The research presented in this thesis was undertaken to examine information about the technology-rich learning environments of students taking computer science or information systems courses in technical institutes and polytechnics in New Zealand. The study focused on learning environments of levels 5 through to 7 computer or information systems diploma and degree courses in technical institutes and polytechnics in New Zealand. The study investigated the perceptions and attitudes of students about their computer learning environments, and aimed at investigating the influences that lead to student perceptions and beliefs in this area, and how these beliefs influence learning in their computer courses. To address this concern, student perceptions of the practices that take place in computer class rooms, and the preferences of how often they wish these practices would take place were investigated.

The research presented in this thesis explores New Zealand education and the changes that have been taking place for the past 50 years. This research attempts to explore the introduction of tertiary computer courses in the New Zealand tertiary education system and the changes that have been taking place since.

Data were collected from volunteering students from seven technical institutes and polytechnics in New Zealand. A mixed method approach comprising qualitative and quantitative research methods was utilized in this study. In the quantitative method, three questionnaires, which had been previously designed and had established validity, were administered to volunteering students. The qualitative method which followed the quantitative method used semi-structured interviews with volunteering students. The findings of the interviews provided richness and insight to the quantitative data previously gathered. The results of the two methods were blended and analysed, to bring about useful responses to the research questions.

Literature about various learning theories and teaching models that had previously been proposed by past researchers were investigated in this thesis. Useful and salient points from these teaching models, which suited the aim of this study, were extracted. The themes, strategies and tactics explored in this study were blended into the extracted teaching model. Finally, a framework to optimize teaching and learning in computing education in technical institutes and polytechnics in New Zealand is suggested.

The study could benefit educators by enabling them to gain a better understanding of their students. The educators will be able to adopt the suggested framework to teach computer courses at their institutes. The study is also aimed at filling gaps in this area of study. Finally, the study is expected to benefit future researchers interested in pursuing further research in this area.

1.2 CONTEXT: HISTORY OF EDUCATION SYSTEM IN NEW ZEALAND

Countries such as USA, UK, Canada and Australia that have British origins have similar histories and stories and demonstrate similarities in their primary, secondary and tertiary education systems. In this study, New Zealand is categorised as one such country that faces similar issues in the education system. For example, a significant number of students not reaching tertiary education is one common issue faced with education in these countries. Many of those who were born in the 21st century did not continue their education after their secondary school studies (Middleton, 2008). In the late 19th century universal primary education was the goal in New Zealand. From the 1920s to 1930s, a couple of years of post-primary education were available for those who had gained proficiency at standard 6. Nevertheless, only about 12.5% remained in secondary education up until the late 1970s (Middleton, 2010).

The period between 1946 through to 1964 was considered to be the baby boomers generation, with the return of the soldiers, and this was a booming time for education. Schools were considered very important; teaching was considered a noble profession that was greatly respected. Most of this generation completed higher education while others got engaged in other opportunities, such as employment, on

the job training, teaching, nursing, accountancy, night classes, apprenticeships and office workers.

Some from the baby boomers generation were considered second class learners. Their main aim was to work and they did not complete secondary school education. Their education was influenced by family stories, the radio, newspapers, magazines, movies and neighbours. Some became part-time students, while some enhanced their situation through professional development. However, women looked after families and could not engage in proper education.

The period from 1965 up to 1980 was considered to be Generation X and children were named ‘Latch-key kids’. They were highly dependent, frequently moved jobs and worked to live rather than vice-versa. Higher education took a downward turn from the 1970s up to the 1980s. During this time, polytechnics emerged and Certificate courses of levels 1 to 3 were introduced. Private training educational institutes (PTEs) emerged and such institutes offered various types of courses. However, some were found blindly following these courses for no significant reason.

From the mid-1980s, tertiary education was considered an important area in the New Zealand education system. Over the years, communities became diverse. Homogenous academic curricula evolved in secondary schools thus causing abandonment of the technical high schools which had existed until then. The opportunities for early school leavers were ripped out due to external forces. Night classes did not help much and polytechnic courses, which were conducted during the day, clashed with day time employment. This prevented individuals getting the education they needed for a specific the job. The reason as discussed by Middleton (2010) is that, to achieve a balance in the economy, the governments of the day destroyed the apprenticeship schemes.

Since then, early school leavers from the age of 14 has amounted to 65%. This serious level of disengagement from education not only produced inactive youth, it also contributed to the unease among youth and created social and political issues between different groups in the community. By the end of the 1980s, universal tertiary education became the goal while primary and secondary education was compulsory. Statistics revealed that 68% of New Zealand’s secondary students left

without qualifications and never reached higher education. Furthermore, 16% of students were out of education by 16 years of age, while 40% left with less than the National Certificate in Educational Achievement (NCEA) level 2 (Middleton, 2008).

Those who were born between 1980 and 1994, were known as the Millenials or Generation 'Y', and were defined by academics as trend spotters and futurists (Middleton, 2010). They were smart but impatient. They expected results immediately and carried an armoury of electronic devices, the more portable the better. Generation Y was culturally diverse and was raised with deliberation and positive reinforcement. This generation had multi-tasking team players who were respectful of authority. They were rewarded for competing and not for winning. However, they lacked basic skills for employment. They lived for 'now' and although highly independent and relied highly on family.

1.3 TERTIARY EDUCATION IN NEW ZEALAND

The New Zealand tertiary education system provides access to a broad range of education opportunities and contributes to the country's national development which centres on social, economic, cultural and environment dimensions. The focus of tertiary education system covers excellence in research, post-school education, community education, literacy and numeracy skills, and industry training. As defined in the Education Act 1989, the current education system in New Zealand is comprised of major Tertiary Education Organisations (TEO) i.e., universities, technical institutes and polytechnics (ITP), Waanaga, private training educators (PTE) and other training providers and industry training organisations. They are run by different professional bodies and have little to do with each other. As a result, they have a lack of connection rather than coherence which has resulted in disengagement, failure and delayed progress for successful individuals (Middleton, 2010). Various tertiary education qualifications are offered by these many types of TEOs such as certificates, diplomas, bachelor degrees and post graduate qualifications. There are eight universities in New Zealand which provide degrees and postgraduate qualifications of international standards. ITPs deliver vocational education, and undertake applied research to support vocational training.

New Zealand currently has three Waanaga or Maori schools which aim at providing Maori ways of teaching and learning, aimed at the well-being of Maori as people. Tertiary education in New Zealand also covers, industry and workplace training, modern apprenticeships, literacy, numeracy and language skills development, teaching adults foundation or advanced vocational skills, helping people transition from secondary school to the workforce, further study, higher education and research and various youth programmes. Quality assurance matters of ITPs New Zealand are handled by New Zealand Quality Assurance (NZQA) body which is responsible for quality assurance of educational quality ad standards in New Zealand tertiary education sector. (http://www.tec.govt.nz/Tertiary-Sector/Types-of-TEOs)

1.3.1 Tertiary Computer Education in New Zealand

Technology is described in the New Zealand Curriculum (2007) as "intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities" (Ministry of Education, 2007). Technology was introduced in the New Zealand curriculum in 1995 allowing students to keep pace with social and technological change. Since then technologies have become more sophisticated, diverse and complex and the demand for technology in workplaces has increased. The 21st century New Zealanders must be innovative to keep pace with growing technology and enable social and economic transformation. Hence, the present-day student must be actively involved in technology and be innovative and creative. The framework of New Zealand's technology curriculum aims at being dynamic and future focused for teaching and learning in technology. It aims at developing a range of outcomes through technological practice to engage with the technological challenges of today and tomorrow (Ministry of Education, 2007). The tertiary education commission (TEC) in New Zealand assesses the educational performance of individual tertiary providers such as universities, institutes of technology and polytechnics, Waanaga, private training establishments (PTE), other tertiary education providers and industry training organisations (http://www.tec.govt.nz).

1.3.2 Computer Education in Institutes of Technology and Polytechnics in New Zealand

Polytechnics first emerged in New Zealand between 1970 and 1980. The National Advisory Committee on Computing Qualifications (NACCQ) was the professional body which provided the central support for technical institutes and polytechnics in New Zealand offering ICT programmes. The NACCQ was founded in 1988 as a result of a review of the national qualification of data processing and information technology and was responsible for developing and maintaining a family of national computing qualifications in New Zealand, ranging from level 3 to level 7 which also integrated with the university sector. Following the review of the NACCQ in 2010, the body which was named as 'Computing and Information Technology Research and Education in New Zealand' which is abbreviated as CITRENZ was formed. Developing and maintaining CITRENZ certificates, diplomas and degrees are among the many tasks performed through this body. It contributes to the maintenance of the relevance of developed courses to meet the changing requirements of New Zealand's computer and information technology industry, by suggesting timely changes to course prescriptions in response to industry developments. CITRENZ also staircases with the secondary schools by offering several level 5 courses which offer cross credits towards the Diploma in Information and Communication Technology courses. It also liaises with the New Zealand Qualification Authority (NZQA) and other relevant national bodies such as New Zealand Computer Society (NZCS) over national issues relating to these courses such as course approval, accreditation, moderation, assessment, professional registration and the like.

1.3.3 Learning Pathways in Institutes of Technology and Polytechnics in New Zealand

There is a rapid advancement of Information and Communication Technology (ICT) in the world. More and more varied technical skills are needed to address this diverse change. Tertiary institutions in New Zealand must offer relevant and up-to-date qualifications which must also be well structured (Joyce, 2009). Also the need for a well-qualified ICT workforce has become extremely imperative.

Tertiary learning pathways were introduced by the Tertiary Education Committee (TEC) in New Zealand in 2004. The TEC was established in 2003 and it is responsible for managing government funding for tertiary education, act according to the Education Act 1989, and advice on education policies and priorities. (http://www.tec.govt.nz/)

A learning pathway is fundamentally a key to achieve improved education outcomes and skill levels that help the students to pursue further education for employment (Joyce, 1999). These leaning pathways link qualifications within and between tertiary education providers, leading the students into a situation of upward linking or progression of qualifications. This is also known as 'Staircasing' and involves recognition and credit transfer from certificate and diploma programmes to the degree programmes. An example of staircasing in computer qualifications offered in a Polytechnic in New Zealand put forward by Nesbit and McCarthy (2007) is shown in Figure 1.1. It shows typical learning pathways, various entry points which lead to different qualifications in technical institutes and polytechnics in New Zealand. An important highlight of this approach is the availability of several pathways to further qualifications leading to a degree, without following the traditional three year approach.

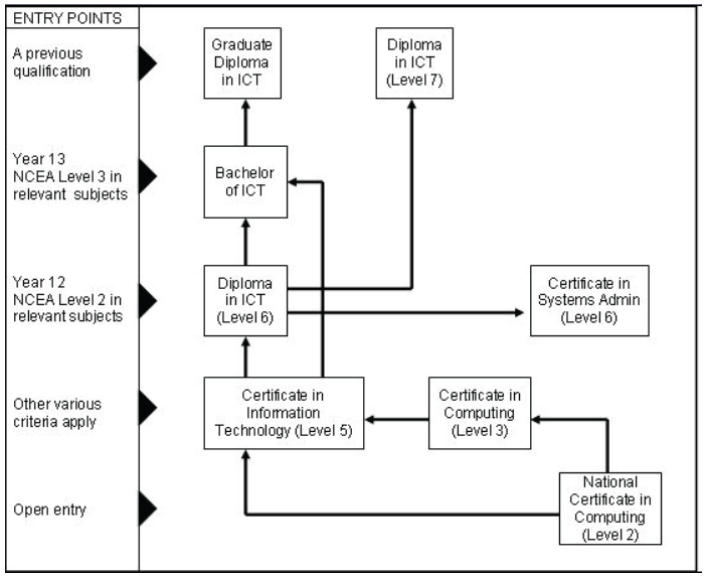


Figure 1.1. Staircasing computer qualifications (Nesbit & McCarthy, 2007).

1.4 MOTIVATION FOR THE STUDY

1.4.1 Introduction

Recent research statistics show that there is a drop in the number of students enrolling in tertiary computer qualifications as opposed to other qualifications. The New Zealand Ministry of Education has expressed its concern in its Tertiary Education Strategy. According to the Ministry of Education, in 2009 the pass rates of Information Technology courses (74%) were the lowest compared with the pass rates of other tertiary courses (http://www.tec.govt.nz/Tertiary-Sector/Tertiary-Education-Strategy).

It is questionable whether the lower pass rates in Information Technology courses are associated with a different pedagogy which contradicts the students' needs or the teaching practices employed. On the one hand, it is questionable whether the students' perceptions of the pedagogy are misaligned. On the other hand, it is also prudent to consider the preferences and the study approaches of the students. However, a promising approach may be to consider the pedagogy as reflected in the conceptions, preferences and the study approaches of the students as the perceptions of persons from different perspectives, lead to different interpretations of the same environment (Fraser, 1998a).

1.4.2 Influence that Determined the Area of Study

A research study and the choice of the methodological approach that is used in a research study is influenced by personal experience (Creswell, 2003 as cited in Ward, 2008). Ward (2008) also has stated that personal background, values and beliefs ultimately influence the questions posed, the methodological approach, and the analysis and interpretation of the data collected.

On the other hand, individual teaching methods vary and naturally have an impact on student learning. Students' expectations of their educators and the support they receive play significant roles in their learning. It is important to find out to what extent the students get involved in class activities, how they interact with the

educator and the peers, their goals and accomplishments, and the way in which they achieve them. In addition, the success of student learning depends on the effort, self-learning and to the extent of investigations done by the leaner to a great extent. In my experience, a significant number of students show a lack of responsibility, and take inadequate control over their learning resulting in poor academic efficacy. It is important that this aspect of learning is addressed for enhanced academic efficacy.

I have worked in the education sector for 25 years. I have worked as a senior lecturer for the past 14 years in Computing and Information Technology Department at a leading technical institute in New Zealand, which gave me insight into teaching and learning in computer courses. The current student body in my classes is comprised of school leavers as well as mature or returning students who may or may not have completed secondary school. The classes are comprised of a mix of ethnic groups including overseas students, with ages ranging mainly from 18 up to late 20s. The more mature-aged student can go be even 40 years. However, there are only a couple of them or none in my classes. During my period of teaching, it was a daunting task to simply construct an acceptable teaching and learning method which addressed the needs of all these students who displayed different learning styles, attitudes and expectations, although my goal was to create a positive learning environment. The only tool which gave an insight to student concerns was the lecturer evaluations completed by the students at the end of each semester. However, the results from them have not contributed much to understanding the students' expectations of teaching and learning.

My MSc project addressed the computer learning environments of the institute of technology where I currently teach. After the completion of the project, I was encouraged to extend the study to a cross section of technical institutes and polytechnics in New Zealand. In my current study, I am aiming to investigate student computer learning environments, student perceptions of their actual and preferred computer learning environments and also their attitudes towards computers and their courses learnt in technology-rich learning environments, thus arriving at proposing a model for teaching computer courses. I aimed at gathering appropriate data using a suitable methodological framework. Based on an analysis of the data gathered together with viewpoints of past researchers, my aim was to develop a framework for

teaching computing in Technical Institutes and Polytechnics in New Zealand, which would possibly progress the teaching situation of computer courses.

1.5 AIM AND RESEARCH QUESTIONS

1.5.1 Aim

The background of this study was the computer learning environments of technical institutes and polytechnics in New Zealand. From my preliminary observations and readings the aim of the study emerged. The aim was to investigate student perceptions and attitudes towards their technology-rich computer learning environments and their computer courses, and to investigate the influences that lead to their perceptions and beliefs, and the way in which these beliefs influence their learning. The study also investigates student preferences of their learning environments.

The literature search aims at searching about various learning theories and teaching models put forward by researchers. The reviewed literature blended with the results of the data analysis aims at constructing a framework for teaching computer courses in institutes of technology and polytechnics technology-rich learning environments.

1.5.2 Research Questions

To achieve the aim of the study the following research questions were derived.

1. How do students studying computer courses in technical institutes and polytechnics in New Zealand perceive their computer learning environments?

2. What are the students' attitudes towards computers and computer courses?

3. What are the students' perceptions of the actual practices that take place in their classes and what are their preferences of how often they wish that these practices should take place?

On analysis of the data collected, the study suggests strategies to improve teaching and learning tertiary computer courses in the tertiary institutes concerned, and aims to derive a possible teaching model to aid teaching and learning tertiary computer courses in technology rich tertiary learning environments. Therefore, the fourth research question was:

4. What is the preferred teaching model that can be recommended regarding the improvement of the teaching of computer courses in tertiary institutions?

The study is expected to help tertiary computer educators to adopt improved teaching strategies by implementing the proposed teaching model. Also future researchers are expected to benefit from this study and will be able to perform further research based on the findings of this study.

1.6 OVERVIEW OF METHODOLOGY

The methodology used in the research described in this thesis is described in detail in Chapter Three. The sample of the participants in this research was from six technical institutes or polytechnics in New Zealand. The participants in the sample were students at learning levels 5. 6 and 7 of the Diploma in Information and Communication Technology courses and the Bachelor degree courses in Computing or Information Systems, in the participating institutes. The total sample consisted of 325 students.

After searching literature about various research methods, a mixed method approach was assumed suitable and was selected for this study which included both quantitative and qualitative methods. The quantitative method involved the use of three questionnaires which were considered most suited to this study. These questionnaires had been previously developed and had proven validity and reliability. The questionnaires had been used in numerous learning environment research studies in many countries. They questionnaires generally are comprised of five-scale response rankings of strongly agree, agree, not sure, disagree and strongly disagree in nature.

The questionnaires selected were;

1. *'Attitude towards Computers and Computer Courses' (ACCC)* (Newby and Fisher, 1997).

This questionnaire was used to establish a broad picture of students' attitudes towards computers and computer courses. The questionnaire is comprised of 28 items that belong in four scales; Usefulness of Course, Anxiety, Usefulness of Computers and Enjoyment (see Chapter 3).

2. *'Technology Rich Outcomes Focused Learning Environment Inventory' (TROFLEI)* (Aldridge, Fraser & Fisher, 2003).

The TROFLEI is comprised of 81 items that belong to ten scales; Student Cohesiveness, Teacher Support, Involvement, Task Orientation, Investigation, Cooperation, Equity, Differentiation, Computer usage, Young Adult Ethos. TROFLEI also consisted of 'Actual' and Preferred' columns. The 'Actual' version measured how often each practice actually takes place in the class while, the 'Preferred' version measured how often a student would like each practice to take place, which was rather a wish list (see chapter 3). This questionnaire was used to establish student views of the scales in TROFLEI.

3. *Attitude Questionnaire* (Newby & Fisher, 1996).

This instrument was used to assess the context of ICT-rich psychosocial environments. This instrument measured three student outcomes namely; Attitudes to the Subject, Attitude to Computer Use and Academic Efficacy (see Chapter 3).

The quantitative method was followed by the qualitative method. In the qualitative method, semi structured interviews were conducted with volunteering students who had already answered the three quantitative questionnaires. The interviews were recorded and notes were also taken down. The qualitative data gathered was expected to add richness and more depth to the quantitative data gathered. The qualitative investigations gave a fuller and a detailed picture to the quantitative information gathered, enhancing, complementing and supplementing the statistical findings. Thus a more comprehensive understanding of the study emerged.

Data entry of quantitative data collected was entered into SPSS statistical software. The qualitative data were transcribed, analysed and various themes were identified. Finally, the results of qualitative and quantitative data were integrated to yield answers to the research questions and to achieve the aim of the study.

1.7 SIGNIFICANCE

Today with the advancement of technology, class rooms in technical institutes and polytechnics are becoming technology-rich learning environments. However, these institutes still use a mix of traditional and ICT-based teaching methods to teach computer courses, thus risking an imbalance of student learning. This study attempts to derive a teaching model that could be used effectively in computer learning environments of such institutes. This could be of significant importance to the institutes to achieve successful teaching and learning in computer courses. This research could be significant to a number of people involved in this area. Educators involved in teaching computer courses in tertiary technical institutes and polytechnics could benefit from the research.

This could lead to positive working environments and in turn enhance student learning. Consequently, the findings of the research could lead towards the institutes achieving better student retention and success, which in turn would benefit the institutes as a whole. At the national level, this study could provide data for improving computer learning environments, for achieving better teaching standards and better academic efficacy of the students. This research could be helpful to other researchers who are researching in similar teaching and learning environments. Finally, this study may have been beneficial to the participants, being able to have a ‘voice’ about their learning environments.

1.8 LIMITATIONS

The study was constrained by the size of the sample. Six tertiary institutes from New Zealand took part in the study which would have limited the generalisation of the findings. The number of participants from each institute significantly varied. The total sample was comprised of 325 participants. The numbers who participated from

levels 5, 6 and 7 computer courses were not evenly distributed. Participants from level 7 computer courses were limited. Some of the participants did not complete all the questions in the questionnaires. The sample also was not evenly distributed in terms of the gender. The number of males was noticeably high compared to the number of females who studied these courses and participated in the survey.

The sample contained many ethnicities thus creating a cultural bias that could have existed when responding to the questionnaires and responding to the interviews. Also, it could be questioned whether some of the participants with language barriers understood the items in the questionnaires in their correct context. Thus, their answers to some of the items perhaps would not have been genuine. It was also noticed that participants of certain age groups had queries when responding to age-biased questions in the questionnaires.

The sample who volunteered to participate in the interviews was limited. The responses of participants may not be fully representative across all the institutes who took part in the study.

The previously developed questionnaires, although validated and used in similar learning environments in many countries, may not have sufficiently addressed the research intentions of this study. Some of the items in the questionnaires which were negatively worded could have created confusion in some of the participants. As such the accuracy of the answers to such questions is questionable.

On analysing the data, there could have been possible inadequacies in the qualitative analysis of this research. However, the qualitative together with the quantitative analysis helped to overcome some of the above mentioned limitations and the risk of generalising the findings.

1.9 OVERVIEW OF THE THESIS

This study addresses the concern that there is lack of research into learning environments of tertiary computing education in the technical institutes and polytechnic sector in New Zealand. This thesis attempts to investigate such learning environments, student perceptions and attitude towards learning computer courses in

such learning environments, and attempts to derive a framework for teaching computer courses in such environments.

This thesis is divided into five chapters. Chapter 1 sets the study in the context of New Zealand tertiary computer education in technical institutes and polytechnics. The history of New Zealand education dating back to the past 50 years is explored. This chapter looked into computer education in technical institutes and polytechnics together with learning pathways and ICT needs in New Zealand. The chapter highlights the motivation for the study along with the aim and the research questions. A brief description of the methodology, the significance and the limitations of the study are outlined in this chapter.

Chapter 2 is the literature review, which first investigates different approaches to learning which incorporates various leaning theories put forward by researchers. Student perception of learning environments and students' attitudes towards learning is then explored. Tertiary teaching models with an emphasis on tertiary computer teaching models are then explored in this chapter.

Chapter 3 presents the methodology used in this study. An appropriate research method for the study is derived after exploring the theoretical framework from the literature review in Chapter 2 and also exploring the literature about general research methodologies, education research methodologies and learning environment research methodologies in Chapter 3. Literature about quantitative and qualitative research methods are explored followed by the mixed methods approach which uses both quantitative and qualitative methods. The suitability and the appropriateness of the mixed methods approach to this study is discussed and justified.

Chapter 3 also presents the three quantitative research instruments used and also and the format of the interviews. This chapter further describes the ethical considerations, sampling and selection, data collection, data analysis, limitations, issues and assumptions of the research method.

Chapter 4 reports on the findings from the study in terms of results and discussions. The results of the quantitative and qualitative analysis are interpreted. Then the findings of the qualitative data and the quantitative data are blended and discussed. Further the findings thus gathered are related to the literature on various learning

theories and the teaching models from Chapter 2, and a generic computer teaching model that can be used to teach computer courses in technical institutes and polytechnics in New Zealand is proposed.

Chapter 5 starts with an overview of the thesis. This is followed by discussion of the findings in relation to the first three research questions blending the quantitative and qualitative findings. Further, the answers to these three research questions together with the findings of gender differences, institutional differences and level differences are used in proposing a framework to optimize teaching and learning ICT courses in technical institutes and polytechnics, thus addressing the fourth research question. This chapter also includes limitations to the study, implications and directions for future research. Chapter 5 concludes the thesis with a final word.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Learning environment research dates back for more than 30 years (Fraser, 1998a, 1998b). Students' reaction to their teaching-learning experience is of considerable importance as they spend approximately 20,000 hours in classrooms by the time that they graduate from the university (Fraser, 1998a, b). This chapter first investigates literature about various learning theories put forward by past researchers. First, traditional learning versus progressive learning is discussed. Then, the literature on behaviourist, cognitivist, constructivist and social learning theories are investigated. Issues on constructivist learning theory, which is a major concern for this study, are then discussed.

Then, this chapter reviews various student learning environments which underpin the context of this study. The foundations of learning environments, culturally diverse learning environments, and technology-based learning environments including online learning environments that are relevant to this study are then investigated.

Furthermore, this chapter reviews various teaching and learning models put forward by past researchers that underpin this research study. These include the traditional teaching models and their transition into progressive teaching models, Biggs teaching model, students' concept of models followed by technology-based teaching models. The application of Moos' theory to technology-rich tertiary learning environments is also considered (Moos, 1974a).

This literature survey attempts to provide the foundation for developing a comprehensive conceptual or theoretical framework from which the research objectives can be developed for testing. The research questions were formulated based on this literature search and generally this review aims at formulating a suitable methodological framework for the study.

2.2 LEARNING THEORIES

2.2.1 Introduction

"Theories of learning, like all scientific theories, come and go… This is what seems to be happening right now in the research on learning" (Sfard, 1998, p. 4). Over the past few decades, researchers have put forward different theories of learning, which reveal different approaches to views of student learning. Researchers are still debating about how students' conceptual changes take place as their learning occurs, and also possible ways to enhance it.

In the first half of the 20th century behaviourism was the dominant theory in education in the USA and other countries. However, cognitively-based research was getting popular at that time and is reflected significantly in research based on science education (Shunk, 1991 as cited in Duit & Treagust, 1998). Among other theories, constructivism was getting popular in the late 1980s and the early 1990s (Duit & Treagust, 1998).

Behaviourism, cognitivism, constructivism and social learning theories are some of the philosophical frameworks underpinning this study which are discussed in this chapter. Behaviourism focuses on the objectively observable aspects of learning. Cognitivism goes beyond behaviourism and it explains brain-based learning. Constructivism is where the learner actively constructs new ideas or concepts based on experience. The social theory describes how the social and cultural factors influence learning.

Duit and Treagust (1998) articulate that, learning is a combination of human construction and tentative construction, where both social and individual aspects of learning are incorporated. Knowledge construction and interpretation are linked with the social and cultural setting of the learner. This theory also states that the best method for introducing the novice learner to a new culture is through 'cognitive apprenticeship' where the learner is allowed to develop a step-by-step apprenticeship gradually in activities of the new context. Science learning involves both personal and social constructivism and can be applied to technology learning as well.

Although different views of learning theories are independently expressed by many researchers, little research had been done to present an inclusive view of these learning theories in order to allow researchers to address the complex learning processes Duit and Treagust (1998).

This part of the literature review first describes the transformation of traditional teaching towards progressive teaching, thus setting the foundation for the investigation of various learning theories that are considered relevant to the aim of this study. Then this section addresses the behaviourist, cognitivist, constructivist and social theories which contribute in various degrees to student learning in the context of this study.

2.2.2 Traditional Learning Versus Progressive Learning

Traditional teaching was adapted from Europe and dominated American education until the end of the 19th century and this was accepted and considered appropriate by the conservative society. This method, being mainly a teacher-centred approach, focused on rote learning and memorisation. This favoured objective educational standards focused on testing the students to assess their learning outcomes. Assessments were often disconnected and often were unrelated to what was learnt. (http://en.wikipedia.rg/wiki).

Students were also separated according to gender, race, and social class. Boys and girls were sometimes taught different subjects. However, much attention was paid to the development of curricula, which was considered academically important. This method did not favour slow learners, and students were not allowed to succeed at their natural speeds (http://en.wikipedia.org/wiki/Traditional education).

With the introduction of current teaching and learning practices the traditional approach has changed into more student-centred and task-based progressive learning approaches. These were introduced in the late 19^{th} century in various forms. The progressive learning approach involved learning by doing, problem solving, critical thinking, group work, development of social skills, understanding and action, (http://en.wikipedia.rg/wiki/Progressive-education) and collaborative learning.

Beginning from the first four decades of the 20th century progressive education is favoured in many educational practices which tend to abandon the teacher-centred traditional approach. It is stated that the educational process could exist as psychological and sociological paradigms as a pragmatic paradigm. However, this process was not feasible and the interest on it declined after the Second World War (http://dewey.pragmatism.org).

2.2.3 Behaviourist Theory

In the first half of the 19th century and the beginning of the 20th century prior to 1970 the behaviourist theory was the dominant theory in education (Schunk, 1991 as cited in Duit & Treagust, 1998) and for many years, concepts from behaviourist theory formed the basis of most of the learning theories.

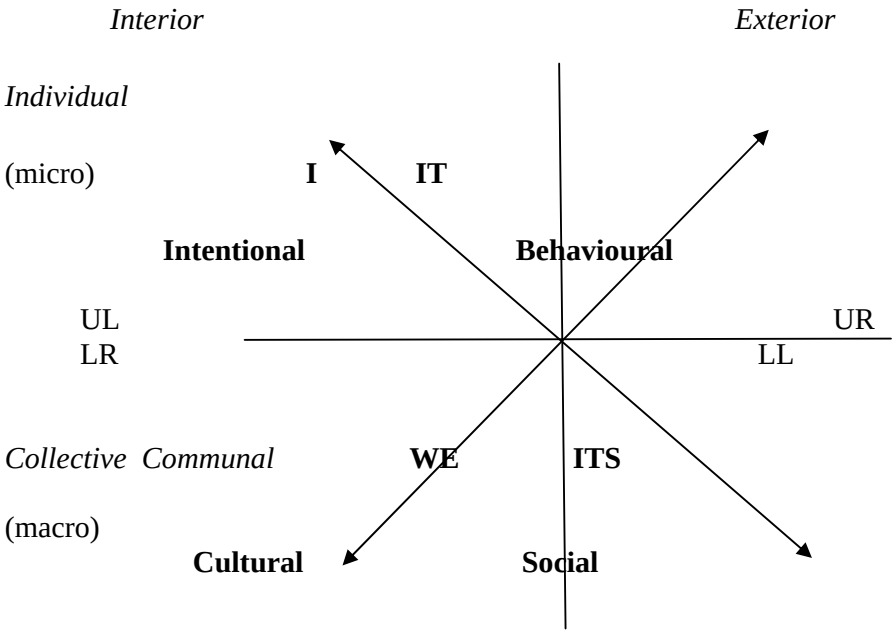
Behaviourism is described in the Collins English dictionary as 'a school of psychology that regards objective observation of the behaviour of organisms as the only valid subject for study'.

The term behaviourism refers to the school of psychology founded by John B. Watson in 1930 based on the belief that behaviours can be measured, trained, and changed (http://psychology.about.com/od/behavioralpsychology/f/behaviorism.htm). Behaviourism assumes that a person is born with a 'clean slate' state of mind. A person has no free will; instead the person's environment determines their behaviour through classical and operant conditioning. Behavior is observable, can be objectively and scientifically measured and does not involve events such as thinking and emotion. Behaviourism mainly manifests instructional technology and the dominance of the teacher in learning and it could lead to understanding of unintended learning. Hence, behaviourist theory allows restricted flexibility and would result in acquiring limited growth in new knowledge.

Skinner's results of the experiments carried out from the 1930s to 1950s, explained behaviourism as radical behaviourism. In the absence of the free will of a person, behaviourist theory states that behaviour is learnt from the environment and depends on physiological stimuli and responses and relates to a set of assumptions about the nature of knowledge. Skinner also explained behaviourism as 'operant conditioning'

where repeated behaviour is reinforced later that brings about new behaviour and continuous reinforcement increases the rate of learning, while intermittent reinforcement contributes to longer retention of what is learned. (http://en.wikipedia.org/wiki/B._F._Skinner#Theory)

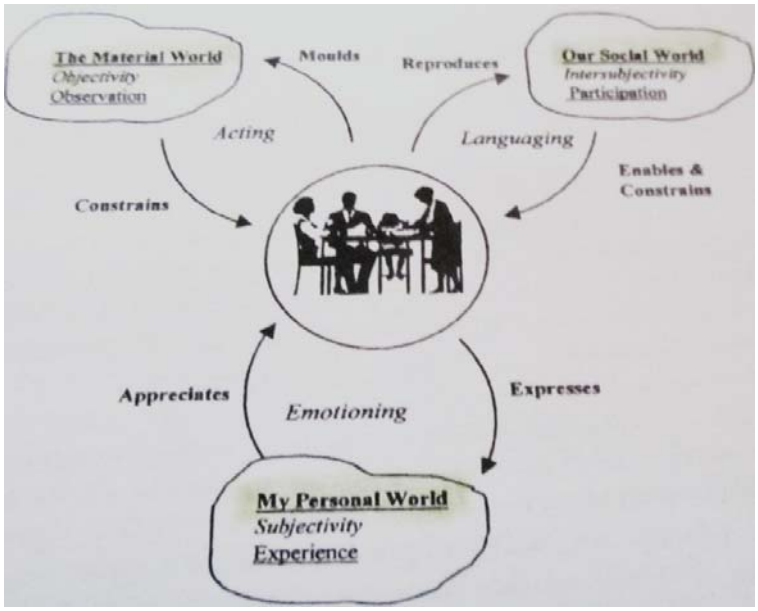
Wilber (2000) explains behaviourism using four holons of human behaviour (see Figure 2.1) that are inter-dependant. The four quadrants represent interior, exterior, individual and collective or communal behaviours. They share common exteriors, therefore common interiors as well. Further, each representation cannot be reduced to the others, but however there would be correlations between all four quadrants. The upper half of Figure 2.1 represents individual holons, and the lower half of the diagram represents social or communal holons. The right half represents exterior hols and the left half interior holons. The exterior quadrants are not objective, but subjective and can only be accessed through dialogical interpretation.



(UL – upper left, UR- upper right, LL-lower left, LR-lower right)

Figure 2.1. The four quadrants representing holons of human behaviour. (adapted from Wilber (2000, p. 125)

Behaviourism is represented by the right hand upper exterior quadrant (UR) which suggests that anything that cannot be seen cannot be trusted. The upper left quadrant (UL) represents the interior form of an individual holon. The lower holons represent shared space and indicate that human beings cannot respond to all stimuli in the environment. They only respond to a very narrow range. The lower right quadrant (LR) is a monological, observable variable in a social action system and therefore, very distrustful. The lower left quadrant (LL) represents the interior meanings that constitute the worldview of collective communal holons which represents the cultural impact on human behaviour (Wilber, 2000).



Adapted from Mingers (2001A), p. 291

Figure 2.2. Habermas' Three Worlds of Humans.

Figure 2.2 describes bbehaviorism as the complex interaction between 'my personal world', 'our social world' and 'the material world' which are experienced by humans as explained by Habermas (as cited in SMEC Course Book, 2006). According to Habermas these three worlds that exist in a person involve triangulation of acting, languaging and emotioning. These three worlds can directly be involved in student learning situations. The material world is the observable objective world where the students tend to build new knowledge from the lessons. My personal world can be mapped to individual experience, perceptions and attitudes towards learning and is subjective. Our social world refers to the community in which the learning is

happening. This depends on student participation and collaboration with peers and teachers and can be subjective.

Habermas' concept of behaviourism is in general agreement with the concept of Wilber (2000), although it is positioned from a different direction. Thus, it can be argued that these two concepts can be considered symbols of behaviourism which can be aimed at applying in learning situations.

2.2.4 Cognitivist Theory

Decades before, researchers were not concerned about individual learning or how learning environments affected the learning outcomes of students. However, they only focused on effects of curriculum changes and changes in teaching procedures which led to changes in student performance. (Shulman, 1997).

In the late 1960s, behaviourist theories of learning were fading and Piaget's idea of intellectual development which emphasised cognitive structures and cognitive development became a focus. Piaget's research on an individual's cognitive structures and cognitive operations was influenced by behaviourism. In the first half of the 20th century, student learning was viewed from a cognitive perspective, particularly in science education.

Cognitivist theories explain brain-based learning and extend beyond behaviourist theories; the brain manages information, put information together and creates designs or ideas (http://www.youtube.com/watch). Hence, in this view learning is seen as an internal mental process which includes insight, information processing, memory and perception which focuses on cognitive and meta-cognitive development towards learning. According to this learning theory what is learnt in short segments is accumulated and at the end reinforced. This theory can be particularly influential in vocational education training modules (http://www.youtube.com/watch).

However, research shows that cognitive learning is also a continuous process and it occurs over the life span of an individual. Furthermore, Ausubel's theory found in 1963, which was known as 'Psychology of Meaningful Verbal Learning' interprets that cognitive learning is a continuous process and occurs over the life span of an

individual. The theory states that cognitive learning is dependent on a framework of concepts and integrating between these concepts. The theory also states that, students' participation in activities, and their contribution towards classroom community as a whole, is important towards learning.

Ausubel's theory of cognitive learning is more relevant to science and mathematics education than Piaget's constructivist theory. Novak (1978) challenged Piaget's theory and supported Asubel's theory. Novak also stated that Asubel's theory gave a more enhanced explanation to student learning than did Piaget's theory. Convey (1997) states that, cognitive psychology seems to be a better method, than the behavioural psychology which existed prior to 1970, for preparing students as lifelong learners.

2.2.5 Constructivist Theory

Advancements in educational technology in the 21st century have hugely contributed to moving from the behavioural perspective to the constructive perspective of learning. Students' cognitive psychology plays a major role in their learning and anticipates them to be lifelong learners within today's technology-based learning environments. Through this method students develop more complex, abstract and powerful knowledge structures than the currently possessed ones (http://en.wikipedia.org/wiki/Constructivism).

"According to the constructivist view, meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed, and this sense making process involves active negotiations and sense building" (Fraser, 2002, p. 3). In addition, Crump and Godley (2000) state that constructivism is a theory of knowledge on how a learner comes to know. Constructivism concentrates on the individual and how an individual derives meaning based on his or her personal circumstances and it does not concentrate much on the existing knowledge of the individual or how any additional knowledge is gathered. Crump and Godley (2000) also state that it assumes that humans generate knowledge and meaning as a result of their interaction between experiences and their ideas. It also assumes that people are individuals and do not live in groups. As

opposed to the behaviourists, the main concern of the educational psychologists was on what was unobservable, what was going on inside the brain of a student.

The main idea behind the constructivist approach to learning is that, knowledge is built by the learner and not supplied by the teacher. Students take control of their own learning which results in being responsible for their own learning, thus creating a student-centred learning environment (Chang & Fisher, 2003). The learner actively builds new ideas or concepts based on current and past knowledge or experience (Papert, 1990, p. 3 as cited in Khine, 2003). It differs from rote learning, where strict instructions are consistently followed and later practised.

These personal endeavours, which emerge from a person's real-world experience, point TO social-constructivism. Habermas' three worlds (see Figure 2.1) also support this argument (p. 26).

Constructivist learning is student-centred, facilitated by the teacher. It requires active engagement and self-motivation of learners in order to affect change in their conceptions. Themes are constructed by integrating them into the already existing structures of knowledge of a student. This is facilitated through discussions with the teacher and peers, negotiating meaning in order to modify a student's already existing concepts and beliefs and to construct concepts and can support in justifying and validating their acquired knowledge (Cruger, 1984).

Diverse views of constructivism

Past researchers have put forward diverse views of constructivism. Some researchers support the constructivist theory while others contradict it. Piaget's theory which was based on 'conceptual learning' had a wide impact over all learning theories and teaching methods in education (Piaget, 1954 as cited in Duit & Treagust, 1998). The theory states that children interpret events according to their already existing mental schema called 'assimilation' and modifications to this already existing schema occur as a result of new experiences 'accommodated' into the new schema and biological maturity known as equilibration occurs as a result of the interplay of the two. According to this, knowledge is constructed in the mind of the learner and it 'fits' rather than 'matches' the reality. Thus, Piaget recognizes that cognitive development of children advances substantially with age (Piaget, 1954 as cited in Bodner, 1986).

Duit and Treagust (1998) state that learning is viewed as conceptual development in much the same way as introduced by the seminal work of Piaget (1954).

Furthermore, in supporting Piaget's theory, the radical constructivist view is explained as the individual self-organisation of the mind taking place through the equilibration process. Thus, it is possible that, in such conceptual change processes parts of initial knowledge merge with parts of new knowledge to form hybrid knowledge (Jung, 1993 as cited in Duit & Treagust, 1998). Von Glasersfeld (1995) has established that in a constructivist learning environment, the concepts have to be conceived by the individual learners, which depend on their existing beliefs and experiences and cannot simply be transferred from teachers to students. The concepts cannot be acquired through accumulation. As such, it is beneficial for the teacher to interpret students' concepts, rather than try to modify their conceptual structures.

Bodner (1986) supporting the constructivist theory states that knowledge is actively created or invented by the person, and is assumed to be developed or acquired through self-construction processes, and thereafter resides in a person's head. Kruger (1994) also states that the students develop a deeper understanding of the content by learning, by engaging in doing activities which enhances the quality of learning, in contrast to non-constructivist learning. Vygotsky (1986) stressed that the cultural and the social environments have a significant contribution towards the cognitive development of a student and states that the teaching methods in such environments must include facilitation and collaboration so that the learners can construct their own knowledge by accepting responsibility for their own learning.

However, Von Glasersfeld (1993) agrees with Piaget's ideas of constructivism, and states that memorisation and rote learning too are useful in certain types of learning. Thus, there are two dominant roots of constructivism. The first, the radical-constructivist view says that learning occurs through individual self-organisation of the mind. The second, the social-constructivist view says that, the mind is a bi-product of external culturally organised phenomena such as practices in language and tools and is modelled to deal with the real world by organising experience.

2.2.6 Application of Constructivism to Science and Technology Education

A constructivist approach to teaching and learning science and mathematics has been adopted over the past few decades (Duit & Treagust, 1998). In the mid-1970s, research on science education was centred on learning science phenomena, principles and concepts. It occurred around the world and led to embracing the constructivist approach to learning science. Some of the reasons for embracing the constructivist approach to learning in various disciplines in science were: considering students' conceptions in isolation based on topics leading to limited success; standards of curricula which were less flexible to change; and efforts invested on student learning outcomes through which the students were influenced to follow various individual approaches to learning science (Duit, 1994).

Conceptual change approaches in learning in science, were brought about in the 1980s and 1990s and they are still being criticized (Duit & Treagust, 1998. Individual differences in learning topic-related science concepts depend on individual abilities and aptitudes, and can be related to to Ausubel's theory. Novak also supports Ausubel's theory.

Different from this, Baird and Mitchell (1986) state that students' learning science store prefabricated knowledge as facts in their memory, and they consider classroom discussions and alternative viewpoints a waste of time. The reason for this could be argued as some students' insufficient background knowledge to absorb new concepts, and difficulty in giving up already established beliefs and attitudes that are accumulated through life's experiences.

Cobb's theory (1998) states that in the constructivist way of learning, the academic success and failure in the classroom depend on teacher–student practices and relations that are co-constructed as a result of their on-going interactions in the class. Cobb's theory also states that students' participation in activities and also their contribution towards classroom community is important towards learning and in order to bring about results these two aspects must exist together (Mehan & Wood, 1975 as cited in Cobb, (1998). Cobb (1998) also states that an individual student's reasoning in mathematical activities vary due to the differences in their social and psychological perspectives. However, Cobb argues that constructivist learning

requires understanding of the concepts and it is used to solve problems rather than in the application of algorithms.

Currently, technology learning environments are mostly embracing a constructive approach to teaching and learning. A variety of subjects are taught using computer-aided tools (Maor & Fraser, 1993 as cited in Crump & Craig, 2000). The software used within a constructivist learning environment help provide students with collaborative and a supportive environment towards learning. Currently used computer-based tools such as graphic-based tools, project planning tools and system design tools have comprehensive capabilities. Due to their complexity, techniques in teaching and learning using such tools need careful consideration. However, it is also stated that the majority of students have reported positively to using software in their learning process and the effect that it had on their learning.

2.2.7 Issues in Constructivist Learning

Although constructivist learning theory was seen as productive by many researchers, on a different note Bodner (1986) has seen certain issues in constructivist learning. Constructivist learning changes teachers' beliefs and institutional beliefs. The constructivist model requires a subtle shift of the teacher; from someone who 'teaches' which is teaching by imposition, to someone who 'facilitates' learning which is considered as teaching by negotiation. The constructivist teacher has to listen to students, insist that students explain their answers to the questions, has to focus on the language used to deliver the lesson and, has to encourage students to reflect on their own knowledge. In summary, the educator has to change from being a narrator of information, to a facilitator who discusses content of lessons, motivates and encourages students.

However, teachers could be faced with challenges in terms of adapting to the constructivist methods BY developing skills, beliefs and confidently make changes to their traditional teaching methods. As a result, teaching and learning roles could be unduly restrained (Taylor, Fraser, & Fisher 1997). In other words, teachers must attempt to give a face-lift to their already existing teaching methods so that students take responsibility for their own learning and the construction of their knowledge

(Clarke, 1994). One imperative challenge that a teacher could face when trying to adapt to the paradigm shift from traditional teaching to a constructivist way of teaching is the inability to transfer the physical and logico-mathematical knowledge from the mind of the teacher to the learner (Bodner, 1986).

Methods of assessment in the constructivist method can become complex. The nature of formative and summative assessments that were applied in the traditional methods need to be changed in order to fit the constructivist methods. The assessments have to be converted into items that search for knowledge that fits the reality experienced by students in their learning (Kruger, 1994).

Students have to be actively engaged and motivated in the constructivist method of learning. Sometimes, in order to absorb new conceptions in learning the students have to give up conceptions, beliefs and attitudes they have formed in the process of adaptation to real life, which would mean a loss of stability. Consequently, motivational factors could impede conceptual changes of a student, if a misconception is held in an area where a student has little interest (Schumacher et al., 1993 as cited in Duit & Treagust, 1998).

With regard to using complex tools in technology-based constructivist teaching, it is important that teachers are aware that the focus could move from teaching the tools, rather than how to use them in learning the concepts of the computer courses, in order to avoid not conveying the concepts of a course appropriately to the students (Azemi, 1995; Maor & Fraser, 1993 as cited in Crump & Craig, 2000).

On another note, it has been reported that major cultural restraints such as powerful cultural myths rooted in the histories of science or mathematics or schooling can offset the development of constructivist learning environments (Taylor, Fraser, & Fisher, 1997)

2.2.8 Social Theory

Social learning theory suggests that learning occurs within a social context, where people learn from one another, in most facets Albert Bandura is considered one of the leading proponent of this theory (Ormrod, 1999). Bandura states that social

learning theory can be considered a transition between behaviourist and cognitive learning theories and people can learn through observational learning, imitation and modelling. There can be live models where an actual person demonstrates a particular behaviour. There can also be symbolic models which can be a person or an action portrayed by various mediums, such as the television, videos or computer programmes (http://teachnet.edb.utexas.edu/~lynda_abbot/Social.html). As cited in Ormrod (1999), an individual's exhibited learned behaviour through social learning is influenced by reinforcement and punishment. Bandura suggests that the environment also reinforces modelling. However, their performance may not reflect their social learning.

Dewey, and educational psychologists such as Vygotsky, Piaget and Bruner have proposed that children actively construct knowledge and this construction of knowledge happens in a social context.

Aldridge and Fraser (2003) state that the social aspects of learning are getting increasingly important, as knowledge is actively constructed by the learner, employing interpretation within the social and the cultural setting. The cultural and social backgrounds of a student have direct impacts on their already established beliefs and attitudes which are accumulated through life's experiences. A student's individual interpretations are shaped by experience and social interactions. However, a student's insufficient background knowledge and difficulty in giving up already existing beliefs could lead to difficulty in absorbing new concepts. Hence, education in countries around the world currently focuses more on factors such as students' differing backgrounds, interests and learning styles than on their outcomes. The social theory is further underpinned by the illustration of Habermas' three worlds expressed in Chapter 2 (see Figure 2.1) and also the four holons of human behaviour put forward by Wilber (2000) (see Figure 2.2). Thus, it could be deduced that the knowledge construction and interpretation is linked with the social and cultural setting of the learner.

How a specific group collectively influence learning activities of an individual, is categorised under social constructivism. Group learning and collaboration can be helpful towards knowledge construction (Piaget, 1970; Vygotsky, 1986 as cited in Maor, & Fraser, 1993).

However, social structures in groups such as individual goals and diverse nature of knowledge construction could sometimes tend to over-simplify issues. Hence, an educator must make sure that the diverse nature of group culture and knowledge construction is taken into consideration when group work is implemented in a course. In addition, in culturally diverse classrooms student perceptions of the teacher's interpersonal communication process is an important factor, which could in turn affect the students' cognitive and affective learning outcomes (Linn & Burbles, 1993).

However, in areas like mathematical activities, students show diversity in reasoning due to differences in their social and psychological perspectives. This is comparable to Piaget's theory and these two features are expected to exist together in order to bring about results (Mehan & Wood (1975) as cited in Cobb, 1998).

The above findings provided valuable frameworks for identifying themes of learning theories in science education research over the past decades and analysed research on science learning using a framework which involved concept learning, developmental, differential and problem-solving perspectives.

2.2.9 Summary

Educational researchers have extended the scope of research in science education. "Researchers were interested primarily in discovering whether or not changes in a teaching procedure or in a curriculum led to changes in student performance" (Duit & Treagust, 1998, p. 4).

Past researchers have put forward various individual learning theories. However, literature suggests that in practice individual learning is a composite of behaviourist, constructivist and social theories. The literature search on learning theories addressed these multi-paradigms. The amalgamation of the above paradigms is considered as the basis of pragmatism and hence this study is considered underpinned by the pragmatic paradigm. Students follow various individual approaches to learning science (Duit & Treagust, 1998). Currently, with technology-based education students are influenced to embrace a constructivist approach to learning in various

disciplines in science and technology and the teachers are expected to take a paradigm shift from the traditional teaching approaches.

2.3 LEARNING ENVIRONMENTS

2.3.1 Introduction

"The field of learning environments has undergone remarkable growth, diversification and internationalisation during the past 30 years" (Fraser, 2001, p. 1). This section of the literature search explores aspects related to teaching and learning in diverse learning environments put forward by past researchers. However, relatively few studies have been conducted at university level to improve learning environments to achieve better student outcomes despite the current availability of instruments to measure classroom environments at university level (Yarrow, Millwater, & Fraser, 1997). At the same time, not much research is available on New Zealand's tertiary computer learning environments.

Most student learning time is spent in classrooms or computer laboratory learning environments. Having experienced many different learning environments throughout their academic career, tertiary students make good judges and form accurate opinions of their current learning environments (Fraser, 1998a). Fraser (2001) also articulates that educators around the world pay more attention to student achievement and little attention to the learning environments. However, "Although the field of classroom leaning environment provides ideas and techniques that could be extremely valuable in teacher education in assisting teachers to become more reflective and to improve their practice, surprisingly little has been done in incorporating learning environment ideas into teacher education" (Fraser, 1989 as cited in Yarrow et .al., 1997, p. 68).

This part of the literature review focuses on the concepts of learning environments, culturally diverse learning environments and technology-based learning environments. This is followed by the types of New Zealand's technology-rich learning environments that are a focus of this study. Online learning environments which are currently quite popular are then examined. Finally, assessing technology-rich learning environments is discussed.

2.3.2 Concepts of Learning Environments

The concept of learning environment has existed since the 1930s, as stated by Fraser (1994, 1998a), and Goh & Fraser (1998). Research on classroom learning environments was started by Walberg and Moos and has been firmly established during the last 30 years or more. Supporting evidence is deduced from the results of research that were conducted on learning environments, engaging large numbers of students in many countries in Asia and Europe (Fraser, 2001). During that period, learning environment research mainly focused on traditional learning environments. With the introduction of technology in class rooms, the research studies have been extended to technology-rich learning environments at both in secondary and tertiary levels of education.

Individual students have their own perceptions of their classroom environments. Classroom environments play a major role in students' learning styles and their perceptions of their classroom environments can affect their academic achievement (Fraser, 1994, 1998). In the past, educators expected every student to accept their learning environment in the same way. However, in the latter half of the 1980s, the assumption that a common learning environment is experienced by all students within a class room was challenged (Fraser, Fisher, & McRobbie, 1996). Since then researchers have been conducting studies in this area and have come up with various findings. It has been found that social and psychological factors in classrooms affect students' perceptions of their classroom environments especially in learning science and student perceptions of their learning environments are vital to their academic achievement (Fraser, 1994, 1998a). Fraser (1998a) states that student perceptions of the learning environments account for considerable amounts of variance in learning outcomes. However, according to Huang (2006) "Little research on psychosocial environments at the higher education level has been reported in recent years, despite an increasing awareness of the important role of environment on student performance" (p. 479). Newby and Fisher (1997) state that the nature of the classroom environments affects students' cognitive and affective learning outcomes. Huang (2006) articulates that, in tertiary education cognitive measures alone cannot provide a complete picture of the academic learning process and its outcomes of

students and the affective domain could dominate the cognitive domain in a psychosocial learning environment.

Students have their preferred learning styles which vastly depend on their culture, cognition, gender and teacher-student communication patterns (Faloon, 2005). However, most educators do not seem to have much concern for adapting to the learning styles of the students and mainly focus on assessments and academic achievement. It is also stated that such educators little realise that meaningful academic achievement cannot be attained by merely concentrating on assessing students' learning and that the student learning outcomes vastly depend on provision of a suitable learning environment (Fisher, Rickards, and Fraser (1996, p. 29, as cited in Kongkarnka & Fisher, 2008) state that most science teachers believe that good relationships with their students are important towards student achievement. Thus, the teacher must take responsibility to judge the trends that are developing in a classroom and address them accordingly (Kongkarnka & Fisher, 2008).

The concept of learning environments is rooted in five foundations, and must be considered in achieving sophisticated learning goals (Land, Hannafin, & Michael, 1996). They are; psychological, pedagogical, technological, cultural and pragmatic. Psychological foundations emphasize how individuals think and learn, while pedagogical foundations emphasize how knowledge is conveyed. Technological capabilities can enhance student learning as well as constrain them. Cultural foundations reflect prevailing beliefs about education, while pragmatic foundations reflect the practical constraints of the environment. These four foundations are integrated in various degrees in different learning environments. This study emphasises these learning environment concepts and is aimed at suggesting a suitable framework for teaching computer courses in technology-rich learning environments.

On another note, Lewin (1935) put forward the formula; $B = f(P, E)$, which indicates that human behaviour is considered to be a function of the person (P) and the environment (E). In this equation, 'person' refers to the motivational personality and tendencies to move towards certain goals, while 'environment' refers to an external situation which supports or frustrates the expression of internalised personality needs.

Hannafin et. al., (1999) have stated that the learning environments consist of at least four elements, namely, enabling context, resources, tools and scaffolds. Enabling contexts help activate existing prior knowledge relevant to the topic learnt. This helps the learner choose strategies that have been deployed for prior tasks that are relevant to the current task. Thus, students can personally choose a problem and manage it using their own procedures. According to Hannafin et al., resources that can be utilised in learning environments are anything ranging from books, journal articles, videos, power point presentations, web sites to human resources such as experts in the field. However, such resources are useful when it is topic related. Tools that are used in learning can exist in the forms of information processing, manipulation, communication and scaffolding. They may or may not be used in a particular area of learning. Scaffolds can be provided by tools, educators, experts and student peers to help decide whether certain tools in learning will be used.

Research studies on science laboratory learning environments have been conducted over the past few decades. As cited in SMEC Reader (2005), Fraser (1998b) has reviewed the following with regard to laboratory classrooms: How do students perceive their class room environments? How do students perceive their actual and preferred learning environments? Does a learning environment affect students' learning and attitudes? Can teachers assess and change the learning environments? Are the student outcomes affected by their learning environments? Do the perceptions of the learning environment affected by student abilities, gender or the ethnic background? (http://www.edtech.vt.edu/edtech/id/models/environs.html).

These areas were used as a basis to explore the learning environments which address the aims of this study in New Zealand, with the assumption that the nature of technology-rich learning environments is comparable to science laboratory learning environments. Since the introduction of technology to New Zealand education curriculum in 1995 (p. 6) technology has become more sophisticated, complex and diverse and the demands for technology in work places as well as keeping up with the social and economic transformation has become vital.

2.3.4 Culturally Diverse Learning Environments

One major characteristic of today's learning environments in most countries is that the tertiary education environments are moving towards being more and more culturally diverse. New Zealand currently experiences culturally diversified, multi-ethnic tertiary class rooms that are comprised of students from various cultures. Student population of the New Zealand institutions under this study are comprised of Europeans, Asians from diverse religions, Pacific Islanders, Indians, New Zealand Maori and New Zealand Europeans.

In culturally diverse learning environments, it is important to focus on students' differing backgrounds, interests and learning styles and introduce suitable teaching and learning methods that suit the student population in a classroom. According to Aldridge and Fraser (2003), in culturally diverse classroom environments students' perceptions of the teacher's interpersonal communication process are imperative towards their achievement of cognitive and affective learning outcomes. However, in most learning situations, the focus is only on students' learning outcomes (Aldridge & Fraser, 2003). According to Tobin and Fraser (1998) when a class has students who are from different ethnicities speaking different languages, the teachers are challenged. Tobin and Fraser (1998) also state that it is significant even when a common language is employed as the teaching medium. Hence, in order to achieve desirable outcomes, educators must be mindful of today's culturally diverse learning environments and the methods of teaching in such environments.

Veldman (2003) suggests that appropriate training must be provided to teachers in order to achieve effective teaching in such culturally diversified environments. It is not clearly known if such a practice is available to the current educators through their institutions participating in this study. As described by Chang and Fisher (2003), three types of communications; one to one, one to many and many to many must exist in these learning environments. Students must be able to work individually, collaborate among each other working in groups and collaborate within groups in these environments. To maintain these types of communication in technology rich, culturally diverse learning environments which are the focus of this study, the learning environments also must display the required psychosocial aspects (Chang & Fisher, 2003).

Figures 2.3 and 2.4 illustrate such culturally diverse ICT learning environments in two of New Zealand's polytechnics and Institutes of Technology which took part in this study.

Figure 2.3. A typical computer laboratory teaching and learning environment in Institution 1 showing cultural diversity.

2.3.5 Technology-Based Learning Environments

The introduction of computers in classroom learning has changed the learning environments significantly (Maor & Fraser, 1996). Over the past decade the use of information and communication technologies in learning environments has dramatically increased (Newby, 2003). Moreover, these technology–based learning environments are under constant change with the rapid advancement of technology (Rickards, 2003).

These learning environments offer the potential to take teaching and learning beyond the four walls of the classroom where the learning can be based on real-world problems where learners seek to actively construct knowledge (Trinidad, 2003). Trinidad (2003) also states that with the introduction of global communications networks learning environments, the local and global communities can be merged. She further, articulates about the new approach to learning using modern technology;

the learner can communicate, interact with peers and share knowledge using these communication networks and other technological methods.

The potential of the internet and the technologies it inspires makes it feasible to not only access and manage information in productive and efficient ways, but also to deliver dynamically interactive, personalised solutions tailored to the needs and preferences of all learners. Therefore, it is important to extend our understanding of how computer technologies can enhance student learning whilst providing some insight into the future learning (Quinton, 2006, p. 543).

Newby (2003) states that effective use of computers in a classroom creates a more student-centred and cooperative learning environment. These psychosocial computer-assisted learning environments (Teh & Fraser, 1995 as cited in Newby, 2003) and university computer courses Newby and Fisher (1997) showed that the learning environment mainly affects student attitudes, and satisfaction, which in turn affect achievement.

Trinidad (2003) observed that "Educators can shift their pedagogical approach towards a balance between the appropriate use of direct instructions with a collaborative, inquiry-driven, knowledge-construction approach allowing students to achieve far beyond their expectations" (p. 98). Trinidad (2003) also has stated that, despite the introduction of technology to most learning environments the teaching and learning processes have hardly changed. As a result of the introduction of technology to today's classrooms, the teachers are faced with the challenge of adapting to the fast-changing technology. However, there is a gap in history in education for successfully meeting the challenge of major shifts in information technology (Trinidad, 1998 as cited in Aldridge & Fraser, 2003).

Findings of studies done in the UK (ImpaCT2, 2000) with regards to teachers' use of technology reveal that little has changed has taken place in the classrooms over the past fifteen years. A research study on 46 classrooms in Hong Kong revealed that the pedagogical beliefs of the teachers has not changed, and did not permit them technology-based teaching, other than teaching the same old methods using new technology (Trinidad, 2003). Spreda and Donnay (2000) as cited in Margianti (2003), articulated of the importance of the computer learning environment at the

tertiary level state that, it is important for many reasons, such as the retention of students, and also for achieving desirable outcomes.

Newby (2003) has stated that the present-day tertiary students prefer to be exposed to practical applications and favour learning by experience. Their learning also depends on attributes such as the software and hardware used, class sizes and usage of multi-user systems. However, certain software that is learnt within a single course can be extremely complex to the students which could make the lab assignments difficult to handle within a given time frame. Newby (2003) also states that, with the growing technology the present day students are required to master computer skills before they master the subject and it is important that they do not waste much time learning the software.

With the advancement in technology, traditional teacher-directed learning environments must take a shift into learner-directed learning environments (Sandholtz, Ringstaff, & Dwyer, 1997 as cited in Trinidad, 2003). Zandvliet (2003) stated that as a result of the application of current technology in classrooms, more and more student-directed constructivist learning environments had been created (see Figures 2.3 & 2.4). However this paradigm shift is not as easy as it sounds and Trinidad (2003) suggests that "Support is needed to help educators teach in learner-directed environments with the educator being the key to creating, maintaining and working in such learning environments" (p. 99). However, research studies have revealed that those teachers who maintained traditional beliefs found it difficult to adjust to working in technology-rich learning environments and reverted to lecture-style teaching (Dwyer et. al., 1990a; 1990b; Sandholtz et. al., 1997 as cited in Trinidad, 2003).

The learning environment has long been perceived as an important factor influencing student behaviour and educational development. Also the class can be regarded as a social system in which group behaviour can be predicted from the interaction of personality needs, expectations and the classroom environment" (Getzels & Thelen as cited in Kongkarnka & Fisher, 2008, p. 90; Lewin, 1936; Murray, 1938)

However, Nesbit and Martin (2011) state that although the learning environment may be technology-rich, it is important that pedagogy, technology and content are kept in balance for effective learning to occur.

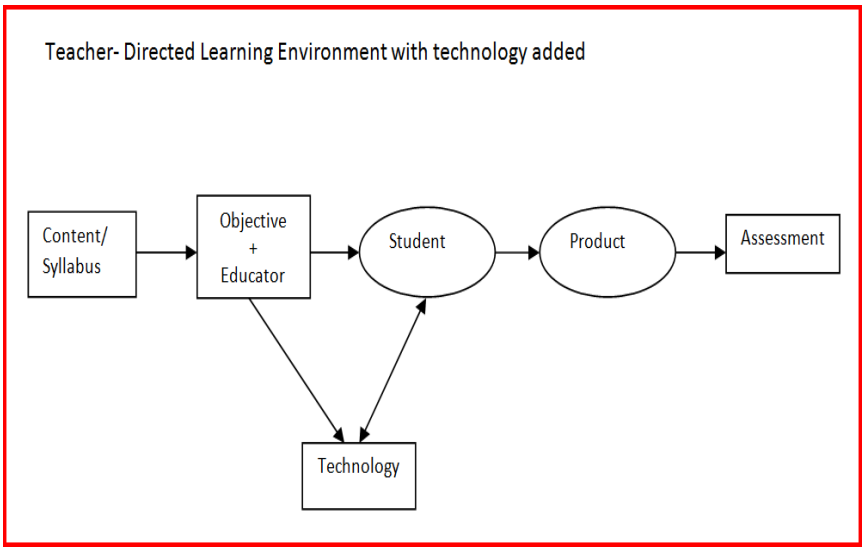
Figure 2.4. Student-directed ICT learning environment in New Zealand Institution 5.

Figures 2.3 and 2.4 reveal that student learning in a technology-based learning environment can be more student-directed. Figure 2.3 shows a student presenting his findings to the class in Institute 1.

Figure 2.5 illustrates a map of a teacher-directed learning environment (Trinidad, 2003). Although the environment is teacher- directed, it includes teaching with technology. In this learning environment, the educator is the seen as the expert with specific knowledge and sets the objectives of the lesson while the students become the passive recipients of the knowledge. The knowledge is passed on to the students using a linear path, which is teacher-directed using a narrow content area (UNESCO, u.d. as cited in Trinidad, 2003). Students later have to demonstrate their learning through static artefacts such essays or tests.

Not only does this model promote a surface learning approach that is incompatible with today's need of producing lifelong learners who can think critically and strategically to solve problems in diverse situations of a rapidly changing world, but it is not based on a clearly articulated theory (Albon & Trinidad, 2001; Nelson, 2001 as cited in Trinidad, 2003, p. 102).

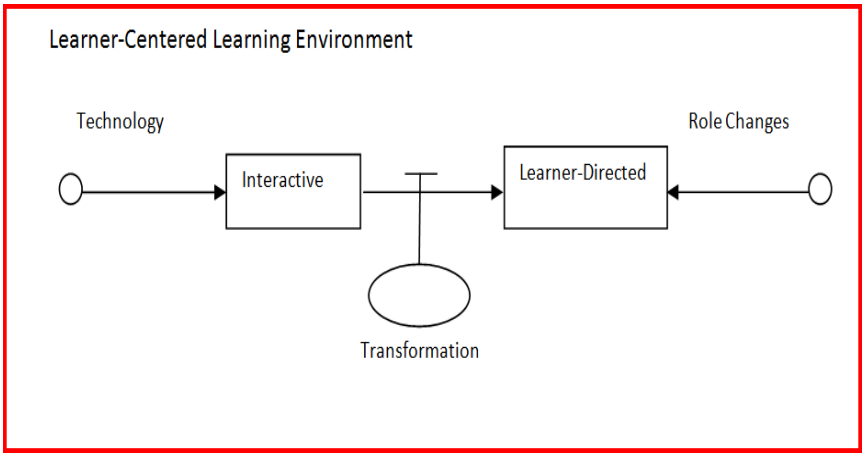
This method does not provide transparency to the educator of what the students have actually learnt.



Adapted from Albon & Trinidad (2001) as cited in Trinidad (2003)

Figure 2.5 A teacher-directed learning environment with technology added.

Figure 2.6 illustrates the learner-centred learning environment with technology (Trinidad, 2003). This model uses learning with technology as opposed to teaching with technology illustrated in Figure 2.3. In this method where technology is integrated into the learning process, the educators need to understand how technology can enhance both teaching and learning processes. Hence, effective, multi-skilled and enthusiastic teachers are required to manage technology-rich learning environments (Rickards, 2003).



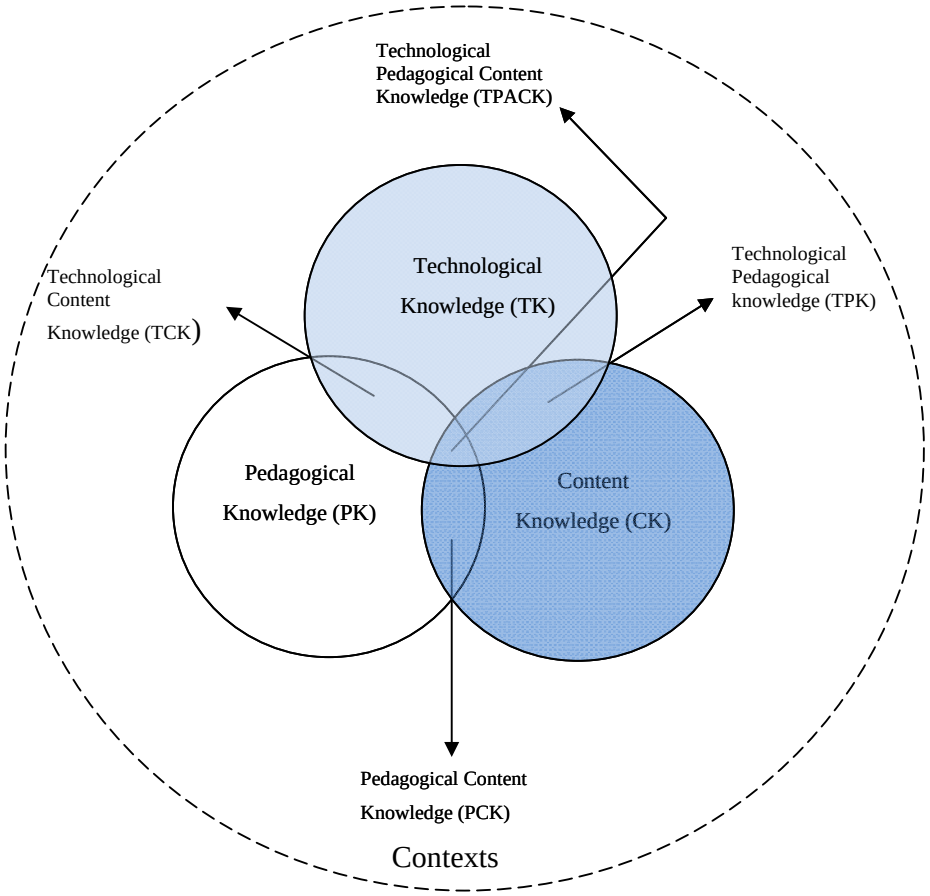
Adapted from Newhouse, Trinidad & Clarkson (2002, *p*.22) as cited in Trinidad (2003)

Figure 2.6. An interactive learner–centred learning environment with technology added.

The type of teaching and learning method illustrated in Figure 2.6 can be considered a social-constructivist approach and allows learners to be actively involved in their own learning process. It also and gives them a sense of ownership and allows them to share with peers and the educator and construct their own knowledge (Trinidad, 2003).

Figure 2.7 presents the TPACK framework (Koehler & Mishra, 2008 as cited in Nesbit & Martin, 2011, p. 200) which illustrates the understanding of the integration of technology in teaching. The framework focuses on the three components technology, content and pedagogy. In this framework technological content merges with the pedagogical content to bring about technological and pedagogical knowledge of the learner. The interaction of all three areas will produce technological pedagogical knowledge of a student.

Factors affecting technology-based learning environments



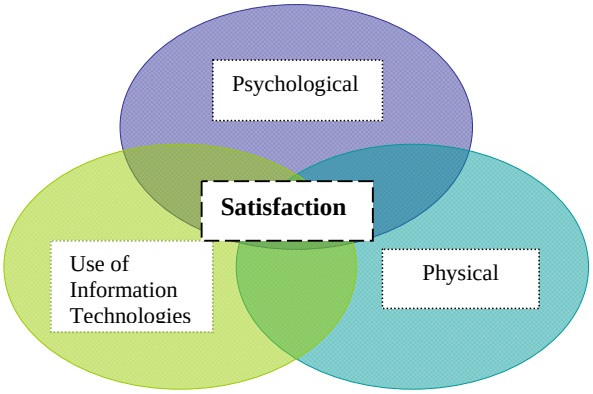
Developed in Koehler & Mishra (2008) and adapted in Harris et al (2009) as cited in Nesbit & Martin (2011), *P*.200

Figure 2.7. The TPACK Framework.

Zandvliet (2003) has found that, the satisfaction of students' learning in technology-based learning environments depends on a combination of *physical and psychological factors* and is influenced by the use of technology in class rooms. This is further illustrated in Figure 2.8 adapted from Gardiner (1989) as cited in Zandvliet (2003). This figure presents a model for potential factors that influence student satisfaction in learning in technology-rich learning environments. It shows that in technology-rich classrooms there is an association between students' physical work space with both their visual and psychological learning environments.

Physical factors can be considered things such as ergonomically correct furniture, placement of computers enabling student to easily see the instructor as well as the computer monitors, movable chairs that help students interact and help the class size affect student learning. According to Clarke (1994), students do not prefer large class sizes and when engaged in class activities they like being facilitated by a lecturer in order to enhance their diversified views.

Psychological factors affect student perceptions of their learning environments. Newby (2003) in his research on computer laboratory learning environments has stated that students had more positive perceptions about aspects of closed computer laboratory settings and their attitudes towards computers, than did the students who experienced open computer laboratory settings. Newby (2003) also states that tertiary students prefer to be exposed to practical applications and to learn by experience which depends on attributes such as the software and hardware used, class size, usage of multi user systems. A large class size could also affect the way students perceive their learning environment. For example, the feeling of inadequacy of technology could be felt among the students when a full class of students trying to access multi-user systems to learn software in a laboratory environment.



adapted from Gardiner, 1989 as cited in Zandvliet (2003)

Figure 2.8. Model of potential factors that influence student satisfaction.

2.3.6 Technology-based Classrooms in New Zealand's ITPs

Figure 2.9. An ICT learning environment in Institution 5.

Figures 2.9 through to 2.12 present types of technology-based learning environments of different institutions that participated in this study. Figure 2.9 shows a classroom which presents the seating arrangements, locations of the screen and the white board which facilitate group discussions. Face-to-face seating during the lessons allows the students to collaborate with other students and the lecturer liberally.

Figure 2.10. An ICT learning environment in Institution 6.

Figure 2.11. An improvised ICT learning environment in Institution 6.

Figure 2.10 represents a learning environment with an interactive smart board and a white board. Such facilities meant to influence satisfactory collaboration between the tutor and the students. The learning environment displayed in Figure 2.11 is set up to allow sufficient space and independent working areas for students. These facilitate easy movement of learners and the lecturer towards informal collaboration in a relaxed learning environment.

Figure 2.12. ICT student project room in Institution 6.

The technology project room in Figure 2.12 is set up differently to a typical computer laboratory. This set up assist the individuals work independently in their work stations, typically doing ICT projects.

Hardware laboratories in institutions under this study

Figures 2.13 through to 2.18 illustrate hardware and data communication learning environments in Institution 6 where, students get hands on practice assembling computers and doing data communication practicals.

Figure 2.13. Computer Hardware laboratory in Institution 6.

Figure 2.13 displays the hardware laboratory equipped with hardware components and tools for students to assemble computers.

Figures 2.14 and 2.15 display the various hardware components mounted on the walls of the hardware laboratory.

Figure 2.14. Computer hardware display 1 (on the wall) in Institution 6.

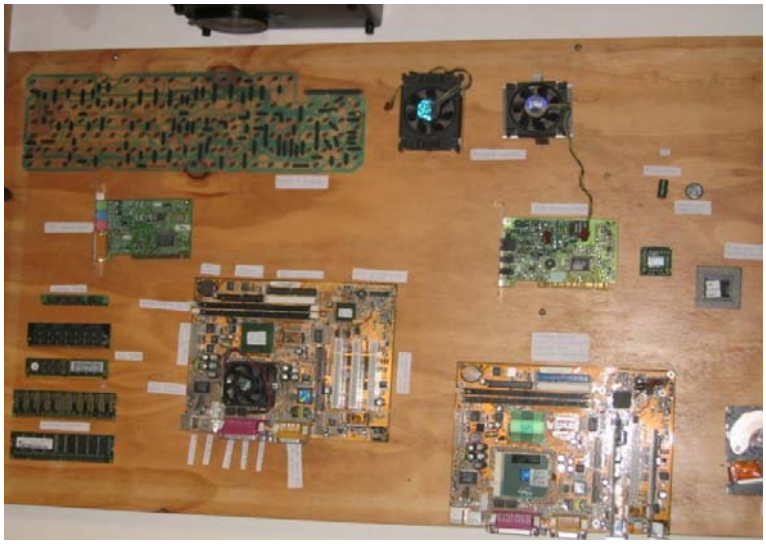


Figure 2.15. Computer hardware display 2 (on the wall) in the laboratory in Institution 6.

Figure 2.16. Computer hardware in the laboratory in Institution 6.

Figure 2.17. Data communication laboratory in Institution 6

Figure 2.17 presents the data communication practical laboratory in Institute 6, where the students communicate with each other using network protocols, in a simulated environment. Further, Figures 2.17 and 2.18 display the equipment in individual boxes provided to students in institution 6 for Data Communication and Networks practical lessons.

Figure 2.18. Data communication equipment boxes in Institution 6

Figure 2.18 illustrates the boxes in which the data communication equipment are stored for each individual student.

2.3.7 Online Learning Environments

The definition of online learning among various definitions given by various authors, is simply the variety of ways of using connected computers by educators, at all levels, in learning via the internet and the world wide web (Clayton, 2003). With the rapid advances in technology over the last decade, traditional and distance learning environments is on the way to merging, since similar technologies are being used to support learning in both environments (Hartnett, 2010). With the growth of the technology-based learning environments such as the modern technology and the internet, online learning environments have become a major part of university studies in the world and increasingly getting popular in New Zealand. The creation of the internet and the World Wide Web has influenced modern society and online learning. These have added to the sophistication of the internet and the World Wide Web along with the advancing computer skills of the students. This has enabled educational institutions lever on internet technologies to supplement classroom instructions on learning (Clayton, 2003). Chang and Fisher (2003) state that, with the introduction of online learning, the classroom is brought to the doorstep of the student and as a result the traditional teaching and learning style in higher education

has transformed resulting a significant paradigm shift in the learning environments. The internet and the World Wide Web has altered the way of student learning and communication and continue to change (McGovern & Norton, 2001; Newhouse, 2001a as cited in Clayton, 2006).

Online learning has become a sub-category of distance education (Ally, 2008 as cited in Hartnett, 2010) with specifically he use of internet and WWW (Bates, 2005 as cited in Hartnett, 2010). The online perspective of learning is further facilitated by the availability of modern software and tools designed for various purposes currently (Barnes, 2003, as cited in Khine, 2003). Hartnett (2010) also states that e-learning has evolved with the use of digital resources and technology-mediated communications in the online learning process. However, Faloon (2005) states that not having adequate and correct software makes it difficult to deal with online learning.

In New Zealand, there are many tertiary institutes that offer distance learning and alternative technology-mediated means to deliver courses to their learners (Cameron & Baker, 2004; Marshall, 2005 as cited in Hartlett, 2010). Some institutes offer web assisted options as a supplement to face-to-face communication between students and educators while some other institutes consider the internet as the sole medium of delivery in web-based learning (Asgarkhani, 2003). Asgarkhani in his article argues about the effectiveness of web-based learning in New Zealand and states that there is an increasing interest in application of e-learning among institutes. While students felt the advantages of a high quality web-assisted course, they also felt that teacher participation was equally important (Asgarkhani, 2003). A research study conducted by Skelton (2009) in a New Zealand institute of technology blended learning environment (Institute 3 in this study) revealed that 60% of the students still value real-world physical interaction with teachers despite the satisfaction they acquire with an online learning environment running in parallel. Interestingly, females responded more positively to undertaking online studies than the males in this institute and also females were found to be more likely to be interacting with other students online (Skelton, 2009).

In online learning environments, students have to take most responsibility for their own learning while the teacher has to take the role of a facilitator. In order to be

successful in online learning, the student has to be active and conscientious about learning. This needs a considerable amount of self-organisation such as proper time management and dedication towards outcomes in learning. Thus, technology-rich learning environments using e-learning give the learner a sense of empowerment engaging them in their own learning, and not depending on specific and limited knowledge of the educator (Trinidad, 2003).

In online education literature, constructivist and social constructivist perspectives have gained prominence (Ally, 2008; Dyke et. al., 2007 as cited in Harnett, 2010). Emphasis on authentic activities, collaboration, learner control, refection, active engagement and intrinsic movement are some of these perspectives (Dalgarno, 2001; Herrington & Oliver, 2000; Moallem, 2001 as cited in Hartnett, 2010). Individual students must create their own knowledge in online learning, which is known as individual cognitive constructivism. This perspective enables individuals to choose, assemble and construct their own representations of knowledge (Jonassen, Howland, Marra, & Crismond, 2008 as cited in Hartnett, 2010). Social constructivism in online learning is represented by participation in shared activities where the context and the nature of learning are integrated among students (Cullen, 2001 as cited in Hartnett, 2010).

Online learning environments provide three types of communications which represent cognitive constructivism and social constructivism. These are; one to one communication, one too many communications, and many to many communications. *One to one communication* is the commonest online communication which addresses tasks such as answering student queries via email. In o*ne to many communications* the facilitator guides students' progress through study materials, readings and other postings is considered. On-going discussions among the learners and the facilitator are considered in *many to many communications*, which include video conferencing and on-line learning support currently available through the institutes to remote students and students working from home (Chang & Fisher, 2003). According to Chang and Fisher (2003), the types of communication that take place in online learning environments are found to be significantly different to that of the traditional teaching and learning environments where collaboration and communication play a major part in addressing the social aspects.

On another note, Moore (1989) as cited in Hartnett (2010) has identified three types of interactions in distance education which are; learner-instructor, learner-content, learner-learner interactions. In addition, Hillman, Willis, and Gunawardena (1994) as cited in Hartnett, 2010 have added a fourth type, learner-interface interaction which concerns the learner's ability to use the required technological tools to communicate with the teacher, other students and access the course contents.

Considering the teacher's role in online learning environments, they should be aware of their new role of being a facilitator rather than an instructor where instructions are delivered to the students in a face to face fashion. This requires the teachers to be responsive, competent and be organised to deliver online teaching, while encouraging the students to contribute, giving feedback and encouraging discussions (Chang & Fisher, 2003, p. 5). Teachers have to face this ever-challenging learning environment issue, by managing the pedagogical shift that arises with the change whilst managing the technical-issues encountered when shifting their courses to the web (King, 2003).

Social-cognitive theory says that motivation influences both learning and performance which involves how people acquire knowledge, beliefs and strategies through interaction with others and also observation of others (Shunk, 1995 as cited in Hartnett, 2010). Hartnett (2010) also states that, motivation of learners is an important requirement in online learning which requires a multidimensional collection of personal characteristics such as, the co-existing intrinsic and extrinsic motivations of the learners.

The most prominent factors that affect online learners are relevance of learning activity, provisions of clear guidelines, on-going support and feedback from the teacher, supportive and caring relationships (Hartnett, 2010). The factors that undermine the motivation of learners are high workload, assessment pressure, the perception that the learning activity lacked relevance. However, according to Chang and Fisher (2003) there is little or no research available on psychological aspects on tertiary online learning environments.

Clayton (2003) in his assessment of online learning environments states that, the perceptions of students and teachers as well as the social and the psychological factors are of equally importance to assess digital environments.

2.3.8 Assessing Technology-rich Tertiary Learning Environments

Moos (1974b) suggested six conceptualised methods as a scheme for classifying human environments. Moos (1974a) has recommended a three dimensional framework of human environments using three of these concepts. In this study, Moos' three-dimensional framework underpins the assessment of the technology-rich learning environments. They are relationship dimensions, personal development dimensions and system maintenance and system change dimensions. Moos (1974a, 1979) found that diverse psychosocial environments can be conceptualised which could exist within these three dimensions (cited in Ward, 2008). Technology-rich learning environments are considered psychosocial learning environments. Hence, Moos' three dimensional framework is applied to examine the psychosocial, technology-rich learning environments in this study.

The relationship dimension in this framework assesses the relationship between people and the environment and how they support one another. This is used to assess the extent to which the spontaneous communication between the people in one environment is free, honest and open. This dimension addresses the extent of student cohesiveness and involvement with other students and teachers (Moos, 1979) and can be applied to the learning environments of technology-rich classrooms. The personal development dimension assesses the directions along which the personal growth and self-enhancement of students occur as a result of and their involvement and collaboration with their own learning environment. Orientation and competition are examples for this dimension (Moos, 1974a). The system maintenance and system change dimension assesses the extent to which the system is structured around the environment, and the extent to which the environment maintains controls and is responsive to change. Orderliness, organisation and innovation are examples for this dimension (Moos, 1979; Ward, 2008).

Habermas' Three Worlds of Humans (see Figure 2.2), the four holons of human behaviour (see Figure 2.1) and Moos' three dimensional framework of human environments are used as the basis to assess the learning environments of this study with the aim of obtaining answers to the research questions.

Haynes (2002) as cited in Clayton (2003) has outlined four features of online learning relationships. They are; student – interface, student – tutor, student – student and student – content relationships. However, Clayton (2003) argues "Although these four broad categories appear to identify all aspects of online learning, they do not investigate how the learner, as an individual, reacts and reflects on his/her experiences in this environment" (p. 160). These features in addition can be used in assessing online learning environments.

2.3.9 Summary

"Researchers should look at the teaching and learning scenarios around them to try and identify the inherent problems, then seek to discover how technologies can be used to address them" (Draper & Brown (2004) as cited in Nesbit and Martin, 2011, p. 198).

According to Trinidad (2003), despite the introduction of technology to most learning environments, there has been little change in the process of teaching and learning. Educators are posed with many challenges with the introduction of technology to most learning environments, and may not necessarily be fully conversant with the technology used in today's classrooms. Also, some educators are not in favour of changing their traditional teaching methods and find it hard to accommodate and make use of the available technology to their advantage (Trinidad, 2003). Furthermore, such a transformation is based on individual teacher's level of competence with the available technologies, their ability to manage classes in technology-rich learning environments, their skill and enthusiasm (Rickards, 2003). Thus, teachers should consider their roles in technology-based learning environments and must adapt to the shift, in order to achieve successful teaching and learning outcomes.

2.4 TEACHING AND LEARNING MODELS

2.4.1 Introduction

Education environments are changing at a very fast pace at present along with the socio-economic environments and the rapidly advancing technology and it has become imperative to construct innovative teaching strategies and learning models for future graduates. Students' expectations and demands in technology-rich learning environments have to be considered in designing strategies to teach in these learning environments and the designer has to think "outside the box" (Quinton, 2006). Quinton (2006) also states that with the advancement of technology, new models of learning that connect people to people and people to technology have become essential.

In the past, text and verbal messages were the predominant medium for human communication in imparting new knowledge and skills to the learners and were mainly teacher controlled. With the advancement of technology, a paradigm shift is currently taking place in tertiary education, from being teacher controlled to student centred. However, Gunstone (1995) argues that student-centred learning requires strong teacher control.

This section of the literature review investigates specific teaching models that are useful for this study. It first investigates traditional teaching models put forward by past researchers. Then, an example of a student concept of a teaching model put forward by a past researcher is discussed. This is followed by Biggs' '3P Model of learning' (see Figure 2.2) which will contribute to forming a base to the teaching and learning model in this study is. Finally, technology-based teaching models are discussed.

In addition, attempts are made to associate the teaching and learning models that are investigated in this chapter to be in line with the learning environments and the learning theories described in sections 2.2 and 2.3.

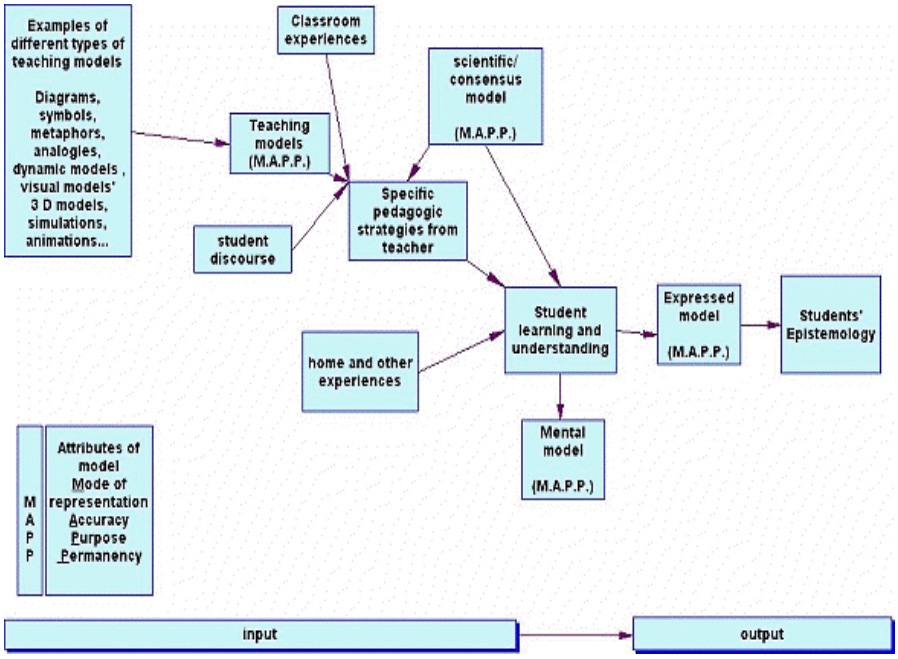
2.4.2 Traditional teaching Models

"In many instances, learning is viewed as a one-way, 'distribute-then-learn' system" (Quinton, 2006, p. 544). Traditional teaching models were popular in the past and to a certain degree in various countries even at present. This teaching model mainly used the behaviourist approach that based on 'cause and effect' relationships. Theorists who favoured the behaviourist theory emphasised traditional teaching and learning where observable indications of learning were expected of the students. They viewed learning as a sequence of stimulus and response actions in the learner, which elucidated the traditional teaching and learning. In the traditional method the teacher was expected to teach lower levels of skills, on which to build, which were expected to be leading up to a higher level, thus creating a learning chain (Convey, 1997). In this method, the teacher determines all of the skills needed to lead up to the desired behaviour and makes sure students learn them all in a step-by-step manner (Roblyer, Edwards, & Havriluk, 1997, p. 59 as cited in Convey, 1997). Therefore, in traditional learning models, there is little room for a student to acquire new knowledge except for what was conveyed by the teacher.

Furthermore, Quinton (2006) reports that the complexity of information and knowledge gathered by learners today increase in size every day and ultimately become a shared property of networked individuals and communities (p. 544).

2.4.3 Student concept of models

Figure 2.19 illustrates the student learning model put forward by Treagust, Chittleborough, and Mamiala (2001) which expresses four model concepts which relate to the students' learning process. They are; teaching models, scientific models, mental models and expressed models which represent Mode of representation, Accuracy, Purpose and Permanency (MAPP) (Treagust et al., 2001).



Adapted from Treagust, Chittleborough, and Mamiala (2001)

Figure 2.19. Teaching models, scientific models, and mental models and expressed models.

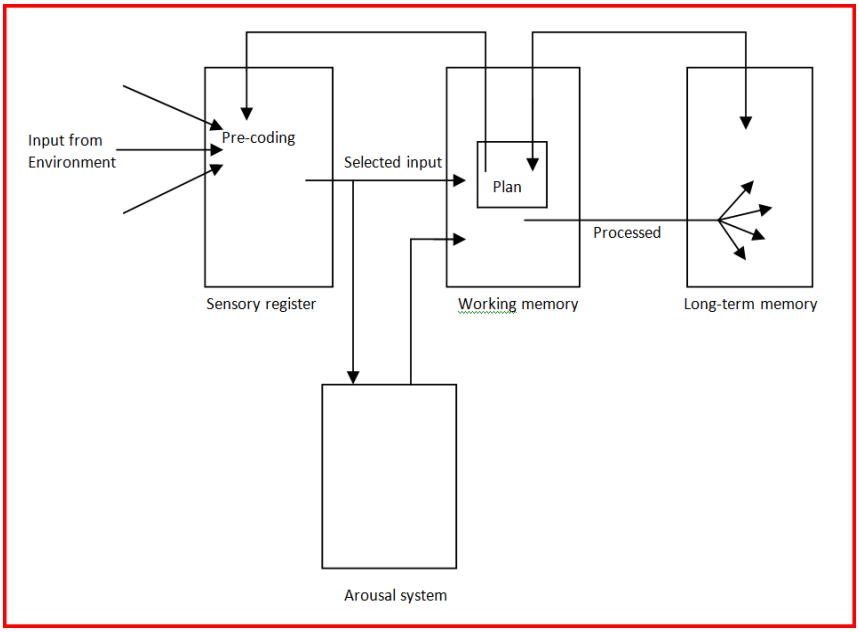
The teaching model (see Figure 2.19) indicates that the teachers endeavour to change, develop or modify students understanding and thinking, to a scientifically acceptable way. This can engage diagrams, symbols, metaphors, analogies, dynamic models, visual models, 3D-models, simulations, animations etc. to communicate the subject matter to the learner. Together with classroom experience, student discourse and specific pedagogy strategies from the teacher, student learning and understanding take place, thus creating a mental model. The learning output also can be mapped to the MAPP concepts of the model.

Referring to good science learning in a constructivist paradigm Gunstone (1995) states that genuine collaboration of the teacher and the student is required, where a student learns more than the content of a lesson. Gunstone also states that an individual constructs knowledge on top of an individual's existing ideas and beliefs, however, the teacher can have a substantial influence on the individual's knowledge construction.

2.4.3 Biggs' Learning Model

Biggs, prior to 1966 was involved in studies relating to the problems of predicting tertiary students' performance. Biggs (1987) used the concept of the Information Processing Model which originated from a model put forward by Atkinson and Shiffrin in 1968 and incorporated his own version of an information processing framework put forward in 1968) to create a model of student learning (as cited in Goh, 2005).

The relationship between arousal and information processing of student learning was put forward by Biggs and Moore in 1993 (see Figure 2.20). In this model, the sensory inputs or information from the environment is received by sensory registers of a person's memory. The information received that is considered important, is pre-coded spontaneously and sent to the working memory which is the short term memory. Processing of information in the short-term memory must be done in order to retain information in the long-term memory. This involves coding and re-coding of the important information. Through this method new materials are linked to previously learnt material.



Adapted from: Biggs and Moore (1993, P.207 & p.238 as cited in Goh (2005)

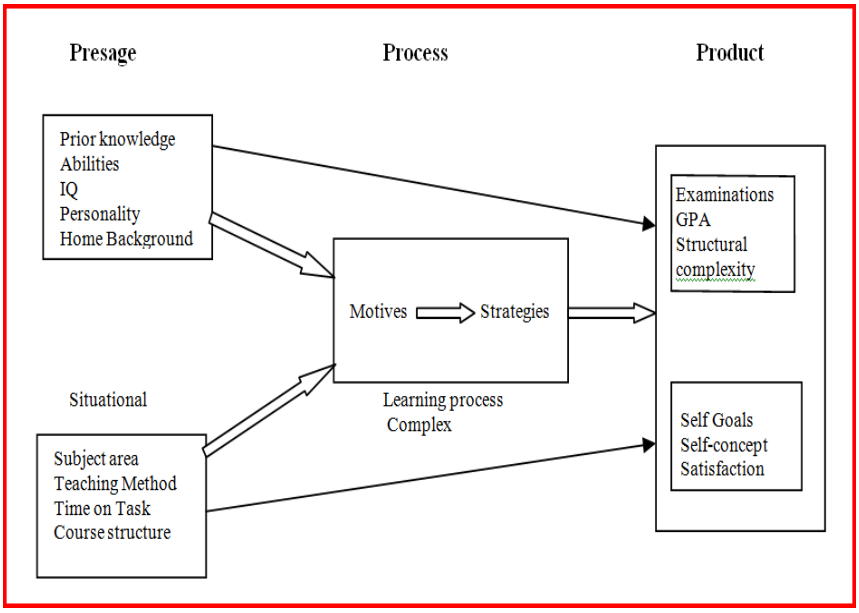
Figure 2.20. Arousal and information processing systems of student learning.

According to this model, an individual forms a schematic system to link knowledge gathered and this is known as meaningful learning and it involves a deep structure. Processed information in the deep structure can be retrieved and reproduced in different forms later on (Biggs & Moore, 1993, p. 207 & p. 238 as cited in Goh, 2005).

This is in contrast to rote learning that involves a surface structure which involves information processed through imagery, recycling and rehearsing. This involves memorisation which can be forgotten more rapidly than the coded and re-coded information and cannot be reproduced in different ways. However, if anything is learnt through understanding, such information can be transformed.

The arousal system (Biggs & Telfer, 1987; Biggs & Moore, 1993 as cited in Goh, 2005) acts to link both the sensory register and working memory in order to orient responses originated due to anxiety, in a learning situation. These facets impact on the working memory or the short term memory. This is considered stress, which could affect a learner's performance. In order to minimise the effects of anxiety, the working memory load of complex tasks has to be reduced. This aspect of this model can be useful in deriving the proposed technology teaching model where complexities in technology learning are involved.

Further, Biggs (1987) as cited in Goh (2005) used the above Arousal and Information Processing Systems model to create a General Model of Student Learning (see Figure 2.21) which included the presage stage, the process stage and the product stage. These three stages incorporated input, process and storage of information processed through the sensory registers, the working memory and the long term memory.

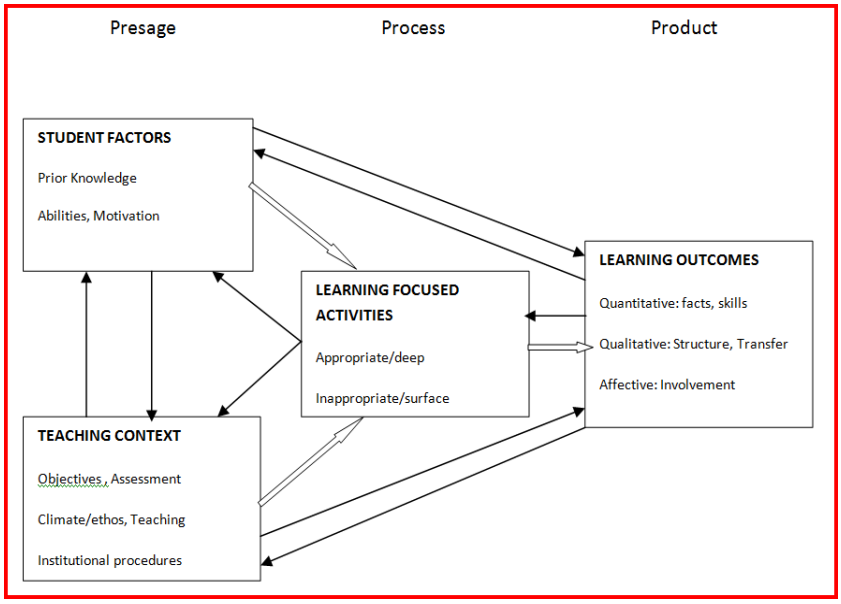


Adapted from: Biggs (1987) as cited in Goh (2005)

Figure 2.21. General model of student learning.

However, when research into learning approaches became intensified, it was found that students have widely differing learning approaches and one set model could not be applied to all types of student learning. Hence, the general model of student learning was modified into the '3P Model of Student Learning' which incorporated a systems approach (see Figure 2.22). Goh (2005, p. 72) states that a student's adoption of a particular learning approach is affected by the interaction of a number of internal characteristics with various contextual factors within an educational eco-system, according to Biggs 3P Model of Student Learning.

Biggs (1993a as cited in Goh, 2005) explained that tertiary education can be explained as a macro system which is comprised of four micro systems. First the individual student, second, the classroom system which consist of the teacher, classroom and teaching context, third, the institutional system which is comprised of the various departments and faculties, and fourth, the community system which imposes its own constraints on higher education and consequently affects the classroom system. Student factors and the teaching context are inter-woven and both these factors affect the learning focus activities and the outcomes.



Adapted from: Biggs (1999, p.18) as cited in Goh (2005)

Figure 2.22. 3P model of learning.

In the 3P model student factors depend on their prior knowledge, abilities and motivation. Gunstone (1995) states that:

In good science learning the learner undertakes the tasks of integrating appropriately what is being learned with what he or she already knows and believes; extending what is being learned into appropriate different contexts; monitoring and learning, including progress through tasks and towards known purposes and goals, which he or she is undertaking. (p. 11).

The classroom system encompasses the teaching context which involves teaching and its objectives, assessments, classroom climate and institutional procedures. All these contribute towards the learning procedure of a student, and in turn to deciding factors of a student's deep learning and the surface learning influences.

Thus, each of the above micro systems must maintain equilibrium and the micro systems must operate within the institutional system which can be interpreted as active contribution and involvement of the head of department, for successful learning to happen (Biggs, 1993a as cited in Goh, 2005).

2.4.5 Technology-based Teaching Models

"Technology is changing the way education is being delivered and educators across the world are faced with a number of Challenges" (Trinidad, 2003, p. 97). With the advancement of technology more and more teaching methodologies tend to embrace the emerging technologies. Thus, a significant pedagogical shift has become necessary in the way courses are delivered by educators as well as in the students' learning styles. This has posed a challenge in transmitting the knowledge of the teacher from a largely memorised one to a process oriented one.

Furthermore, with the advancement of technology, it not only requires the learners to absorb knowledge from the educator, but also requires them to gather their own knowledge through various applications of technology. Thus, "It is also feasible to enhance the learner's capacity to generate new knowledge by designing learning environments that assist to connect prior insights and understandings to multiple, at times incongruent contexts" (Quinton, 2006, p. 545).

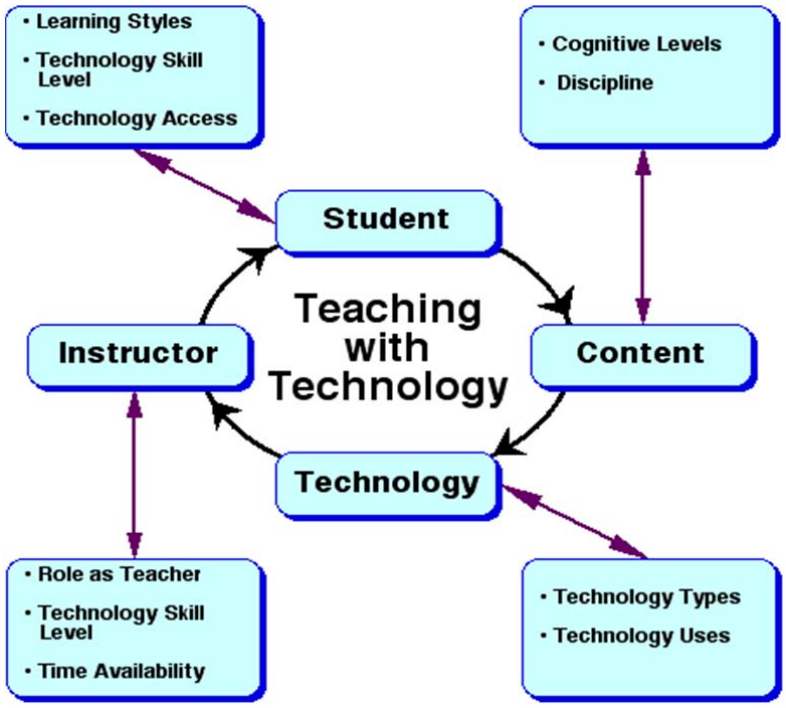
Today, the web and related technologies have made it possible to access and manage extensive amounts of information and also to deliver lessons to the learners at their convenience in respect of place and time (Quinton, 2006). However, Quinton also states that ready access to vast amounts of information does not mean being educated, and design of effective learning environments which cater towards this purpose is equally important, which can be highly complex and diverse.

Technology-based teaching and learning models

This study assumes that theories put forward with regard to science education research are applicable to technology education. Eylon and Linn (1998) and Diggory (1994) as cited in Duit and Treagust, (1998), both provided valuable frameworks for identifying themes of learning theories in science education research over the past decades. The framework put forward by Eylon and Linn as a result of an analysis of science learning, involved concept learning, developmental, differential and problem-solving perspectives. Bruner as cited in Duit and Treagust (1998) has put forward four themes of learning which greatly influenced learning activities in science education (Schulman & Tamir, 1973 as cited in Duit & Treagust, 1998). They are; the role of the structure of the subject matter in learning, readiness for

learning which address learning new ideas and revisiting them often in order to use them in more complex forms, intuition and analytical thinking that led to discovering of concepts and inquiry creating a long term influence and the desire to learn and the ways in which it can be stimulated. These themes can be considered as addressing the areas of the first three research questions. Also taking into consideration the learning theories described in this chapter, which are appropriate to this study, these themes can be applied in deriving a technology learning model which is one of the aims of this study.

A typical model for teaching and learning with technology was put forward by Zhu and Kaplan in 2001 (see Figure 2.23). According to this model which follows the systems approach, four major components, must be integrated towards successful teaching and learning. They are student, instructor, content and technology. The content must cover the discipline which is required by the learning outcomes of a course and must be suitable intended to outfit the cognitive levels of the students. The instructor must consider the role as a teacher and must consider upgrading skills needed to use the required technology to teach the course, and allocate time for up skilling and planning lessons using technology. The students need to have access to technology, must adapt their learning styles to work with technology and attempt to improve their skills with technology. Technology used in classes must be the accurate type that is useful to teaching and learning a particular course.



Adapted from Zhu & Kaplan (2001) McKeachie's Teaching Tips.

Figure 2.23. A model for teaching with technology.

This brings about an understanding that the tutors must create an awareness of their students 'exposure and access to technology, as well as their preferred learning styles to achieve reasonable learning outcomes (http://www.crlt.umich.edu/inst/model.php).

Teacher involvement in technology-based teaching

Today, most tertiary educators are required to apply technology-based teaching models to a considerable extent and this could be a challenge to some educators, especially for those who are not familiar with manipulating diverse software. Hence, it is important that educational institutes provide educators with adequate training relevant to technology-based teaching in order to achieve desired outcomes. Currently, there is a vast repository of available technology for the educators and learners. However, careful consideration must be given to the type of technology used and educators must carefully employ useful and meaningful technology, in their technology-based teaching models, so that the students gain real and authentic experience (Solomon, 1999 as cited in Khine, 2003). Also, educators must make the maximum use of the available technology in an institution and aim at adapting

innovative methods in teaching and learning technology with the aim of maximising the students' learning potential and academic growth. This also could mean that educators themselves have to be educated about using particular technologies before applying them accurately in their teaching.

Thus, careful planning is important in developing new courses and shifting the delivery methods of the existing courses to embrace technology and shift into a technology-based teaching paradigm. Also, in designing technology-based teaching models, educators must also make sure that the academic achievement and success of the students are not jeopardized but rather enhanced.

Student involvement in technology-based teaching

Modern teaching models are geared towards collaboration among students. For a traditional teaching model to be collaborative a student has to be physically present in a class room at a given time which lacks any flexibility. Technology-based teaching models display a useful aspect in student collaboration using software. This can be in the form of online discussions, blogs and simple emails. Also the teacher could facilitate the collaboration process, and has to be organised to be successful in the facilitating process. Online discussions enable the students to save time and also overcome the limitations of available space. By being communicative and collaborative in small communities of students provides beneficial effects to the students' achievement and psychological well-being. Such communities or associated groups of learners build up meaningful relationships, share common values and develop common understanding of the learning process. They develop common structures that link traditional disciplines and co-curricular structures.

Software involvement in technology-based teaching

Technology has had a great impact on education and on information manipulation and distribution. With the technological development in recent years, multimedia played an important part in teaching and learning. Presentations of information consisting of audio, video, animation, still pictures and text-based materials, into a hyper-linked structure in order to promote human learning have been used with the advancement of technology. With the use of multimedia, the learners are able to retain information longer than when the traditional learning methods are used. At the

same time, applications of what is learnt in other situations become easier to the students with the use of multimedia in their lessons (Khine, 2003).

Many tertiary institutes are moving towards online learning. However according to Chang and Fisher (2003), little or no research is available at the tertiary level about online learning. However, the students have to be motivated and active online to be successful in online learning (Khine, 2003). Using an online teaching model, students can work at their own pace, at any convenient time and in any desirable location. This is a very flexible method and is preferred by most students, in particular the working students.

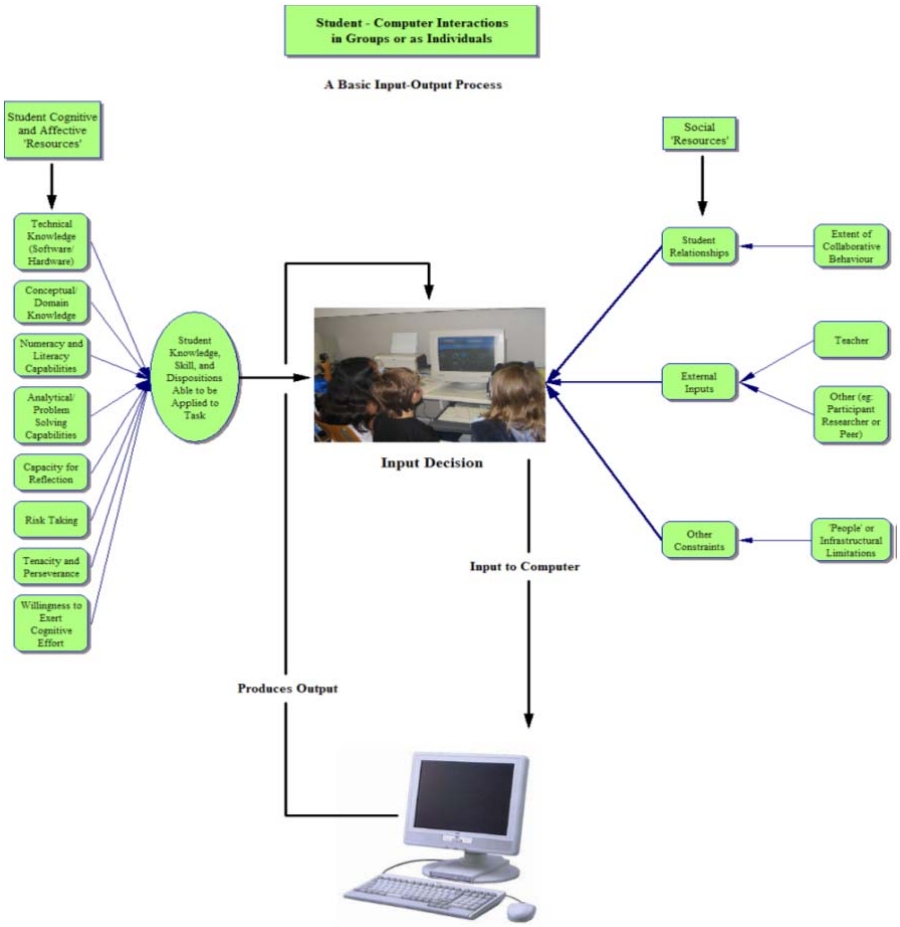
Web involvement in technology-based teaching

The web has created an evolving change in learning styles where the information is shared with the wider community (Brodsky, 1998 as cited in Chang & Fisher, 2003) and has created a paradigm shift in education. The web can be involved in searching for materials that help in students' learning. Wilson and Lawry (2000) as cited in Khine (2003) state that of all available technology, the web provides the students with a challengeable but a motivating way of learning. This type of learning is mostly self-directed and the students have to be active and dedicated to gain required knowledge and aim to be constructivists. However, teacher-directed traditional methods can be still be blended into this type of constructivist learning. This method allows the students to build up on the content learnt in the traditional way from the educator. They can construct their own knowledge further using online learning technologies. The web provides access to rich information, support meaningful interaction with the content and also brings people together for different ways of interaction.

The web also has made an impact on communication in teaching and learning processes. The latest technologies utilize various kinds of software systems and allow multiple methods to communicate and interact with peers as well as lecturers, using tools such as emails, text messaging, wikis and blogs. This increases the opportunity of students to have more interaction with peers as well as explore topics on their own and also think critically (Khine, 2003).

A model for learning in groups in an e-learning environment

Online learning was discussed in Chapter 2 in section 2.3.7. Hannafin et al. (1999) articulated that learning environments consist of at least four elements (p. 43), namely, enabling context, resources, tools and scaffolds. A model created using research conducted in a New Zealand higher educational e-learning environment reflects the four elements (Faloon, 2005) (see Figure 2.24). This model explains learning in groups in an e-learning environment and exhibits less teacher intervention and more student engagement. The model illustrates friendship-based social aspects of students working in groups. In this process, the students select their own groups and work collaboratively for maximising their own learning as well as the others in the group. It is found that these groups are comprised of friends who have regard for the high level of capabilities of their peers. They structure the work to utilize each person's capabilities in order to display superior overall performance. However, sometimes a few students were non-collaborative and displayed anti-social behaviour. It was also discovered that such students attached themselves to whichever group tolerated their behaviour and frequently were unacceptable to the other group members. Faloon, 2005 states that according to this model, the quality and the rate of work produced by a student vastly depended on the factors described by Hannafin et al. (1999).



Adapted from Faloon (2005) p.187

Figure 2.24. Student work process and contributing resources.

2.4.7 Summary

Technology-based teaching in today's tertiary classes is getting popular in New Zealand and other countries. It is becoming vital that educators are competent to handle such classrooms. To meet the challenge, they must receive proper training in manipulating modern software and involved technology. Training must be provided to the educators on designing the courses and assessments involving techniques that use modern technology in order to foster better student outcomes. There is a clear lack of research involving this area.

On another note, teaching with technology does not necessarily mean that traditional teaching must be completely avoided and not incorporated into technology-based

teaching and learning. Hence, traditional teaching and learning and technology-based teaching must attain a balance to an expected degree.

2.5 SUMMARY

In response to new innovations in tertiary education, the education community must re-design teaching and learning practices. With the current advancement in technology, tertiary teaching and learning methods using technology rich learning environments are being re-invented in many countries around the world.

The literature review in this chapter first provided literature about various learning theories put forward by past researchers which included traditional and progressive learning, behaviourist, cognitivist and constructivist learning theories. It also investigated the application of constructivism in science and technology education and issues involving constructivist learning. Furthermore, this chapter extended the review into investigations into social theory which involves literature about culturally diverse environments.

Secondly, this chapter provided a review of literature about various learning environments, which included the concepts of learning environments, culturally-diverse learning environments and technology-based learning environments. Technology-based environments in New Zealand's ITPs and polytechnics were then investigated and reviewed. This was followed by reviews of online learning environments and finally assessing of learning environments which led to the aims of this study.

Thirdly, various learning models put forward by past researchers which were likely to impact on the aims of this study were investigated. First, traditional teaching models were discussed followed by an example of a research finding put forward by a past researcher of students' concepts of learning. Bigg's learning models which are expected to contribute towards the aims of this study were reviewed.

Finally, the literature about technology-based teaching models was investigated along with a typical technology teaching model put forward by a past researcher. This section explained literature about teacher involvement, student involvement,

software involvement and web involvement in technology-based teaching. The literature review winds up with literature about a model for learning in groups in an e-learning environment in New Zealand put forward by a past researcher.

CHAPTER 3

METHODOLOGY

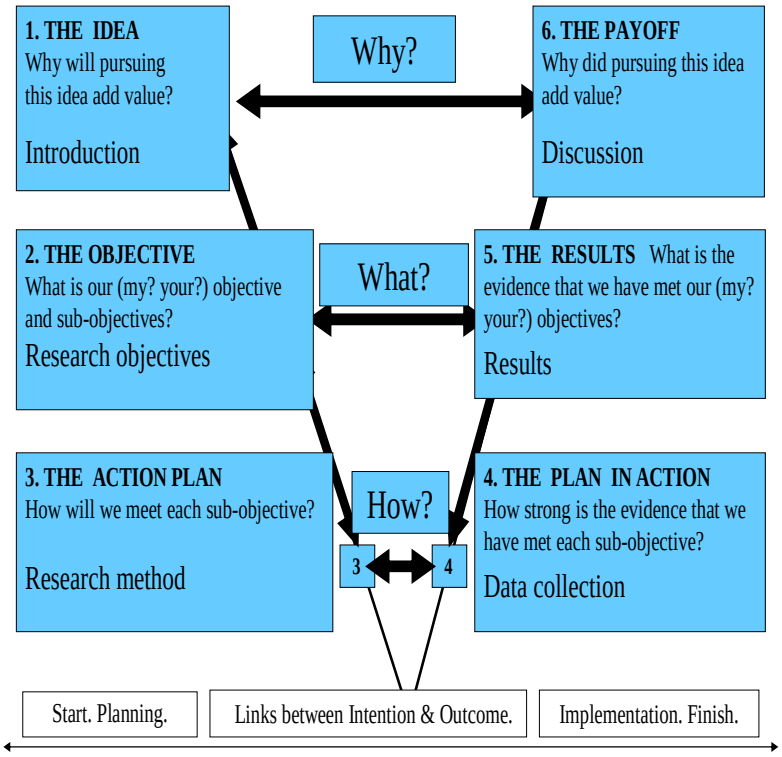
3.1 INTRODUCTION

Chapter 2 provided a review of the learning theories that were put forward by previous researchers and various learning environments with an emphasis on technology-rich, outcomes-focused learning environments. Finally, various teaching models suggested by past researchers were investigated. Developing a good methodological framework is based on the theoretical framework which is central to examining the problem under investigation. The theoretical framework deduced from the literature review in Chapter 2, was used as a logical base for developing the methodological framework in this study. The theoretical framework provided a conceptual model of how the relationships of several factors that have been identified as important to the problem, make logical sense.

Cavana, Delhaye and Sekaran (2000) states that an accepted methodological framework has to be derived in a study that aims to acquire new knowledge and address gaps in the area of research. They also state that these relationships can be represented in the form of inter-related variables in regard to the research activity towards the current investigation, and states that this framework must aim at addressing how the inter-related variables behave in regard to the current investigation of the research activity. Complex relationships of the research study had to be considered in the research method discussed in this chapter, in order to aim at addressing the research questions of this study.

According to Dana L. Zeidler of Science education, University of Florida two questions must be answered before arriving at a methodological framework for a particular study. (http://www.coedu.usf.edu/jwhite/secedseminar/theoryframe.pdf on 3rd October 2011). The two questions are: first ‘What is the problem?’, and secondly ‘What is your approach to a feasible answer?’ In addition to these questions, thirdly, this chapter justifies the reasons for choosing the particular methodology for the study. In order to arrive at a suitable research methodology for this particular study,

general research methodologies and subsequently education research methodologies were investigated.



Sample presentation in V model form

adapted from Shefield (2001)

Figure 3.1 Sample presentation of a V-Model indicating the direction of a research study.

The V-model methodology (see Figure 3.1), designed by Sheffield Information Systems and Operations Management Department of the University of Auckland, is used as a guideline to the direction of research. This methodology has six questions and three criteria that have proved important to managing complexity in many different domains and covers both qualitative and quantitative methods.

This chapter presents the selected methodological framework for this study and attempts to justify it in the context of New Zealand where the study was carried out. In order to support building an appropriate methodological framework for the study, this chapter further aims at exploring literature about research design which explains

general research methodologies and education research methodologies. Quantitative, qualitative and mixed research methods approaches are further investigated and the appropriateness of mixed methods approach to this study is described. The chapter explains the type of mixed methods approach employed for this study that uses quantitative data gathering followed by qualitative data gathering. This chapter further presents and argues the rationale for using the type of mixed methods approach in this study.

Questionnaire design in educational research is discussed in this chapter involving questionnaires designed for technology rich learning environments. Further, actual and preferred questionnaires which are used in this study are discussed. Three quantitative instruments that were considered appropriate and used in the quantitative data collection of this study are described and the appropriateness of them justified. The type of qualitative method that involved interviewing volunteering students who had already completed the quantitative questionnaires is described and justified. A strategy which was adapted to interview students that used semi-structured interview questions is further explained and justified in this chapter.

The sampling methods for both quantitative and qualitative data collections, strategies for quantitative and qualitative data collections, data entry and data analysis methods are further explained in this chapter. This includes describing the statistical methods and the various statistical tests used in the analysis of the quantitative data and the thematic methods used in the content analysis of the qualitative data respectively.

Finally, the ethical considerations of the study, assumptions, limitations, bias, reliability and validity of the study are addressed in this chapter.

3.2 RESEARCH METHODS

3.2.1 Introduction

Research is a step by step process that is used to collect and analyse data and information, in order to bring in meaningful understanding of a concerned area or the problem (Creswell, 2005 as cited in Ward, 2008). Creswell states that research

addresses gaps in knowledge, broadens the knowledge in a particular area, replicate knowledge and compares the knowledge gathered with other situations that have similar contexts. According to Cavana, Delhaye and Sekaran (2000), the research approach adapted in a particular study has to align with the context and the aim of the study, must be aimed at eliminating improper research methods, must adapt proper research methods and must not be limited to any specific method or methods. Newman (2003) as cited in Ward, 2008 states that, in order to gain an understanding of the social world answers are sought to questions, in the case of social research.

Cavana et al. (2000), have put forward eight hallmarks of scientific research; *purposiveness* or the aim and purpose of research, *rigour* or a good theoretical base and a sound methodological design, *testability* of the hypothesis, *replicability* where the results of the tests of research objectives are supported under similar circumstances, *accuracy* where definitive conclusions based on the analysis of data is drawn, *objectivity* where the conclusions drawn from the interpretation of results of the data analysis are objective, *generalisability* or applicability of the research findings to similar settings, and *parsimony* or simplicity in generating solutions to problems under research.

Research methods are diverse in general and researchers reveal that a range of research methods would provide richer and more reliable results in a particular study. Some of the research methods currently practiced are, library-based literature reviews, experimentation, case studies, surveys and ethnography, action research or critical intervention in real world situations. Considering the various research methods adopted from the 19th century through to the 1950s of the 20th century, the mostly used were either quantitative or qualitative methodologies (Tashakkori & Teddlie, 1998). While the methodological focus that dominated the Asian research environments was mainly quantitative and qualitative methods were used in a minor way (Fraser, 2002). However, the methodologies used globally were mainly quantitative.

The mixed methods approach became popular in the first half of the 20th century (Ward, 2008). This method involved a mix of different research methods. However, there is no evidence to say that mixed methods were not used before this period (Tashakkori & Teddlie 1998 as cited in Ward 2008). Case study research is another

research methodology, which examines a phenomenon in its natural setting. It is most appropriate when the relations between the contexts of the phenomenon are examined. Surveys can be used to conduct case study research. In the case study method, the researcher does not have any control over the phenomenon and can only control the scope and timing of the study. Laboratory experiments are one other research method which only involves the phenomenon in the present. In this method, the phenomenon is examined in a controlled setting, and the researcher manipulates the variables, something that has a differing value for the same object or the person at different times.

3.2.2 Disciplined Inquiry Education Research

Among the existing educational research methodologies, disciplined inquiry is valued as a well-ordered investigation that distinguishes research activity from mere observation and speculation. An important quality of disciplined inquiry is that, it is conducted and reported in such a way that the argument can be thoroughly examined and can be distinguished from other sources of opinion and belief (Cronbach & Suppes, 1969 as cited in Shulman, 1997). Another feature of the accuracy of disciplined inquiry depends on the discipline themselves which is employed by the investigator. “What distinguishes disciplines from one another is the manner in which the questions are formulated, how they define the content and organize that content conceptually of their domains, principles of discovery and verification that constitute the ground rules for creating and testing knowledge in their fields” (Shulman, 1997). Shulman also states that a central concept must be adapted for education research that displays the characteristics of disciplined inquiry, in order to address this phenomenon. However, according to Shulman, there is a possibility that disciplined inquiry in educational research can be controversial due to lack of consensus about the grounds, lack of the starting points for chains of reasoning and also how the questions are designed.

3.2.3 Quantitative Research Methods

Quantitative research method gathers standardised information from or about the subjects being studied. These subjects can be individuals, groups of individuals,

organizations, and communities etc., which are referred to the ‘population’ or a ‘sample’ for the research purpose. Surveys are used to gather information about characteristics, actions, or opinions of a population in this method (Pinsonneault et al, 1993). Quantitative research is also utilised to examine a phenomenon in a variety of natural settings. In such situations, clearly defined independent and dependent variables together with specific models of expected relationships that can be tested against the observations of the phenomenon, have to be present. In such a study, the phenomenon occurring both in current time and the past are tested. This method of quantitative research involves, stating the problem, gathering information, forming a hypothesis, testing the hypothesis based on evidence presented and finally drawing conclusions (Pinsonneault & Kenneth, 1993). To aim at accuracy, quantitative research methods require large but random samples of participants.

“Quantitative research is an organised method for combining deductive logic with precise empirical observations of individual behaviour in order to discover and confirm a set of probabilistic causal laws that can be used to predict general patterns of human activity.” (Newman 1997, as cited in Cavana et al., 2000). Auguste Compte has declared that quantitative research is based on the principles of positivism which arose around two hundred years ago (Cavana et al., 2000). Furthermore, Cavana et al., (2000) states that the of positivist research aims to identify universal laws of human behaviour with the aim of predicting and controlling events and explains quantitative research methods as follows; Measures are systematically created before data collection and are standardised. Data are in the form of numbers from precise measurement. Analysis proceeds by using statistics, tables or charts. The discussions of such results show how they relate to hypotheses.

Quantitative research methods use various types of questionnaires developed for a particular research. These questionnaires have to be tested for reliability and validity before analysing the data gathered. Also they have to be tested in similar environments before they can be reused. Over the last three decades questionnaires have been developed to assess various types of learning environments and also to assess student perceptions of learning environments (Fraser, 1998). Past research on assessing learning environments used mostly quantitative methods, which later extended towards qualitative methods as well, thus creating a mixed method

approach. Various survey instruments were developed to serve a particular research context in the quantitative method.

Research on classroom learning environments was started by Moos in 1974 and Walberg in 1979, as cited in Aldridge and Fraser (2003), Moos (1974) classified learning environment instruments as schemes for classifying human environments. In order to study different aspects of learning environments, diverse research programmes were conducted around the world and assessment instruments were developed (Fraser, 1998b). These developments began around 40 years ago with the development of quantitative survey instruments for the use in psychiatric hospitals. Moos developed the *Classroom Environment Scale* in 1968. Walberg developed the *Learning Environment Inventory* in 1974 as part of the research and evaluation activities of Harvard Physics Project (Fraser, 1998a). These were later extended towards major research programs all over the world. Also recent questionnaires have been developed to study learning environments of higher education levels such as, university distance learning environments, interactive learning environments, web-based or online learning environments (Chang & Fisher, 2003).

Chang and Fisher (2003) stated that there was a gap in research about online learning environments especially in the tertiary education sector. They declared that there were no comprehensive instruments developed for research studies in this area at the time. It is further stated that there was no significant research available on the psychological factors that affect online tertiary learning. However, Tobin (1998) as cited in Chang and Fisher (2003) has developed a framework to evaluate interactive learning environments, which could be utilised to assess online learning environments. Hence, the research on online learning environments has increased since that time.

In quantitative analysis, hypotheses are tested using statistical analysis patterns put forward by statisticians. The word “statistics” refers to a range of techniques and procedures for analysing, interpreting, displaying, and making decisions based on data. This also means calculating numerical quantities in a sample where parameters such as the mean are estimated. Modern statistical methods compared to the traditional methods, use statistical programmes such as SPSS to provide advanced analysis of data. These methods can estimate the likelihood and the size of errors

more precisely. However there is a possibility of potential confusion in the given context occurring, if researchers do not handle the statistical analysis carefully (http://www. ruf.rice.edu).

3.2.4 Qualitative Research Methods

The interactions of individuals with the external world enables them construct their own interpretive knowledge (Von Glasersfeld, 1993). In the qualitative research method, the researcher is seeking to gather new understanding of situations, and the experience of a person in a given situation. Thus, the researcher attempts to gather information from the explanations that people express in their own words.

Qualitative data collection can be done by the researcher recording, taking down notes as the person in a given scenario talks, by observing participants or even going through the documents if it is applicable to the situation under research. In education research, some of the methods used by researchers in qualitative data gathering involve, going through student diaries, interviewing teachers, students and school administrators, obtaining video recordings, summarising field notes etc. (Fraser, 2002). In some settings, a process is monitored or observed over time, whereas in the others there is rapid access and speedy discovery of the necessary information to further work with.

One of the most popular methods in qualitative data collection is conducting interviews with the participants. Interviews can be classified as structured interviews, semi-structured interviews or unstructured interviews. In interviewing, the wording of the interview questions must be precise and subtle. Imprecise wording of questions could cause inaccuracy in the responses and could bring about slanting results. The respondents must be a representation of the scenario under the study and attentive listening is important to be successful in any of these interview strategies. The interview strategies can be descriptive or exploratory in nature.

When interview questions are created, they should prompt participants to speak. The interviewer must look for ways for the participants to tell their stories and relate their personal experiences. The outcome of this is well-defined methodologies, easy summarising results with little ambiguity in interpretation of the results. This type of

interview falls under the structured, closed-ended approach. As opposed to the above strategy, the open-ended approach has an exploratory nature where an open-ended question is given to the participant and the participant talks about his or her opinion about it. This approach is aiming to explore what is in the respondents' minds, rather than answering set questions.

Analysis of qualitative data requires attention to detail and sensitivity to the context. A researcher working with qualitative data has to aim at gathering new understanding of the study and attempt to interpret the participants' words in order to achieve high quality results. The complexity of the answers provided by the participants also plays an important part in discovering new information. Qualitative data are relatively unstructured, therefore cannot easily be reduced to numbers appropriately. There are many techniques to analyse qualitative data. One way is thematic content analysis, which involves accessing the information gathered, exploring themes and discovering and testing patterns. However, this could be time consuming depending on the expectations of the research. In this method, patterns must be discovered first, in the responses of the participants by a transparent process. Then, indicators that could be included in the next phase of the analysis must be discovered. Subsequently categories into which the indicators are fed into must be recognised. These categories must be conceptually-sound and cohesive, and at the same time noticeably different from the others. Finally, central statements that best express a theme must be identified (Research Methods II course book, 2002).

Another way of analysing qualitative data is using modern software. NVivo is currently becoming popular. NVivo software serves to minimise divisions between data and interpretation. NVivo also contains many ways of connecting various parts of a project. However, in order to use NVivo for the analysis of qualitative data, the researcher must be aware of the knowledge of supporting techniques such as indexing, searching and theorising. These must be learnt by the researcher in advance and must be applied in order to use the software accurately and derive accurate results (Research Methods II Course Book, 2002).

If quantitative data are collected in research, as the case in this study, the researchers need to link the qualitative data with the quantitative data analysis (Research Methods II Course Book, 2002).

3.3 MIXED METHODS

3.3.1 Introduction

The mixed methods approach to research is relatively new compared with other existing methodologies, but has been used frequently during the past decade. When mixed methods are used in a study, it can occur at several stages of the research, such as data collection, data entry, data analysis, discussion and conclusions (Tashakkori & Teddlie, 2003 as cited in Ward, 2008).

Fraser et al., (1996) stated that, the research potential for assessing learning environments could be maximised by using a 'mixed method' approach where a combination of qualitative and quantitative methods are used. Using both quantitative and qualitative methods in one research came about after 1960s (Neumann, 1987 as cited in Goh, 2005). Significant progress have been made when a combination of quantitative and qualitative research methods are used in assessing learning environments (Tobin & Fraser, 1998).

"A combination of qualitative and quantitative methods in learning environment studies can be considered noteworthy for several reasons, for example, the richness resulting from qualitative observational data complementing quantitative classroom environment data, and greater credibility of data obtained by triangulation data collection method"(Fraser & Tobin, 1991, Webb, Campbell, Schwartz, & Sechrest, 1996 & Webb, Campbell, Schwartz, Sechrest, & Grove, 1981 as cited in Kongkarnka & Fisher, 2008, p. 94). Also, Yin (1994) as cited in Kongkarnka & Fisher (2008) states that, "the qualitative method helped the researcher focus on the interesting issues of immediate concern, and provide data that are rich, detailed and insightful (p. 94).

This type of approach to research focuses on a collective analysis of both qualitative and quantitative data in a single study (Creswell et al., 2003 as cited in Ward, 2008). The two methods have distinct differences. Quantitative methods in education seek to examine associations, effects, and causes through statistical methods while the qualitative methods occur in more naturalistic settings and data are collected

naturally. Although the two methods differ from each other, they are not incompatible with each other (Ward, 2008).

The two methods have different, complementary strengths sometimes overlapping, thus enabling more comprehensiveness to the research (Goh, 2005, p.87). In such research, qualitative data gathered may well bring new insights to the quantitative data. In a research study in-depth understanding of the participant's views and a richer, and a descriptive understanding of the social reality could be achieved using both quantitative and qualitative methods (Ward, 2008).

Enrichment of interpretations through the quantitative data collected using both questionnaires and qualitative data collected through interviews are sought when both methods are utilised in the data collection of a research study.

3.3.2 Justification of the Mixed Methods Approach Used in this Study

This study, in the discipline of educational research, addresses the technology-rich learning environments in technical institutes and polytechnics in New Zealand. The theoretical framework from which the research questions were generated addressed learning theories, learning environments and teaching models. Based on the theoretical framework of this study, five research questions were generated. The foundations that underpin the research questions were based on student perceptions and attitudes towards technology-rich computer learning environments and their attitudes towards computers and computer courses learnt in polytechnics and technical institutes in New Zealand. The study was based on students engaged in studies of a variety of computer courses in the degree a diploma programmes which involved levels of study ranging from levels 5 through to 7. The gender of the students was also noted; however the study did not particularly aim at addressing issues based on the gender of the students. The research questions of this study are stated in Chapter 1 (see 1.5.2, p.11).

The theoretical framework of this study addresses multi-paradigms that exist in humans such as behaviourist, cognivist, constructivist, social and humanist paradigms. These multidimensional worlds experienced by humans put forward by Habermas (as cited in Mingers, 2001a) are expressed in Figures 2.1 and 2.2 in

Chapter 2. Habermas has suggested that as a result of these multidimensional worlds which is experienced by a person, triangulation of acting, languaging and emotioning occurs in the person's learning process. The combination of the above paradigms are considered as the basis of pragmatism which clarifies that this study is underpinned by pragmatism. Hence, deducing the methodological framework for this research was based on the pragmatic paradigm which was previously explained in Chapter 2.

In order to provide a comprehensive research outcome based on these multi-paradigms which link together different parts of the problem situation, a combination of research approaches was utilized in this study. A mixed methodology approach which used quantitative and qualitative methods was considered best suited (Mingers, 2001b) to maximise the understanding of the research questions.

During the data collection the quantitative phase preceded the qualitative phase. Questionnaires were used as the quantitative data collecting instruments and unstructured open-ended interviews were used to gather qualitative data. The quantitative instruments used in this study focused on gathering data pertaining to the research questions, where technology-rich learning environments in tertiary education and the perceptions and the attitudes of the students who studied computer courses in such environments were the focus. Ramsden (1979) as cited in Goh (2005) states that, associations between students' learning environments and students' learning approaches cannot be effectively carried out using questionnaires alone. Interviews must be carried out to further investigate the perceptions of students' learning environments, their interactions with their learning environments and different approaches to their learning. The refinement of specific ideas of the students gathered through the interviews would not have been possible if qualitative data gathering had not been used.

The advantage of this mixed methods approach is that the limitations of one method are offset by the strengths of the other method (Ward, 2008). These two methods were supposed to complement each other by providing in-depth data to supplement each other, rather than when a single method was used by itself. Ward (2008) also states that studies performed by researchers involving paradigms such as interpretive knowledge or positivism and constructivism, have used both quantitative and qualitative research methods, leading to more meaningful results.

Since the mixed methods approach is used in the data collection phase of this study, similar methods were used in the following phases of the study as well. In order to counterpart the mixed methods approach used in the data collection phase, a triangulation method was used in the data analysis phase in this study.

3.4 QUANTITATIVE METHOD

3.4.1 Questionnaire Design in Educational Research

Quantitative methods use questionnaires to collect data in a particular study and researchers have developed instruments for assessing various types and aspects in research studies. In the 1960s, Herbert Walberg and Rudolf Moos began research on learning environments. In 1968 Moos conducted quantitative research in psychiatric and correctional institutions using social climate scales (Moos, 1974a). These were later extended towards major research programs all over the world. At that time, as part of the Harvard Physics project, Walberg developed the *Learning Environment Inventory* (LEI) which became popular and was widely used at that time (Walberg & Anderson 1968 as cited in Fraser 1998a).

Since then, instruments for assessing learning environments have been developed ranging from elementary to tertiary education (Clarke, 1994). Instruments were developed to suit different countries in Europe and Asia, and were found to be significantly useful in understanding learning environments of different cultural backgrounds (Fraser, 2002).

In 1968, an instrument named the *Classroom Environment Scale* (CES) (Moos 1979; Moos and Trickett 1987 as cited in Fraser 1998a) was developed. Fraser and Fisher (1983) developed short versions of classroom questionnaires which could be conveniently administered to students. The *My Class Inventory* (MCI) is one such questionnaire developed to assess primary and lower secondary class room environments. This instrument consisted of ‘Yes’ and ‘No’ response format making it easy for students to respond (Fraser, 1989).

Some of the historically important questionnaires that were developed for the use of assessing secondary and tertiary learning environments were; the *Classroom Environment Scale* (CES) (Moos & Trickett, 1973), the *Learning Environment Inventory* (LEI) by Fraser, Anderson, and Walberg (1982), the *Individual Classroom Environment Questionnaire* (ICEQ) by Fraser (1990), the *My Class Inventory* (MCI) by Fraser and Fisher (1982), the *College and University Classroom Environment Inventory* (CUCEI) by Fraser and Treagust in 1986, the *Questionnaire on Teacher Interaction* (QTI) by Wubbels and Levy in 1993, the *Constructivist Learning Environment Survey* (CLES) by Taylor, Fraser, and Fisher (1987) and the *What Is Happening In this Class* (WIHIC) by Fraser, McRobbie, & Fisher (1996). The *Science Laboratory Environment Inventory* (SLEI) was designed to evaluate school science laboratories (Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 2000) The *Computer Learning Environment Inventory* (CLEI) and *Attitude towards Computers and Computer Courses* (ACCC) questionnaires were later developed by Newby and Fisher in 1997 as extensions to the SLEI, to be used in studies relevant to technology based learning environments. Subsequently, as online learning was becoming popular, the *Web-Based Learning Environment Instrument* (WEBLEI) was developed to be used in university settings (Chang & Fisher, 2003). All these instruments were tested for reliability and validity in similar leaning environments and shown to be valid, before they were used in other research studies.

3.4.2 Actual and Preferred Questionnaires

These questionnaires have been developed to incorporate students' individual views. These individual views are of two forms: the students' view of the actual practice that is happening in the class and the students' view of what they would prefer that practice to be like. Such questionnaires have been tested in targeted environments and a significant variance between the outcomes of 'Actual' and 'Preferred' results were observed (Fraser, 1998a). In addition, Fraser states that, the same classroom is perceived differently by students of different genders, abilities or ethnic backgrounds.

3.4.3 Rationale for the Quantitative Instruments Used in this Study

I arrived at a decision to use three instruments that were considered suitable for this study, which followed Moos' framework, after investigating several instruments previously developed by researchers. These instruments had proven to be reliable and valid, having been tested in a variety of diversified similar learning environments in many countries, at different levels of study, on a vast number of students.

The three questionnaires selected to use in this study to collect quantitative data were; the *Attitude towards Computers and Computer Courses* (ACCC) developed by Newby and Fisher in 1997 (see Appendix E), the *Technology-Rich Outcomes-Focused Learning Environment Inventory* (TROFLEI) (Fraser, 1998a) (see Appendix F) and the *Attitudes questionnaire* (Fraser, 1998a) (see Appendix G). These instruments have shown validity and high reliability when tested in similar environments and were found to be the best suited instruments for this study as they directly address the research questions of this study.

3.5 QUANTITATIVE INSTRUMENTS USED IN THIS STUDY

3.5.1 Attitude Towards Computers and Computer Courses (ACCC)

The ACCC is comprised of 28 items which belong to four scales. Each scale contains seven items, some of which are negatively worded. The four scales are Usefulness of the Course, Anxiety, Usefulness of Computers and Enjoyment.

Table 3.1.

Descriptive Information for Attitude towards Computers and Computer Courses (ACCC) Scales

Scale	Description	Sample Item	Negative & Positive Items
Usefulness of the Course	Extent to which the student found the course useful	This class has increased my technical skills (+)	(+) 1,5,9,21 (-) 13, 17
Anxiety	Extent to which the student feels nervous or uncomfortable using a computer	Computers make me feel uneasy and confused. (+)	(-) 2, 6 (+) 10,14,18,22, 26
Usefulness of Computers	Extent to which the student believes computers are useful	My future career will require a knowledge of computers (+)	(+) 7,11,15,19,21,25 (-) 3
Enjoyment	Extent to which the student enjoys using a computer	I would like to work with computers (+)	(+) 4,8,12,20,24 (-) 16,28

Items designated + are scored 1, 2, 3, 4 and 5 respectively, for the responses Almost Never, Seldom, sometimes, often and very often.

Items designated - are scored 5, 4, 3, 2 and 1 respectively, for the responses Almost Never, Seldom, sometimes, often and very often.

Table 3.1 adapted from Newby and Fisher (1997), explains the ACCC scales, their descriptions, a sample item, the negative and the positive items of each scale. ACCC questionnaire measured students' attitudes towards computers and computer courses. The items are responded to on a five point scale with the alternatives of Almost Never, Seldom, Sometimes, Often, and Almost Always. Also the item responses are considered to have interval scales among them for statistical analysis purposes.

3.5.2 Technology-Rich, Outcomes-Focused Learning Environment Inventory (TROFLEI)

Relatively few studies have been conducted at university level to investigate the impact of learning environments on student outcomes (Dorman, 1998) as cited in Margianti, 2003) and there was a lack of learning environment instruments to measure this aspect at university level (Margianti, 2003). The Technology-Rich,

Outcomes-Focused Learning Environment Inventory (TROFLEI) was developed to use in ICT-rich learning environments in higher level education to measure the impact on student learning environments that affect learning outcomes (Aldridge & Fraser, 2003). This was created as an extension to the instrument 'What is happening in class? (WHIC) (Fraser, McRobbie, & Fisher, 1996). Aldridge and Fraser (2003) articulate that this impact is due to the challenges faced by the teachers as a result of having to adapt to the teaching and learning in technology-rich learning environments.

The TROFLEI was created to measure the three dimensions classified under Moos' scheme (Aldridge & Fraser, 2003). "This is a rich source of diverse, valid, economical and widely-applicable assessment instruments that are available in the field of learning environments" (Fraser, 1998b, as cited in Aldridge & Fraser, 2003, p. 43). Thus, the TROFLEI was one of the instruments used to measure the trends in the technology-rich learning environments of this study.

The TROFLEI consists of 80 items belonging to ten scales with eight items per scale. The TROFLEI contains 'Actual' and 'Preferred' columns which are included as two adjacent response scales on one sheet although historically researchers have administered separate versions of actual and preferred questionnaires (Aldridge & Fraser, 2003). The 'Actual' column describes the students' view of how often each practice actually takes place in the class or a response to the current situation of an item. The 'Preferred' column describes the student view of how often the student would like each practice to take place. All items in the TROFLEI were written to have a positive scoring direction which to minimise the possible confusion of the students answering the questionnaire. Also, the grouping of the items provided contextual cues to the students who are answering the questionnaire (Aldridge & Fraser, 2003).

The scales in the TROFLEI are, Student Cohesiveness, Teacher Support, Involvement, Task Orientation, Investigation, Cooperation, Equity, Differentiation, Computer usage and Young Adult Ethos. Table 3.2 presents the TROFLEI scales, their descriptions and a sample item from each scale. The actual and preferred items in this questionnaire are each responded to on a five point scale with the alternatives of Almost Never, Seldom, Sometimes, Often, and Almost Always.

Table 3.2.

Descriptive Information for Technology-Rich, Outcomes-Focused Learning Environment Inventory (TROFLEI) Scales

Scale	Description	Sample Item
Student Cohesiveness	The extent to which the student collaborates with the fellow students in the class.	I work well with other class members. (+)
Teacher Support	The extent to which the teacher supports the students individually.	The teacher takes a personal interest in me. (+)
Involvement	The extent to which the student's ideas are acknowledged.	My ideas and suggestions are used during classroom discussions. (+)
Task Orientation	The extent to which the student is oriented towards the tasks done in class.	I know what I am trying to accomplish in this class. (+)
Investigation	The extent to which the student is being investigative about class work	I solve problems by using information obtained from my own investigations. (+)
Cooperation	The extent to which the students co-corporate with other students to do different tasks	I cooperate with other students on class activities. (+)
Equity	The extent to which the student is treated equally as the other students	I receive the same encouragement from the teacher as other students do.
Differentiation	If the student is given different tasks according to ability	I do work that is different from other students' work.
Computer Usage	The different tasks the student uses the computer on	I use the computer to find out information about the course.
Young Adult Ethos	The extent of independence given to the student towards own learning	I am encouraged to take control of my own learning.

3.5.3 Attitudes Questionnaire (AQ)

The Attitudes Questionnaire (AQ) was developed as a second instrument to investigate student attitudes Aldridge and Fraser, (2003). Table 3.3 presents the Attitude scales, their descriptions, a sample item, the negative and the positive items of each scale.

Table 3.3.

Descriptive Information for Attitudes to Subject, Computer Usage and Academic Efficacy Scales

Scale	Description	Sample Item	Negative & Positive Items
Attitude to Subject	Extent to which the student likes the subject	I look forward to lessons in this subject. (+)	(+)1,2,5,6,8(-) 3,4,7
Attitude to Computer Use	Extent to which the student enjoys working with computers	Working with computers is stimulating. (+)	(+)9,10,11,12,13, 16 (-) 14,15
Academic Efficacy	Extent to which the student performs in the subject	I find it easy to get good grades in this subject. (+)	(+) 17 – 24 (-) None

Items designated + are scored 1, 2, 3, 4 and 5 respectively, for the responses Almost Never, Seldom, sometimes, often and very often

Items designated -are scored 5, 4, 3, 2 and 1 respectively, for the responses Almost Never, Seldom, sometimes, often and very often.

The AQ consists of four scales and 24 items, some of which are negatively worded. The scales are; Attitude to Subject, Attitude to Computer Use, and Academic Efficacy. The items are responded to on a five point scale with the alternatives of Almost Never, Seldom, Sometimes, Often, and Almost Always. The first scale, Attitude to Subject is based on a scale from the *Test of Science Related Attitudes* instrument (TOSRA) by Fraser (1981). The second scale, Attitude to Computer Use is adapted from the *Computer Attitude Scales* (CAS) instrument was developed by Newhouse in 2001. The third scale, Academic Efficacy is based on a scale developed by Jinks and Morgan in 1999.

3.6 QUALITATIVE METHOD

3.6.1 Interview Strategy Used

The qualitative approach used in this study was aimed at addressing the pragmatic paradigms on which the study was based. The participants to be interviewed were not selected from a target population. The interviews were conducted following the quantitative data collection, with volunteering students, who had already answered the three quantitative questionnaires. Answering the questionnaires prior to the interviews provided the students with an idea about what the researcher was trying to accomplish.

The interview strategy was semi-structured and exploratory in nature. The questions in the interviews were not worded according to a specific technique or in an explicit order, but focused on the key issues underpinning the research questions. I had an interview plan and that kept me focused on the actual aims of the study. The approach to the guiding questions in the interviews was adopted from the scales of the quantitative instruments used in this study, which addressed the key issues of the research questions. Leading questions were avoided to reduce bias. The interviews allowed the students to further convey their views and feelings about their experiences which were not covered in the quantitative phase, thus enabling in-depth information gathering. Subsequently, the interview was driven by the student followed by spontaneous generation of questions by the researcher.

Examples of the open-ended interview questions asked of the students were as follows:

Sample interview strategy used by the interviewer

Thinking of the items you have already responded to in the three questionnaires, could you tell me a bit more know about your concerns of your computer learning environments?
Could you also tell me about how the computer courses are taught in these environments?
I am also interested to know about your preferences of how you prefer the learning environments to be, and the way you wish the computer courses should be delivered in such environments.

When the students started responding to the interview, subsequent probing was done by me to gather more in-depth information in areas of concern. All attempts were

made to conduct the interviews within the parameters of the scales of the questionnaires the students have already answered.

3.7 THE SAMPLE

3.7.1 Sampling

In a study it would be practically impossible to test the entire population. Hence, a sample which supposedly represents the population is chosen to gather data. “Sampling is the process of selecting a sufficient number of elements from the population so that by studying a sample, and understanding the properties or characteristics of the sample subjects, it would be possible to generalise the properties or characteristics to the population elements” (Cavana et al., 2000, p. 253). Roscoe (1975) as cited in Cavana et al., 2000 states that, for most research studies, sample sizes of greater than 30 and less than 500 are appropriate and when the samples are broken into sub samples a minimum of 30 for each sub sample is necessary.

There are two major kinds of sampling; probability sampling and non-probability sampling. Probability sampling design is used when the representation of the sample is concerned of wider generalisability. Non-probability sampling is used when other factors such as time, rather than generalisability is critical to the research. Probability sampling design can be either unrestricted which is simple random sampling or restricted which is complex probability sampling.

The sampling design used for this research was a probability sampling design, simple random sampling. In this sampling method, every element in the population has a known and equal chance of being selected as a subject. Thus, this method has the least bias and offers the most generalisability in the results. At the same time, this design method can have its disadvantages. It could be expensive and also the required population may not always be available.

The targeted sample for the study was composed of the students who were studying computer courses from levels 5 through to 7 in the degree and the diploma

programmes in the computing and information technology departments of technical institutes and polytechnics in New Zealand.

Sampling started first by finding technical institutes and polytechnics in New Zealand that were willing to participate in this study. Telephone conversations with the heads of computing departments of the institutes were made to explain the research study. After the conversations request letters were emailed to the volunteering institutes with the description of the research. Subsequently, the documents needed for the ethical approvals, in order to conduct the research were mailed to the institutes. The ethical approval from the sponsoring institute, Curtin University, Perth was attached as part of the requirements.

Six institutes from both north and south islands of New Zealand participated in the research which represented New Zealand's technical institutes and polytechnics. Table 3.1 illustrates the details of the sample. In the table, the participating institutes are numbered and remain anonymous.

3.7.2 Quantitative Sample

Table 3.4 shows the details of the quantitative sample. The quantitative sample comprised of 325 volunteering students from the six participating institutes, to whom the three questionnaires were administered.

Table 3.4.

Description of the Sample

Institution No	Details of respondents						
	Level 5	Level 6	Level 7	Total	Male	Female	Unknown
1	64	46	5	115	104	27	19
2	13	0	0	13	11	2	0
3	0	11	9	20	17	2	1
4	28	17	14	59	52	7	0
5	23	13	23	59	44	10	5
6	0	16	5	21	20	1	0
TOTALS	128	103	56	287	248	49	25

3.7.3 Qualitative Sample

Table 3.5 shows the details of the qualitative sample. A total of 23 students participated in the interviews from the six participating institutes.

Table 3.5.

Description of the Quantitative and Qualitative Samples

Institution No	Quantitative sample	Qualitative sample
1	115	7
2	13	6
3	20	0
4	59	3
5	59	7
6	21	0
		23

3.7.4 Validity and Reliability of the Sample

A sample is a subset of a population. Sampling is done as a representation of the entire population under a particular study although it will rarely be an entire replica of the population. Hence, in order to achieve consistency in the results, it is important to attempt to select samples in a study which match to a considerable degree.

The samples from the institutes that participated in this study were matched in terms of five characteristics.

a) The participants were from a cross section of tertiary technical institutes and polytechnics in New Zealand.

b) All the participants were from New Zealand, studying computer courses in technology rich learning environments.

c) The participants were students engaged in diploma and degree programmes courses in computing and information systems programmes. The courses were prescribed by a single national accreditation qualification body in New Zealand.

d) The study assumed that the cohort of participants of these institutes who participated in the survey had comparable backgrounds.

e) The study assumed that the participants from a particular institute were a representation of the total population from the targeted area of study of that institute in terms of background, age, ethnicity and levels of study.

The number who answered the questionnaires in this study is considered adequate for statistical analysis and also valid.

3.8 DATA COLLECTION

The data collection of this study involved quantitative and qualitative methods. This was according to the mixed methods approach which was adapted as the data collection method in this study, as explained previously in this chapter. The aim of this data collection method was to obtain in-depth and rich information of the

perceptions and attitudes of students towards these environments and the computer course learnt in the technology-rich learning environments addressed in this study.

3.8.1 Quantitative Data Collection

Three questionnaires previously developed and validated in similar learning environments were used to gather quantitative data. They were the ACCC, TROFLEI and AQ which were described earlier in this chapter.

Dates and times were arranged with the heads of department of the participating institutes for the data collection. Administration of the questionnaires was done by an experienced person, a lecturer or by me, on the dates and times arranged with the participating institutes. Five of the institutes were visited by me personally for data collection. The responsibility of the quantitative data collection in two institutes was undertaken by the heads of department and the hard copies of student responses were posted to me.

Prior to administering the questionnaires the *participant information sheet* (see Appendix C) was distributed to the students and were allowed time to read. It was also explained to the students by the researcher or the person appointed to administer the questionnaires. The nature and type of data to be collected, the means of collection and the uses to which it is intended, and where the data were to be stored were clearly described to the participants. The sheet also specified that each response to the questions in the questionnaires should be one that most accurately reflected their point of view. Participants' anonymity was guaranteed and no student or institute was identified in the study. Participants were informed that they had the right to withdraw from the study at any time. Also, the students were provided with a *consent form* (see Appendix D), to sign off their willingness to participate in the study.

3.8.2 Qualitative Data Collection

The interview questions followed an unstructured interview model (Minichiello et al., 1990 as cited in Ward, 2008). Dates and times were arranged for conducting the interviews by me with the students who had already faced the quantitative phase. The students who volunteered had already filled the consent form to express their willingness to participate in the interviews. Those students who were willing but were not available on the dates were interviewed over the telephone at an agreed date and time. The details of the qualitative phase were explained to all the volunteering students individually prior to the interview.

The duration of an interview was between 15 to 20 minutes. The interviews were audio taped and notes were also taken down as required. In the case of the telephone interviews, notes were essentially taken down. The students were informed about the anonymity of the interviews and of their participation. During the interviews I made sure that the participants felt at ease and were not forced into expressing their views.

3.9 DATA ENTRY

3.9.1 Data Entry for the Quantitative Phase

The SPSS data editor was used to enter the quantitative data gathered. SPSS software is a spread sheet where data could be entered, edited, the contents of the data file viewed and analysed using various analytical tests. Each row in the spread sheet represents a respondent and each respondent is numbered. Each column represents a variable which is an item in a questionnaire. The responses to each item or variable were entered in a cell in the spread sheet, as a numerical value varying from 1 to 5; 1 for Almost Never, 2 for Seldom, 3 for Sometimes, 4 for Often and 5 for Almost Always. Cells were left blank where there were no responses to items. Missing values or no responses which were not entered appear as dots in the cells.

The ACCC and the AQ contained negatively worded questions. Item numbers 3, 10, 13, 14, 16, 17, 18, 22, 26, 28 were negatively worded in the ACCC questionnaire were as item numbers 3, 4, 7, 14, 15 in the AQ. However the negatively worded items were not changed into positive items in the questionnaires. Hence the students

had to answer such items as negative questions. Handling such items was done during the data analysis phase by transforming the negative responses to positive ones.

There would have been limitations in data entry due to human error, which is usually hard to avoid. However, random checks of the data entered were done and no errors were identified. Hence, it could be assumed that the human errors in entering data manually would have been negligible in this study.

3.9.2 Data Entry for the Qualitative Phase

The interviews were conducted with the consent of the participating students at a convenient date and time and were audio taped with the permission of the interviewees. Also some notes were taken down by me the interviewer. The audio tapes were later posted to the Science and Mathematics Education Centre at Curtin University, Perth where they were transcribed. The transcriptions mailed to me were later used in the data analysis.

Telephone interviews were conducted with the students who were unable to attend the interviews at the specific dates allocated. Notes were taken down of such interviews by me and as result the interview time was extended by about five more minutes.

3.9.3 Data Storage

Access to the data gathered was only available to the researcher and the supervisor and the data were treated very carefully. Data that was collected in both quantitative and qualitative nature were stored on the researcher's computer while analyses were completed. The data will be safely stored electronically for five years in the Science and Mathematics Education Centre, Faculty of Science and Mathematics at Curtin University, Perth, Western Australia, after which they will be destroyed. Questionnaires answered by the participants will be in the possession of the researcher and will be destroyed at the conclusion of the study.

3.10 DATA ANALYSIS

3.10.1 Quantitative Data Analysis

The quantitative research method involved three questionnaires that were administered to the participants. Statistical analysis methods were used to analyse the responses of the participants. Statistical analysis tests that were appropriate and best suited to this research study to analyse the quantitative data in order to fulfil the aims of the investigation in this study, were decide on and used (Cavana et al., 2000).

Statistical analysis deals with measurable variables. A variable is something that must have a differing value for the same object or the person at various times, or it can vary at the same time for differing objects or persons. In simple terms, a variable is an item in a questionnaire to which a participant is required to respond.

According to Cavana et al., (2000) various measurement scales are used to analyse the quantitative data of a research study. The type of measurement scale is decided when designing questionnaires, according to what is expected to be investigated using the questionnaire. The scales allow performing arithmetical operations on the qualitative data collected. Properties such as the arithmetic mean was used to measures the central tendency, while the standard deviation, variance and coefficient of variance were used to measures the dispersion of the responses on the variables.

The t-test value was used to predict the goodness in the items analysed. The goodness of measures includes reliability measures, which shows how consistently an instrument measures a concept. Then, the validity of the instrument measures was established. Factor analysis and correlational analysis were used to prove the validity of the instruments. The F test which state the significance of the responses on the variables were also performed on the responses to the variables in the questionnaires.

3.10.2 Qualitative Data Analysis

Qualitative data are unstructured and cannot be appropriately reduced to numbers. However, a researcher's investigation needs to discover what is not found during the quantitative analysis. It is a non-mathematical procedure to analyse peoples' words

and behaviours. The interpretation of the researcher plays the major role in the analysis of qualitative data.

A content analysis method was utilised to analyse the qualitative data collected in this study. The goal of *thematic content analysis* is to discover immerging patterns of the raw data. This is a manual process which constitutes identifying, coding and categorising the primary patterns in the data (Patton, 1990, as cited in Cavana et al., 2000). Themes are allowed to immerge from the raw data. Each theme is separately identified from the other themes. Galsser and Srauss (1967), as cited in Cavana et al., (2000) (p. 171) used *constant comparative method* to separate themes. Subsequently, sub themes must be uncovered from the themes identified.

It is not easily possible to derive valid definitions from the subjective data gathered in the qualitative method. There are numerous possible qualitative statements obtained from the respondents that might serve as indicators to patterns of themes or sub themes. Each statement has to be judged, in context to determine the extent to which it should be considered evidence for the construct in question.

3.11 LIMITATIONS, ISSUES AND VALIDITY OF THE RESEARCH METHOD

3.11.1 Introduction

The type of mixed method approach used in this study followed a sequential exploratory design, where the quantitative phase preceded the qualitative phase. This method tested the large sample first to test variables in the quantitative method. Then, the qualitative method was used with fewer respondents to explore in more depth (Creswell et al., 2003 as cited in Ward, 2008).

However, this method had its own limitations and issues. Qualitative research attempts to access hidden tactic knowledge, while quantitative research explores explicit knowledge of the respondents. Thus, a variety of data and analyses were required in this research approach in order to arrive at a complete conclusion. Mixed method approaches are relatively new and there is little support and clear-cut

methods available on how to integrate the data. As such it was a challenge for me using mixed methods approach for the analysis and integration of data. There was a gap in literature in this area for the future researchers to work on.

3.11.2 Quantitative Method Issues

Three questionnaires were given to the participants to answer and the time taken exceeded 20 minutes. Students may have got exhausted and perhaps it could be assumed that due to this, the responses to some questionnaire items could have been not so accurate.

There would have been instances where the students responding to the items in the questionnaires would have faced uncertainty about the responses they should provide, thus generating a degree of inaccuracy. The negatively worded questions in the ACCC questionnaire could have been misinterpreted by some students affecting the accuracy of the responses.

Also some students found ambiguous items in the questionnaires and hence their responses could have been biased. For example, item 3 in the ACCC questionnaire questions such as 'Studying about computers is a waste of time' was not especially relevant since this research as the research was based purely on tertiary computer education. I suggest that the future researchers using this questionnaire could consider changing this item to suit the purpose.

Many students from the participating institutes raised their displeasure about ambiguity of certain items in the TROFLEI questionnaire. Two items under the scale 'Young adult ethos' were confusing to some of the students. Several students from the institute 5 raised questions about this item. Two young male students and one older student were slightly confused about this scale; as to which age group it was aimed at. The two questions state 'I am treated like a young adult' and 'I am treated as a grown up'. In most tertiary classes there are mature students who are not young adults. Those concerned students were confused how to answer those items. Although not raised, there could have been similar doubts with students from other institutes about this TROFLEI scale and most probably their responses too would have been biased. Hence, it could be assumed that the responses for the items 74

through to 81 would have displayed some inaccuracy. I suggest that these items should be replaced by other items or totally taken out of the questionnaire to avoid confusion, when used in future researches in the tertiary education sector.

Those items in the ACCC questionnaire where the wording aimed at the current class would have produced biased responses. Item 1 in ACCC questionnaire is one such situation (I think I will use what I learned in this class in the future). Students would have most likely responded to the item, taking into consideration the class they were in at the time of doing the survey. However, the students were notified by me, that they should consider their overall learning experience when answering the questionnaires.

ACCC item 9 (This class has increased my technical skills), and item 13 (I gained a few useful skills from this class) being a negative item would have created some controversy among the respondents. However, item 13 was transposed before the data analysis.

3.11.3 Qualitative Method Issues

When there is little known about the concepts under research, the strengths of qualitative research become evident (Cavana et al., 2000). Although the focus of qualitative research is finding out unknown concepts, qualitative research methods have their own limitations, issues and validity depending on the methods used for gathering data and subsequent analysis.

A limitation of qualitative research is that, it hugely depends on assumptions. As stated by Cavana et al., (2000), qualitative research has its own assumptions and thus differs from positivist assumptions. Qualitative research uses the human as an instrument for the collection of data. It tries to understand and interpret people's words, actions and reports and does not deal with numerical data. It does not have an objective stance, but rather takes a perspectival view. Also qualitative research attempts to understand a respondent's point of view empathetically. Accuracy and replicability in this research has to be ensured and must be given high priority. Burns (1994) and Neuman (1997) as cited in Cavana et al., (2000), have suggested a number of options a qualitative researcher has to be aware of. They are

trustworthiness, verification, acknowledging, subjectivity and bias, process and sequence, interpretation, referential adequacy and painting the path. These areas could pose as limitations to qualitative research.

Face-to-face interviews

The main advantage of conducting face to face interviews was that I could adjust the questions as the interview proceeded, due to the semi-structured, open ended nature of the interviews. This involved repeating or rephrasing the questions in order to make sure that the responses were properly understood. I was able to pick non-verbal cues during the interviews. Any discomfort, stress or problems that the respondent experienced and exhibited could be noted and I was able to react accordingly.

Telephone interviews

From my point of view, a number of participants who were unable to face the interview on the set dates could be reached through this method. Also some respondents would have felt less uncomfortable revealing information over the phone than face to face. One disadvantage of telephone interviews was that I would not have been aware of the non-verbal signs of the participants, especially signs of impatience. Also recording the telephone interviews were not possible and notes were taken down, and had to pause the interview occasionally. This would have created a discontinuity of the interview.

3.11.4 Generalisability of Findings

Often research findings tend to be generalised by the researchers (Sekeran, 2000). This could be an issue which is difficult to avoid. Generalisability assumes that the degree to which the findings are derived from one context with a set of conditions applies to another with some other conditions. Generalisability can be of two forms, i.e., generalisability of people and of situations. Generalisability of people assumes that a particular sample of individuals represent the whole population under research. However, the existence of a true random sample where each individual in a population has an equal chance of participating in the study is very slim.

Sampling of individuals and situations must be conducted in order to maximize the generalisability of the findings to the whole population under any particular study (Shulman, 1997). To minimize the effects of generalisability of people, the researcher can aim to select a fair sample that represents the population under study. However, Shulman (1997), also states that it is up to the critical reader to judge and appreciate the fairness of the results of such a research study. The reader must be able to judge whether the findings represent the whole population of the study. Generalisability across situations in a given study assumes that all situations in similar studies represent the same thing. For example, in educational research attempting to characterise education generally using quantitative research methods is common. However attempts must be exerted that the researcher must always attempt to avoid generalisability as far as possible.

3.12 ETHICAL CONSIDERATIONS

Several ethical issues have to be addressed before collecting data. These concern the sponsor of the research who asks the study to be undertaken in the interest of their organisation, those who wish to collect data and those who offer it. The sponsor should respect the confidentiality of the data collected by the researcher (Cavana et al., 2000).

The researcher must ensure that the information given by the respondents are treated confidentially and their privacy guarded. The confidentiality of the survey and also the questionnaires if necessary must be communicated and revealed to the executives of the participating institutes. In this study, the ethical approval for data collection was first obtained from Curtin University, Perth, Western Australia, the sponsor for this study. Subsequently, ethical approvals from the participating institutes in this study in New Zealand were sought. Documents required by the ethics committees of the institutes under this study were submitted for their ethical approvals. The documents forwarded for ethical approval contained, a letter to the head of department of the participating institute, the participant information sheet, participant consent form, ACCC, TROFLEI, AQ and the interview structure.

When further renewals to the ethical approvals were necessary, in order to continue with the data collection, renewal applications were submitted first to Curtin University and subsequently to the respective institutes in New Zealand.

3.12.1 Informed Consent

Prior to the distribution of the questionnaires to the participants, a participant information sheet was distributed to the participants. This carried clear information about the research study, such as the aim and the nature of the research, the participant's role, their anonymity and confidentiality of the data gathered, storage of the data etc. The information contained the contact details of the sponsoring organisation and the researcher's contact details, in case the participants wanted to obtain further details of the research they were participating. The participant information sheet was explained by the person who conducted the surveys and very often it was me, the researcher. Also the participants were given the opportunity to discuss anything with regards to the research with me and it was explained that they had the opportunity to withdraw from the research at any time.

3.12.2 Risks to the Participants

This research involved no more than 'low risk' and the only foreseeable risk was one of discomfort or inconvenience. The participant anonymity and confidentiality were maintained and as such the risk to the participants was minimised. In the data entry phase, the participants and the institutes under the study were coded as numeric values to preserve anonymity. Both surveys and the interviews were aimed at minimal inconvenience and disruption to the students' class times. The length of time required by the questionnaires and the interviews were taken into consideration to avoid disruption to participants' time. The questionnaires required 20 to 25 minutes time and the interviews were limited to 15 to 20 minutes.

3.13 SUMMARY

This chapter provided an evaluation of different research methods in order to arrive at a suitable methodology for this study. First, this chapter investigated various research methods used in education research. Under education research methods, disciplined inquiry and qualitative and quantitative research methods were discussed. The mixed methods approach currently used in education research followed. The appropriateness of mixed methods approach for this study which was underpinned by pragmatism was then presented. The mixed methods approach involved using a quantitative method followed by a qualitative method. Overall, using the mixed methods approach was justified this in this chapter.

Then the quantitative method used in this study was discussed in more detail. This involved describing the rationale of selecting three questionnaires, which previously had been developed and validated.

The qualitative research method involved conducting semi-structured interviews with volunteering students. How the interviews were conducted was explained and this was followed by an explanation and justification of the interview strategy.

Sampling methods used in educational research were also investigated in this chapter. The selection of the quantitative and qualitative samples from the participating institutes was described. The rationale for the sampling method used in this study, and the validity and the reliability of the selected sample were also explained.

In the data collection phase, the procedures involved in both methods were outlined. This was followed by an explanation of data entry and storage procedures.

The quantitative and the qualitative data analysis methods followed were then discussed. The triangulation method which was utilised to merge the two types of data collected in order to bring about more accurate and in-depth results was then discussed.

Finally, the limitations, issues, and the validity of the research method used were discussed. The ethical considerations of the research and how the ethical approvals were obtained from the participating institutes in New Zealand were explained. This

section indicated how the informed consent was obtained causing minimal risks to the participants.

In the following chapter, the results of the data analysis are presented. The results presented in Chapter 4, the answers to the research questions and the findings of the literature review are blended to propose a generic model of teaching and learning over the context of this study.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 INTRODUTION

The previous chapter discussed the methodology adapted in this research study. Mixed methods research was chosen as the appropriate methodology and the rationale for using mixed methods was discussed in the previous chapter. Sequential explanatory design where the quantitative method precedes the qualitative method was used as the particular type of mixed method. Chapter 3 also described the questionnaires used in the quantitative phase; ACCC, TROFLEI and AQ (see Appendices E and F). Descriptions of the samples used in the data gathering and the administration of the questionnaires followed by how the interviews were conducted were further discussed.

This chapter reports the findings of the quantitative and the qualitative phases and discusses the integration of the two types of data aiming at finding answers to the research questions.

First, this chapter describes how the validity and reliability of the questionnaires were tested in the New Zealand context of this study. Then, correlations between the scales of each questionnaire are discussed. This is followed by discussions of inter-scale correlations of all the questionnaire scales. These findings are aimed at discovering possible responses to the first three research questions;

1. How do students studying computer courses in technical institutes and polytechnics in New Zealand perceive their computer learning environments?

2. What are the students' attitudes towards computers and computer courses?

3. What are the students' perceptions of the actual practices that take place in their classes and what are their preferences of how often they wish that these practices should take place?

The quantitative analysis was further extended to the other areas addressed in this research study. Statistical tests were performed with regards to institutional differences of the questionnaire scale responses, the differences in the levels of study and the gender differences. The findings of these tests together with the previously discussed findings are used in seeking an answer to the fourth research question;

4. What is the preferred teaching model that can be recommended regarding the improvement of the teaching of computer courses in tertiary institutions?

In the qualitative phase, findings of the interviews were reported and analysed using thematic content analysis. Common themes were examined in the interview responses and the corresponding themes were matched against the significant quantitative findings. Subsequently, findings of the qualitative themes were integrated into the corresponding areas of the quantitative findings, further strengthening them aiming at bringing further insight towards the research aims.

4.2 QUANTITATIVE FINDINGS AND DISCUSSIONS

4.2.1 Introduction

The sample for quantitative data collection consisted of 325 students from six New Zealand institutions who studied computer courses from levels 5 through to 7. Data were entered into SPSS for Windows statistical software and analysed.

The questionnaire items were responded to on a five point scale, with the alternatives of Almost Never, Seldom, Sometimes, Often, and Almost Always which were considered to have ratio or interval level features. The responses were entered into a SPSS spread sheet using a numeric scale ranging from 1 through to 5, respectively, 1 being Almost Never and 5 being Almost Always. Some items in the questionnaires were negatively worded and the scoring was reversed on these items.

Missing value handling

Some items of the questionnaires carried no responses. Blank responses exist possibly due to the fact that the respondent did not understand the question, did not

know the answer, was unwilling to respond or was simply indifferent to responding (Cavana et. al., 2000). In the data entry phase such items were left blank and in the analysis phase these user-defined missing values were treated as missing, thus allowing the software to handle them. Consequently, statistics for the analyses were based on cases with no missing data for any variable in the analysis.

Statistical tests performed in SPSS

The statistical tests performed on the data responses using the SPSS statistical program were carefully chosen. The three questionnaires used in this study had been previously developed, tested in similar environments and had proven reliability and validity (see Chapter 3). However, the reliability and the validity of the three instruments in New Zealand tertiary educational environments within the context of this study were further established.

Reliability of the questionnaires was measured using Cronbach's alpha reliability test on the questionnaire scales. The means and standard deviations of the actual and preferred TROFLEI scales were then assessed, in order to measure the differences that existed between the two versions. To distinguish the scale responses between students in different institutes analysis of variance (ANOVA) was performed on the scale responses of the three questionnaires. Further, student gender differences and level differences were measured using ANOVA. The findings of the above tests are reported and discussed in this chapter.

4.2.2 Reliability of the Questionnaires

Cronbach's alpha reliability measure was used to establish the reliability of the measurements or the internal consistency of the three questionnaires scales, including both actual and preferred versions of the TROFLEI Generally an alpha coefficient greater than 0.8 is considered acceptable (Bryman & Cram, 1990, as cited in Cavana et al., 2000). However Nunally (1978) as cited in Cavana et al., (2000) suggests that values above 0.60 is accepted especially for initial investigations and is applied in this investigation. The alpha reliability measures range from 0 to 1.0 with a higher value indicating a better measuring instrument (Cavana et al., 2000).

All the scales of the ACCC (see Table 4.1), the actual and the preferred scales of the TROFLEI (see Table 4.2) and the scales of the AQ (see Table 4.3) showed satisfactory internal consistency, with values greater than 0.60, which was the level proposed by Nunnally, 1967, 1978 (as cited in Ward, 2008). The only exception was with the 'Attitude to Computer Use' scale in the AQ which yielded a low alpha reliability of 0.41 (see table 4.3). Therefore, in order to find out which items did not contribute towards the reliability of the AQ, further reliability tests were performed with the eight items belonging to the scale 'Attitude to Computer Use'. The contributions of items which did not contribute to the reliability of this scale were eliminated before performing further analytical tests in this study.

Table 4.1

Internal Consistency (Alpha Reliability) for ACCC Scales

Scale	No of items	Alpha Reliability
Usefulness of course	7	0.63
Anxiety	7	0.83
Usefulness of computers	7	0.63
Enjoyment	7	0.73

N=325

All the scales in ACCC showed accepted reliability (see Table 4.1) in the context of this study. The Anxiety and Enjoyment scales showed the highest reliability. All the actual and preferred scales in the TROFLEI showed very high reliabilities (see Table 4.2) in the context of this study.

Table 4.2

Internal Consistency (Alpha Reliability) for Actual and Preferred Scales of the TROFLEI

Scale	No of items	Version	Alpha Reliability
Student Cohesiveness	8	Actual	0.85
		Preferred	0.87
Teacher Support	8	Actual	0.88
		Preferred	0.90
Involvement	8	Actual	0.89
		Preferred	0.92
Task Orientation	8	Actual	0.89
		Preferred	0.87
Investigation	8	Actual	0.90
		Preferred	0.93
Cooperation	8	Actual	0.89
		Preferred	0.81
Equity	8	Actual	0.93
		Preferred	0.94
Differentiation	8	Actual	0.73
		Preferred	0.81
Computer Usage	8	Actual	0.81
		Preferred	0.86
Young Adult Ethos	8	Actual	0.88
		Preferred	0.91

N=325

Table 4.3

Internal Consistency (Alpha Reliability) for AQ Scales

Scale	No of Items	Alpha Reliability
Attitude to Subject	8	0.70
Attitude to Computer Use	8	0.41
Academic Efficacy	8	0.76

N=325

Attitude to Subject and Academic Efficacy showed high reliabilities. However, Attitude to Computer Use showed a less than desirable alpha reliability score of 0.41. Further tests were performed on the responses of the eight items (items numbers 9 to 15) of the Attitude to Computer Use scale. Items 11 and 14 scored negative values and item 15 scored a poor internal consistency of 0.26 (see Table 4.4). The tests were performed after deleting item 11 and 14 and then, item 15 yielded an improved reliability of 0.76 (see Table 4.5).

Table 4.4

Internal Consistency (Cronbach's Alpha Reliability) for Scale of Attitude to Computer Use in AQ

No	Item	Alpha Reliability if Item Deleted
9	I'm good with computers.	0.30
10	I like working with computers.	0.29
11	I like working with computers.	0.56
12	I am comfortable trying new software on the computer.	0.38
13	Working with computers is stimulating.	0.33
14	I get a sinking feeling when I think of using a computer.	0.58
15	I do as little work as possible using a computer.	0.26
16	I feel comfortable using a computer.	0.31

Through the statistical evidence provided in Tables 4.4 and 4.5, can be argued that items 11, "I like working with computers", item 14, "I get a sinking feeling when I think of using a computer" and item 15, "I do as little work as possible using a computer" in the AQ are responded to differently by the students in this sample.

Table 4.5

Internal Consistency for scale of Attitude to Computer Use in AQ after items deleted

No	Item	Corrected Item-Total Correlation	Alpha Reliability if Item Deleted
9	I'm good with computers.	0.54	0.57
10	I like working with computers.	0.53	0.60
12	I am comfortable trying new software on the computer.	0.46	0.59
13	Working with computers is stimulating.	0.36	0.63
15	I do as little work as possible using a computer.	0.14	0.76
16	I feel comfortable using a computer.	0.58	0.57

Furthermore, this study addresses students' perceptions and attitudes of technology-rich learning environments in tertiary education and of the computer courses learnt in these environments. It is apparent that the above items are irrelevant to the study and testing these items may not provide any benefit to the study aims. Consequently, items 11, 14 and 15 were deleted and the responses to these items were not used in further analyses.

4.2.3 Discriminant Validity of the Scales of the Three Questionnaires

Discriminant validity (or divergent validity) tests that constructs are unrelated. Discriminant validity of the questionnaire scales were measured using inter-scale correlations. These estimate the degree to which any two scales are related to each other. For a questionnaire to have discriminant validity, correlations between two scales should be significantly less than 1, proving that they are theoretically dissimilar. Correlations of all three questionnaire scales were significant at $p < 0.01$ and $p<0.05$ (see Tables 4.6, 4.7, 4.8).

Table 4.6

Discriminant Validity as Mean Correlations of ACCC Scales

	Usefulness of Course	Anxiety	Usefulness of Computers	Enjoyment	Mean Correlation
Usefulness of Course		.08*	.40*	.37*	0.28
Anxiety			-.41**	-.52**	0.34
Usefulness of Computers				.65**	0.48
Enjoyment					0.57

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

The inter-scale correlations of the ACCC presented in Table 4.6 ranged from 0.08 to 0.68 meaning that significant amounts of variance could be found among the scales. The correlations presented indicate that the instrument measures distinct although somewhat overlapping aspects of the learning environment of this study (Fraser, 1988a). The mean inter-scale correlations of the ACCC ranged between 0.28 to 0.57 indicating that the scales measured distinct, though partially related elements with regards to students' attitudes toward computers and computer courses.

Table 4.7

Discriminant Validity as Mean Correlations of TROFLEI Scales (actual)

	A-Student Cohesiveness	A-Teacher support	A-Involvement	A-Task Orientation	A-Investigation	A-Cooperation	A-Equity	A-Differentiation	A-Computer Usage	A-Young adult Ethos	Mean Correlation
A-Student Cohesiveness											0.34
A-Teacher support	.31**										0.34
A-Involvement	.47**	.50**									0.46
A-Task Orientation	.38 **	.36**	.56**								0.44
A-Investigation	.25**	.32**	.62**	.54**							0.38
A-Cooperation	.57**	.33**	.46**	.55**	.38**						0.42
A-Equity	.24**	.46 **	.43**	.53**	.37**	.44**					0.39
A-Differentiation	.21**	.20**	.43	.28**	.38**	.31**	.23**				0.28
A-Computer Usage	.30**	.30**	.40**	.42**	.35**	.40**	.34**	.41*			0.36
A-Young adult Ethos	.34**	.31**	.29**	.42**	.23**	.37**	.49**	.12*	.40**		0.33

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

The correlations of the TROFLEI scales in Table 4.7 ranged from 0.12 to 0.62 indicating that significant amounts of variance could be found among the scales. The mean correlations between scales of the TROFLEI ranged between 0.33 and 0.46. This meant that the scales measured distinct elements with regards to Technology-Rich Outcomes-Focused Learning Environment.

These values indicate that most students get involved with their peers in investigating the topics of their lessons. Cooperation among students led to student cohesiveness and as a result students got more oriented towards their tasks. The students experienced satisfactory support from the teacher and as a result there was more involvement of students with each other during their class activities.

Table 4.8

Discriminant Validity as Mean Correlations of AQ Scales

	Attitude to Subject	Attitude to Computers	Academic Efficacy	Mean Correlation
Attitude to Subject				0.39
Attitude to Computers	.38**			0.36
Academic Efficacy	.40*	.33 **		0.37

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Table 4.8 presents correlations of the AQ scales which ranged from 0.33 to 0.40 indicating that the scales measured distinct characteristics of the attitudes questionnaire. The mean inter-scale correlations ranged from 0.36 to 0.39 indicating that the scales measured distinct elements in the attitudes questionnaire.

4.2.4 Means and Standard Deviations of the Questionnaire Scales

Mean values indicate the average of the responses while standard deviation shows how much variation or dispersion exists from the average mean value. A low standard deviation indicates that the student responses tend to be very close to the

mean, whereas a high standard deviation shows that the student responses are spread out over a large range of values (http://en.wikipedia.org/wiki/Mean).

The mean scores and standard deviations for the scales of ACCC, AQ and TROFLEI are illustrated in Tables 4.9, 4.10 and 4.11, respectively. Except for Anxiety, the mean values of the ACCC scale responses were greater than 3, meaning that, on average students showed positive responses to the scales. Usefulness of course (3.60) and Usefulness of Computers (4.16) showed above average means along with average standard deviations. This could be interpreted that the students perceived their courses, computers and the skills gained are going to be useful in their future careers.

Table 4.9

Means and Standard Deviations for ACCC Scales

Scale	No of items	Valid Cases	Mean	Standard Deviation
Usefulness of course	7	308	3.60	0.58
Anxiety	7	308	2.68	0.91
Usefulness of computers	7	308	4.16	0.56
Enjoyment	7	308	4.18	0.62

Usefulness of Course (4.16) and Enjoyment (4.18) had high mean values. The standard deviation value of 0.98 indicated that Anxiety was perceived differently by individual students. Enjoyment with a standard deviation of 0.62 was a noteworthy variation as well.

Table 4.10

Means and Standard Deviations for AQ Scales

Scale	No of Items	Valid cases	Mean	Standard deviation
Attitude to Subject	8	318	3.44	0.62
Attitude to Computer Use	8	318	3.80	0.53
Academic Efficacy	8	315	3.31	0.61

The mean value of Attitude to Subject (3.44) indicates that students had positive attitudes towards their subjects and they enjoyed learning them. Attitude to Computer Use showed an above average score (3.8) indicating that most students were comfortable using computers and they liked working with computers. Academic Efficacy had a medium mean value (3.31) indicating that on average students felt confident about their achievements in the computer courses learnt.

Although the mean values of the three scales of AQ showed medium values, the Academic Efficacy and Attitude to Subject scales showed a noteworthy standard deviation.

4.2.5 Actual and Preferred Differences in TROFLEI Scales

In order to determine if there were significance differences between the scale means on the actual and preferred versions of the TROFLEI, means and standard deviations were calculated for each scale, along with paired sample t-values and significance (see Table 4.11).

The overall mean values of the preferred scores were higher than the actual means for every scale, indicating that generally the students would prefer more favourable learning environments than their currently perceived learning environments at their institutions. However, the standard deviations of both actual and preferred versions indicated that there is much variation in student responses in all the scales.

Standard deviations illustrated in Table 4.11 shows that the variations in the preferred values were always higher than that of the actual values, meaning that individual students had their own preferred learning environment all the time.

Table 4.11

Means, Standard Deviations, t-values for Actual and Preferred Forms of the TROFLEI

Scale	Version	Mean	Standard Deviation	t-value
Student	Actual	3.75	0.68	10.542***
Cohesiveness	Preferred	4.07	0.70	
Teacher Support	Actual	3.43	0.75	11.080***
	Preferred	3.85	0.78	
Involvement	Actual	3.15	0.75	10.934***
	Preferred	3.56	0.83	
Task Orientation	Actual	4.00	0.73	13.209***
	Preferred	4.46	0.80	
Investigation	Actual	3.24	0.86	13.204***
	Preferred	3.78	0.93	
Cooperation	Actual	3.74	0.76	8.705***
	Preferred	4.06	0.86	
Equity	Actual	4.00	0.81	-6.670***
	Preferred	4.22	0.83	
Differentiation	Actual	3.06	0.67	8.462***
	Preferred	3.35	0.82	
Computer Usage	Actual	3.94	0.71	5.437***
	Preferred	4.12	0.76	
Young Adult Ethos	Actual	4.15	0.73	4.121***
	Preferred	4.27	0.85	

N= 325, No of items in each scale = 8

*** $p < 0.001$

A paired samples *t*-test was conducted to compare the means of each of the actual and preferred versions of the TROFLEI (see Table 4.11). Table 4.11 shows that statistically significant differences existed between all the scales of the actual and the preferred versions of TROFLEI. This can be interpreted as the students always preferring a more positive learning environment than the one they perceived to be present.

The greatest differences between the actual and preferred scores occurred on the Student Cohesiveness, Teacher Support, Involvement, Task Orientation and Investigation scales. The Differentiation and Cooperation showed moderate differences while the Equity, Computer Usage and Young Adult Ethos showed the smallest differences in their means. This could be interpreted as that the students were somewhat satisfied with the actual scales and wished they could be improved to some degree according to their preferences.

4.2.6 Inter-scale Correlations of the Questionnaire Scales

Pearson SIMPLE correlations were used to test the associations of the scales of the three questionnaires. Cavana, et al. (2000) state that this test confirms that the correlations between two scales does not occur by chance alone, and confirms that there is a high probability that its actual existence is significant.

Inter-scale correlations of the TROFLEI with ACCC scales are presented in Tables 4.12. The significant values ranged from 0.11 to 0.39 indicating that the scales of TROFLEI had considerable associations with each of the scales of ACCC.

Table 4.12

Inter-scale Correlations of TROFLEI Scales with ACCC Scales

	Usefulness of Course	Anxiety	Usefulness of Computers	Enjoyment
A-Student Cohesiveness	0.21**	-0.16**	0.39**	0.37**
A-Teacher support	0.33**	0.08	0.20**	0.14*
A-Involvement	0.30**	-0.04	0.21**	0.23**
A-Task Orientation	0.20**	-0.05	0.29 **	0.25**
A-Investigation	0.27*	-0.03	0.22*	0.18*
A-Cooperation	0.21**	-0.14*	0.31**	0.30**
A-Equity	0.23*	-0.04	0.21**	0.12**
A-Differentiation	0.14*	-0.05	0.10	0.07
A-Computer Usage	0.28**	0.00	0.30**	0.27**
A-Young adult Ethos	0.2**	-0.08	0.31**	0.26**

**Correlation is significant at 0.01 level
*Correlation is significant at 0.05 level

Simple correlations of the TROFLEI with AQ scales are presented in Table 4.13. The significant values ranged from 0.12 to 0.43 indicating that the TROFLEI scales are significantly related to each of the Attitude scales.

Simple correlations of the ACCC with AQ scales are presented in Tables 4.14. The significant values ranged from 0.14 to 0.70 indicating that the TROFLEI scales are significantly related to each of the attitude scales.

Table 4.13

Simple Correlations of TROFLEI scales with AQ scales

	Attitude to Subject	Attitude to Computers	Academic Efficacy
A-Student Cohesiveness	0.31**	0.33**	0.33**
A-Teacher support	0.34	0.12*	0.28*
A-Involvement	0.40**	0.23**	0.43**
A-Task Orientation	0.34**	0.24**	0.34**
A-Investigation	0.42**	0.19**	0.38**
A-Cooperation	0.23**	0.25**	0.26**
A-Equity	0.24**	0.19**	0.18**
A-Differentiation	0.28**	0.08	0.29**
A-Computer Usage	0.30*	0.22**	0.19**
A-Young adult Ethos	0.19**	0.30**	0.18**

Table 4.14

Inter-scale Correlations of ACCC Scales with AQ Scales

	Usefulness of Course	Anxiety	Usefulness of Computers	Enjoyment	Attitude to Subject	Attitude to Computers	Academic Efficacy
Usefulness of Course							
Anxiety	0.19*						
Usefulness of Computers	0.40*	0.52**					
Enjoyment	0.37**	0.68**	0.65**				
Attitude to Subject	0.47**	0.48**	0.38**	0.40**			
Attitude to Computers	0.28**	0.70**	0.55**	0.66**	0.38**		
Academic Efficacy	0.70**	0.14*	0.21**	0.24**	0.40*	0.33**	

** Correlation is significant at 0.01 level, * Correlation is significant at 0.05 level

Discussions of noteworthy associations among questionnaire scales

There are some noteworthy associations when the overall correlations of the questionnaire scales are considered presented in Tables 4.12, 4.13 and 4.14. The strongest relationships were found between Academic Efficacy and Usefulness of Course (0.70), Enjoyment and Anxiety (-0.51), Enjoyment and Attitude to Computers (0.66), Usefulness of Computers and Enjoyment (0.65), Investigation and Involvement (0.62), and Cooperation and Student Cohesiveness (0.57).

The results reveal that the strongest association existed between Academic Efficacy and Usefulness of Course. This can be interpreted as that, the students felt strongly that what they learnt in the computer courses are very useful and will be used in their future computing careers. Consequently, they could work towards achieving good grades and would perform well in their computer courses and may help their friends as well.

Enjoyment and Anxiety had a strong association (-0.51). This shows that, in classes where students enjoyed learning their computer courses, there was less Anxiety or when there is less anxiety among students, they enjoyed their learning. Anxiety and Usefulness of Computers also had a strong relationship (-0.52) indicating that when students are less anxious they realize the usefulness of computers more. The items of these scales indicate that the students felt confident about handling computers and tackling unfamiliar problems involving computers. As a result, the students felt confident to try new software, felt positive about tackling unfamiliar problems involving computers and did not feel nervous. Thus, it can be suggested that teachers need to focus on making the classes enjoyable and less stressful to students for better outcomes. This in turn would help educators to have less stress communicating with the students and managing the classes. Also, the strong association between Usefulness of Computers and Attitude to Computers (0.55) supports the above. When the students realized the usefulness of computers they in turn had a positive attitude towards computer use.

There was a strong association between Involvement and Investigation (0.62) indicating that the students prefer to investigate to find out answers to questions and solve problems that arise in their lessons individually. On the other hand, this could be interpreted as that the students would also like to express their opinions when the

teacher asks questions, would like to discuss their findings to questions that arise during the lessons and would like discussing them with other students.

There are also significant relationships between Involvement and Student Cohesiveness (0.47) and to a slightly lesser extent between Involvement and Academic Efficacy (0.43). The former suggests that when there is more involvement with peers and teachers, more student cohesiveness occurred. The latter suggests that the more students are involved in their classes the better they feel about their performance and achievement.

Involvement was also associated with Cooperation (0.46). This reveals that student cooperation with other students and the teacher is important to achieve their goals. This means sharing their work and resources with other students, engage in team work and doing projects together with the others in the class. There is a strong correlation between A-Cooperation and A-Student Cohesiveness (0.57). This showed that a greater cohesiveness was built among students when they cooperated with the teacher and their peers. This can be interpreted as that getting to know other students in a class and making friends facilitates learning, sharing knowledge and collaborating among teams. Furthermore, Cooperation is also strongly associated with Task Orientation (0.55). Cooperation would facilitate the task orientation which describes how a student is engaged in his or her work, setting goals in order to accomplish the aims of a course. Task Orientation also had strong relationships with Involvement (0.56), Investigation (0.54) and Equity (0.53). These figures indicate that when the students are involved and collaborate with peers and the teacher, while taking the initiative to investigate and solve problems through class discussions, their orientation towards different tasks improved. Also, it could be inferred that most students felt that they received the same encouragement from the teacher as the other students did, had the same opportunity to answer questions as the other students and therefore felt that they were treated equally in the class.

Involvement showed a strong association with Teacher Support (0.50). This explains that when the teachers showed personal interest in students and help them individually, the students felt that the teacher was interested in their problems and felt safe and confident. This indicates that the teachers must be conscious of each individual student and support them and get them involved in discussions and team

work. Some students could display an introverted nature in class and wished to work on their own. However, it is important that the teachers made such students feel that, despite their introverted nature, they are treated equally in class. Furthermore, the association between Teacher Support and Equity (0.46) suggests that when the teacher supports a student, the students were made to feel that the teacher was interested in their problems and they got the feeling that they were treated equally.

Young Adult Ethos showed a correlation of 0.49 with Equity, and could be interpreted that the students felt that irrespective of their age they were treated equally, in their classes. Also, Young Adult Ethos showed a correlation of 0.40 with Computer Usage and 0.42 with Task Orientation, which are relationships. The mature student responses would have resulted in these values as they felt that they were less oriented towards their tasks and the use of computer. This is further clarified through the findings of qualitative data.

Involvement and Computer Usage (0.40) and Cooperation and Computer Usage (0.40) showed associations to a lesser extent. These scores suggest that when computers were utilised as a communication media to communicate with the students and the teacher, to access material and submit assignments, personal involvement during the class increased as did cooperative behaviour among peers and the teacher.

Associations occurred between Attitude to Subject and Usefulness of Course (0.47), Anxiety (-0.22), and with Enjoyment (0.40) and Investigation (0.42) and Involvement (0.40) to a lesser degree. This can be interpreted as when the students realised that the courses were useful, they had a better attitude towards learning the courses and showed less anxiety. Also, if they did not enjoy learning a course, their attitude towards learning declined and their involvement and self-learning decreased.

The simple correlations of ACCC and TROFLEI presented in Table 4.12 indicate that a number of relationships are weakly associated and not very significant. Among the weak associations, the highest correlation was found between Student Cohesiveness and Usefulness of Computers (0.39) and Enjoyment (0.37). These values indicate that, students not collaborating much with the peers did not benefit them in realizing the usefulness of computers and they were restricted in enjoying working with computers.

4.2.7 Institutional Differences for the Questionnaire Scale Responses

Means, standard deviations and ANOVA were carried out with the aim of finding out the differences that existed among the six institutions in the participants' responses to the scales of the three questionnaires (see Table 4.15).

In order to find out the significant mean differences of the scales between the institutions ANOVA tests were performed on the data responses of the six institutions with institute membership as the main effect. Through the F statistic values at $p<0.001$, it was revealed that only seven scales among the three questionnaires were significantly different between the six institutions (see Table 4.15).

Further ANOVA tests were carried out with the data of the seven significant scales. It was revealed that only four scales, Usefulness of Computers, Enjoyment, Attitude to Subject and Attitude to Computers were actually significantly different between the six institutions (see Table 4.16).

Table 4.15.

Means, Standard Deviations, F values for the Six Institutions

Scale	Institute	Mean	Std. Deviation	F	Significance
Usefulness of	1	4.33	0.51	8.34	0.000
Computers	2	3.98	0.46		
	3	4.21	0.50		
	4	4.21	0.54		
	5	3.81	0.58		
	6	4.39	0.30		
Enjoyment	1	4.31	0.57	12.21	0.000
	2	4.39	0.47		
	3	4.28	0.62		
	4	4.32	0.59		
	5	3.70	0.51		
	6	4.44	0.62		
A-Student	1	3.91	0.67	3.78	0.001
Cohesiveness	2	3.59	0.68		
	3	3.38	0.49		
	4	3.71	0.62		
	5	3.58	0.73		
	6	4.02	0.57		
A-Teacher	1	3.34	0.70	1.52	0.172
Support	2	3.54	0.84		
	3	3.72	0.65		
	4	3.36	0.67		
	5	3.51	0.90		
	6	3.55	0.53		

A-Involvement	1	3.18	0.74	1.25	0.278
	2	3.08	0.73		
	3	2.80	0.68		
	4	3.20	0.65		
	5	3.12	0.89		
	6	3.27	0.63		
A-Task	1	4.10	0.64	1.54	0.166
Orientation	2	4.22	0.59		
	3	3.78	0.62		
	4	3.96	0.58		
	5	3.88	1.00		
	6	4.20	0.53		
A-Investigation	1	3.26	0.76	0.68	0.665
	2	3.28	1.05		
	3	3.03	1.07		
	4	3.26	0.75		
	5	3.19	1.1		
	6	3.50	0.60		
A-Cooperation	1	3.69	0.76	1.39	0.219
	2	3.73	0.79		
	3	3.76	0.87		
	4	3.93	0.60		
	5	3.59	0.91		
	6	3.82	0.45		
A-Equity	1	3.90	0.81	1.60	0.149
	2	3.99	0.68		
	3	4.41	0.65		
	4	4.00	0.73		
	5	3.94	0.97		
	6	4.24	0.66		
A-Differentiation	1	3.05	0.63	1.21	0.301
	2	3.10	0.76		
	3	2.76	0.57		
	4	3.18	0.71		
	5	3.01	0.74		
	6	3.08	.51		
A-Computer	1	3.90	0.68	0.75	0.610
Usage	2	3.70	0.71		
	3	4.07	0.58		
	4	3.99	0.60		
	5	3.97	0.88		
	6	3.92	0.61		
A-Young Adult	1	4.16	0.64	7.12	0.000
Ethos	2	4.22	0.51		
	3	4.32	0.57		
	4	4.21	0.60		
	5	4.00	0.92		
	6	4.34	0.45		
Attitude to	1	3.42	0.65	7.57	0.000
Subject	2	3.25	0.78		
	3	3.23	0.44		
	4	3.50	0.58		
	5	3.27	0.47		
	6	4.16	0.59		

Attitude to	1	3.93	0.47	19.26	0.000
Computers	2	4.04	0.47		
	3	4.06	0.44		
	4	3.90	0.50		
	5	3.33	0.41		
	6	4.14	0.38		
Academic	1	3.34	0.64	2.18	0.045
Efficacy	2	3.32	0.72		
	3	2.98	0.56		
	4	3.33	0.61		
	5	3.25	0.58		
	6	3.54	0.36		

*p<0.05, **p<0.01, ***p<0.001

Table 4.16.

ANOVA Tests for Institutional Differences

Scale	Institute	F	Sig
Usefulness of Computers	Between Groups	10.05	0.000
	Within Groups		
Enjoyment	Between Groups	14.35	0.000
	Within Groups		
A-Student Cohesiveness	Between Groups	4.51	0.001
	Within Groups		
A-Young Adult Ethos	Between Groups	1.36	0.239
	Within Groups		
Attitude to Subject	Between Groups	8.57	0.000
	Within Groups		
Attitude to Computers	Between Groups	22.65	0.000
	Within Groups		
Academic Efficacy	Between Groups	1.99	0.080
	Within Groups		

***p<0.001

Post hoc tests for multiple comparisons between the institutions were then carried out with the four significant scale responses in order to determine between which institutions there are differences. The results revealed where the differences occurred between the institutions (see Table 4.17).

Table 4.17.

Post Hoc Tests (Mean Differences, Significance) for Multiple Comparisons Between Institutions for Significant Scales

Dependant variable	(I)Institution	(J)Institution	Mean Difference (I-J)	Sig *(p)*
Usefulness of Computers	1	5	0.52*	0.000
	4	5	0.40 *	0.000
	5	1	-0.52*	0.000
		4	-0.40*	0.000
		6	-0.58*	0.000
	6	5	0.13*	0.000
Enjoyment	1	5	0.62*	0.000
	2	6	0.69*	0.001
	4	5	0.62*	0.000
	5	1	-0.62*	0.000
		2	-0.69*	0.001
		4	-0.62*	0.000
		6	-0.74*	0.000
	6	5	0.74*	0.000
Attitude to Subject	1	6	-0.74*	0.000
	2	6	-0.91*	0.000
	3	6	-0.94*	0.000
	4	6	-0.66*	0.000
	5	6	-0.89*	0.000
	6	1	0.74*	0.000
		2	0.91*	0.000
		3	0.94*	0.000
		4	0.66*	0.000
		5	0.89*	0.000
Attitude to Computers	1	5	0.60*	0.000
	2	5	0.71*	0.000
	3	5	0.73*	0.000
	4	5	0.57*	0.000
	5	1	-0.60*	0.000
		2	-0.71*	0.000
		3	-0.73*	0.000
		4	-0.57*	0.000
		6	-0.82*	0.000
	6	5	0.82*	0.000

Sig $p<0.001$

The interpretation of the means and the standard deviations gathered from Table 4.15 and the significant mean differences presented in Table 4.17 for the scale responses are discussed in the following section.

A-Involvement, A-Differentiation and Academic Efficacy

Table 4.15 reveals that all the mean values were above 3.0 except for three scale responses in Institution 3. It was observed that, Institution 3 yielded mean values below 3 in A-Involvement, A-Differentiation and Academic Efficacy. The mean value for A-Involvement (2.8) indicated that in the computer classes in Institution 3, the students recognised that the discussions and interactions with the teacher and the peers during the lessons were not adequate. The mean value (2.76) for A-Differentiation indicated that the students in Institution 3 felt that despite the varying abilities of individuals these were not considered when setting tasks and assessments. The mean score of 2.98 for Academic Efficacy indicated that in Institution 3, the students had to work harder to achieve good grades compared to the other institutions.

Usefulness of Computers

Referring to the means in Table 4.15 reveal that, Institutions 1, 3, 4 and 6 yielded highest mean scores in Usefulness of Computers scale (M > 3.81). Institute 6 (M = 4.39, SD = 0.30) showed the highest score. This was greater than both institute 1 (M = 4.33, SD = 0.51) and institute 4 (M = 4.21, SD = 0.50).

The post hoc comparisons of the six institutes in Table 4.17 indicated that Institutions 1 and 4 have significantly higher ratings for Usefulness of Computers than all other institutes with Institution 1 being the highest (p<0.001). All other institutions yielded low ratings for usefulness of computers. This indicates that students in Institutions 1 and 4 were more positive about the importance of computers than were the students in the other institutes.

Enjoyment

The mean values in Table 4.15 show that five institutions scored high (M > 3.70) for *Enjoyment.* The lowest score was reported in institution 3 (M = 3.70) which is also an above average score. Therefore the results could be interpreted that the students in all the institutions enjoyed using computers in general.

The post hoc comparisons of the six institutions in Table 4.17, which yielded more precise results (p<0.001), indicated that Institutions 1, 2, 4 and 6 had the highest

scores for Enjoyment. Institution 6 yielded a very high score indicating that the students in that institution enjoyed their courses most, compared to all other institutions.

Attitude to Subject

Table 4.15 indicates that Institution 6 (M = 4.61) was greater than all other institutes in *Attitude to Subject* scale. All the other institutions yielded mean scores between 3.23 and 3.50. The results indicated that the students in all the institutions displayed a satisfactory attitude towards their computer courses.

The post hoc comparisons of mean differences of the six institutions in Table 4.17 revealed that only Institution 6 had a high score for Attitude to Subject ($p<0.001$). This further underpins the results shown in Table 4.15. This can be interpreted as that the students in Institution 6 were the most interested and enjoyed their computer courses more compared with the students in the other institutions that were involved in this study.

Attitude to Computers

Referring to the mean scores in Table 4.15, the scores for the scale Attitude to Computers ranged from 3.33 through to 4.14 in all six institutions. These results reveal that the students in these six institutions generally had a positive attitude towards using computers. It also revealed that institutions 1, 2, 3, 4 and 6 scored high ratings for Attitude to Computers. Institution 6 scored the highest among other institutions. Institution 5 showed a very low score when regressed with the other institutions for this scale. This can be interpreted as those students in most institutions had a positive attitude towards computers, while Institution 5 showed that the students were least comfortable using computers.

4.2.8 Level Differences for the Questionnaire Scale Responses

Students from levels 5, 6 and 7 participated in this study from the six institutions. In order to find the differences that existed between different levels of students in these institutions ANOVA statistical tests were performed using the data from the five scales that were found significant among the six institutions through the previous

analyses. F values for A-Student Cohesiveness, A-Involvement, A-Task Orientation, A-Investigation and Attitude to Computers for all the levels were calculated. The results presented in Table 4.18 reveal that the level differences was significant at $p<0.05$ and $p<0.01$.

Table 4.18.

ANOVA Statistics for Level Differences Among Institutes

Scale	Institute	F	Sig
A- Student Cohesiveness	Between Groups Within Groups	5.262	0.006
A-Involvement	Between Groups Within Groups	6.734	0.001
A-Task Orientation	Between Groups Within Groups	5.648	0.004
A-Investigation	Between Groups Within Groups	3.325	0.037
Attitude to Computers	Between Groups Within Groups	3.906	0.021

$p< 0.05$ or $p < 0.01$

Further, post hoc ANOVA were performed using data for the five scales in order to find out where the differences lie with regards to the different levels of the computer courses among the six institutions (see Table 4.19).

Table 4.19.

Post Hoc Tests- Multiple Comparisons for Level Differences

Scale	(I) Level	(J) Level	Mean Difference (I-J)	Sig
A-Student Cohesiveness	5	6	0.238*	0.019
		7	0.261*	0.016
	6	5	-0.238*	0.019
		7	0.223	0.970
	7	5	-0.261*	0.016
		6	-0.023	0.970
A-Involvement	5	6	0.251*	0.027
		7	-0.127	0.442
	6	5	-0.251	0.027
		7	-0.378	0.001
	7	5	0.127	0.442
		6	0.378*	0.001
A-Task Orientation	5	6	0.315*	0.003
		7	0.116	0.480
	6	5	-0.314*	0.003
		7	-0.198	0.138
	7	5	-0.116	0.480
		6	0.198	0.138
A- Investigation	5	6	0.138	0.438
		7	-0.182	0.289
	6	5	-0.138	0.438
		7	-0.320*	0.028
	7	5	0.182	0.289
		6	0.320*	0.028
Attitude to Computers	5	6	-0.058	0.679
		7	0.151	0.105
	6	5	0.058	0.679
		7	0.209*	0.018
	7	5	-0.151	0.105
		6	-0.209*	0.018

.05 or $p < .01$

Level 5 students showed the highest Student Cohesiveness and Involvement, followed by level 6 and then 7. Level 7 scored the least in both these scales. This could be interpreted as that the students in the lower levels showed better involvement with each other and tend to support each other in their tasks than the higher levels.

Task Orientation was significant only in level 5 and was not significant in levels 6 and 7. This could be interpreted as that, when students are at lower levels they are more interested in understanding the volume of work and wanted to do their tasks without delay.

Investigation showed the highest score in level 7 followed by level 6. Level 5 yielded no significant value to this scale. This could be interpreted as that the students in higher levels tend to carry out investigations individually and towards achievements in their studies more, while level 5 students were not that interested in this area to the extent of the higher level students.

The Attitude to Computer Use scale had the highest value in level 6 followed by level 7. This shows that the students who have reached higher levels become more familiar with computers and they would find it easier to handle new programmes and computers.

4.2.9 Gender Differences for the Questionnaire Scale Responses

The percentage of females doing Computer Science had been dropping since 1985. Statistical evidence reveals that, in many universities in the US and also in New Zealand, females who study Computer Science are less than 20% (Bernstein, 2000). However, in his research article Bernstein states that, although the male students thought that they were more experienced in software applications and felt more comfortable with computing than females. This study also revealed that, there were no significant differences between the two genders studying a programming paper in a New Zealand university in the computer science degree.

However, Buch (1995) as cited in Bernstein (2000) states that male students had more computing experience than the female students when they enter university.

Hence, it was noted that women start their university computer science papers at a disadvantage (Bernstein, 1991 as cited in Bernstein, 2000).

The means and the standard deviations for the scales of the three questionnaires were calculated in order to examine the central tendencies in gender differences in the data collected from the five institutions (see Table 4.20). The number of females was relatively low compared to the number of males in these classes. Data were analysed using the within-class gender mean as the unit of analysis, to provide a matched pair of means (Cavana et al., 2000). This reduces confusion in such a way that for each group of males within a class, it was considered that there is a corresponding group of females in the same class. Table 4.18 reports the average item mean and average standard deviation for male and female students for each scale of the three questionnaires. In the case of the TROFLEI the actual version was considered.

Table 4.20.

Average Means and Standard Deviations for Gender Differences

Scale	Gender	N	Mean	Std. Deviation	Significance
Usefulness of	M	233	3.62	0.58	
Course	F	53	3.52	0.49	
Anxiety	M	233	3.99	0.96	
	F	53	3.83	1.01	
Usefulness of	M	233	4.12	0.56	
Computers	F	53	4.12	0.54	
Enjoyment	M	233	4.12	0.62	
	F	53	4.12	0.60	
A- Student	M	242	3.76	0.67	
Cohesiveness	F	55	3.67	0.73	
A- Teacher	M	242	3.42	0.73	
Support	F	55	3.44	0.86	
A- Involvement	M	240	3.16	0.72	
	F	55	3.03	0.91	
A-Task	M	240	3.98	0.73	
Orientation	F	55	4.11	0.77	
A- Investigation	M	239	3.21	0.88	
	F	55	3.24	0.83	
A-Cooperation	M	241	3.72	0.78	
	F	55	3.80	0.72	
A-Equity	M	239	4.00	0.83	
	F	55	4.02	0.77	
A-Differentiation	M	223	3.07	0.68	
	F	54	3.02	0.66	
A-Computer	M	239	3.90	0.72	
Usage	F	55	4.12	0.62	

A-Young Adult	M	236	4.14	0.72
Ethos	F	55	4.12	0.62
Attitude to	M	239	3.43	0.65
Subject	F	55	3.50	0.54
Attitude to	M	239	3.82	0.53
Computers	F	55	3.72	0.53
Academic	M	236	3.28	0.61
Efficacy	F	55	3.34	0.62

The mean scores for both males and females presented in Table 4.20 did not show a noticeable variation. All scored above 3 for both genders. This indicated that there is no significant difference between males and females in the way they perceived their technology-rich leaning environments in all the institutions.

However, in Computer Usage (M = 3.90, F = 4.12) and Task Orientation (M = 3.98, F = 4.11), females scored higher means than the males. These values indicate that the female students use the computer more towards the tasks involved in their lessons such as doing assignments, online communication with the peers, communication with the teacher through emails, surfing the net to find more information related to the course, more than the male students. Also the statistics reveal that the female students tend to be more aware about their classes, setting goals, paying attention and getting the work done on time than the male students.

For both genders Usefulness of Computers, Enjoyment, A-Equity and A-Young Adult Ethos scored a very high mean greater than 4.0. This further reveals that there is no difference between the genders with regards to the above mentioned scales, and at the same time the responses towards the scales of both genders were almost equal.

4.2.10 Summary

The findings of the quantitative phase revealed that the three instruments used in the quantitative phase are reliable in the context of this study in New Zealand tertiary computer learning environments. ACCC, the actual and the preferred versions of the TROFLEI and the AQ scales showed satisfactory internal consistency, except for Attitude to Computer Use scale in the AQ. Further post-hoc reliability tests performed on the items of this scale revealed that three items were not beneficial towards the aims of this study. Hence, they were removed from further analyses.

All individual scales of the three questionnaires showed satisfactory discriminant validity established through the mean correlation deviation values, which indicated that the three questionnaires were suitable instruments to be used in the New Zealand environment of this study.

Further, mean differences and standard deviations for the actual and preferred versions of the TROFLEI indicated that the responses to the two versions were significantly different. The mean values of the preferred columns always scored higher than the actual column for each scale, indicating that the students always preferred a more positive learning environment than their currently perceived one environment.

Institution 3 showed significant differences in Involvement, Differentiation and Academic Efficacy scales while the other institutes did not differ significantly in their scale responses. The quantitative findings revealed that level differences existed in various areas under investigation. No significant gender differences existed in response to the questionnaire scales.

The qualitative findings which are discussed in section 4.3 in this chapter are expected to provide further insight to the quantitative findings.

4.3 QUALITATIVE FINDINGS AND DISCUSSIONS

4.3.1 Introduction

"Qualitative research believes that meaning is co-constituted-reality is socially and subjectively construed rather than objectively determined" (Ticehurst & Veal, 1999 as cited in Cavana et. al., 2000, p. 135). "The goal of qualitative research is to discover patterns that emerge after close observation, careful documentation and thoughtful analysis" (Cavana et al., 2000, p. 135). Cavana also states that, qualitative research places emphasis on closely examining peoples' words, actions and records and no mathematical symbols are assigned to these. Furthermore, Ticehurst and Veal (1999, 1995) as cited in Cavana et.al. (2000) articulate that qualitative research

concentrates on collecting rich information from relatively few people which tend to identify more fluid and recursive relationships among the elements of the research.

Cohen, Manion and Morrison (2003) state that in qualitative research nothing should be accepted at face value; it must reflect evidence. Checks on the evidence and interpretations must be available and one such method supporting this is 'triangulation'. Three types of triangulation options were utilized in analysing the qualitative findings of this study; researcher-subject corroboration which involved cross checking of qualitative data between the researcher and the respondents for confirmation of accurate reporting; confirmation from other sources, which involved cross checking the qualitative responses already gathered from the participating interviewees; and utilising two or more data collection methods and comparing interpretations, which was fulfilled by using quantitative and qualitative methods.

Section 4.2 in this chapter highlighted the findings of the quantitative phase where the data were gathered from 325 students from six institutions across New Zealand. Twenty two students in total from four institutions who volunteered faced the interviews in the qualitative phase (see Table 4.21). This was 6.8% of the total number of respondents who participated in this study. Students from two other institutions did not express their willingness to participate in the interviews. The students who faced the semi-structured interviews had already filled in the questionnaires and had a fair understanding of the research aims. The interview questions were aimed at gathering further insight to the quantitative findings; sample interview questions were explained in Chapter 3. According to McNamara (1999) as cited in Baynes and Fraser (2008), "Interviews are particularly useful for getting stories behind participant's experience and for obtaining in-depth information about a topic" (p. 51).

Face-to-face interviews with the respondents from institutions 1, 2, and 5 were conducted by me and were recorded and later transcribed. Three telephone interviews from institution 4 were conducted by me with students who were unable to have face-to-face interviews. Notes were taken down during the telephone interviews. During the interviews, verifications towards specific concerns expressed by the previous interviewees were cross-checked and confirmed from the other

interviewees of the same institutions to support the triangulation theme which is used to interpret the qualitative findings.

4.3.2 Analysis pattern of qualitative findings

Analysis of interview findings took place in several stages using thematic content analysis as follows.

1. First, all recorded interview responses were transcribed and entered into a MS Word document.

2. Then, the interview responses were carefully read, common themes discovered and the interview responses were sorted under each theme.

3. The interview responses under each theme were read iteratively to establish similarities and differences between them.

4. The interview responses in each theme that correspond to and could be linked to the finalised quantitative findings in section 4.2 were then listed collectively to bring about further insight towards the research aims.

Table 4.21.
Interview Statistics

Institution No	Number of interviewees
1	6
2	6
4	3
5	7

Total = 22

Fraser and Tobin (1991) state that quantitative findings incorporated with the findings from students' interviews are valuable tools for the investigation and the interpretation of ICT-rich learning environments.

During the investigations of the interview responses, attempts were made to discover themes which pointed at various scales of the three quantitative questionnaires. Using my judgement, noteworthy interview responses were documented under different scales to which they referred. These statements were then compared and justified, with the quantitative findings of the respective scales and were recorded under each research question for further interpretations.

Finally, the interview responses together with the corresponding quantitative findings which were answering the fourth research question were recorded and discussed in this section.

Subsequently, in this section qualitative data that were incongruent or provide a different picture under the first three research questions are also examined.

Pseudonyms are used to preserve the anonymity of the participants in this section.

4.3.3 Integration of qualitative findings with quantitative findings

Student Cohesiveness

According to the quantitative findings student cohesiveness was an important variable of this study. However, the mean difference for actual and preferred versions of the TROFLEI indicated that the students experience student cohesiveness in their classes to a satisfactory level; however they would prefer it to be improved. Strengthening this finding is the noteworthy theme that emerged with four student responses towards student cohesiveness in the qualitative findings. John, Ross and Jason had positive comments about this scale indicating that they would like an increase in student cohesiveness in their classes. Jason indicated that student cohesiveness could be affected especially doing group assignments due to lack of contact with the group members.

I quite often find that I am helping people and you can see lots of people helping each other out. You tend to get groups of two or three that know each other a bit better and they tend to help each other out. I think that works quite well.
John, Level 6 (Male)

We do work in groups and there is also individual work that is given. We are allowed to interact with others so that you can learn from what others are doing. Students seem to be helping each other and it is useful.
Jason, Level 7 (Male)

Everybody is friendly in a class. Most people won't ask, they'll just try and figure it out on their own but if they're really lost, you're always free to ask someone for help and they help.
Ross, Level 6 (Male)

Group assignments are sometimes difficult because it can be harder to get together and do the assignments because of different times and timetables, holidays and things like that.
Jack, Level 6 (Male)

Involvement

For the Involvement scale, the actual score (3.15) and the preferred score (3.56) showed a mean difference of 0.41 indicating that the students would prefer more involvement in their class activities. They indicated that they liked group work where they were able to learn from each other, interaction with the tutor and more participation and discussions. A theme emerged from the qualitative responses about student and teacher involvement in their classes from six students which predicted the scale Involvement. The quantitative analysis results also revealed that Involvement had a satisfactory score.

However, in the qualitative findings one student had a different opinion. Ross indicated that group work also can sometimes hinder their progress and scoring marks, when some individuals do not contribute towards the task equally. He also

indicated that students should be given the option to work individually as well. Also, William indicated that involvement in group work could be affected due to communication problems, when students are not fluent in English. John indicated that, year difference also could hinder interacting with students in their classes. Jason expressed his preference of being in small classes for better interaction with the tutors and for better outcomes.

> *Quite a few tutors have quite an enthusiasm for the subject they teach and that comes through in their classes. Most of the tutors try to get students engaging interactively. We have small classes here and I like that. It's one of the things I like about a polytechnic as opposed to a university; that you get small groups, you get more interaction.*
> Jason, Level 7 (Male)

> *One of the things I have noticed, especially in the first year, is that the tutors have a lot of trouble getting the students to participate. I just think that especially in the first year everybody is just shy. By the second year, everybody is feeling more comfortable with each other.*
> John, Level 6 (Male)

> *What I found very helpful in the course is interaction, like open discussions, different opinions, being able to discuss between groups in class, or even with the tutor certainly is very handy.*
> Ray, Level 6 (Male)

> *They encourage group work and talking amongst your peers which I find really good. However, there are certain tasks which you could do on your own but you are forced to work in a group and rely on other people. Sometimes you don't know how well they do their work. And then your overall mark can go down, where you think you could have done better. They could at least give an option to do 'individual' or 'group'.*
> Ross, Level 6 (Male)

In group activities I don't really talk much! I've been here for two months and I'm not that fluent in English and other communication. I enjoy having group work and making friends. We have thoughts and opinions and share ideas.
William, Level 5 (Male)

What I found very helpful in the course is interaction, like open discussions, different opinions, being able to discuss between groups in class, or even with the tutor certainly is very handy, especially when you're not sure about something.
Keith, Level 5 (Male)

Teacher Support

A key aspect in student perceptions of a positive computer learning environment was the support extended by their teachers according to the quantitative findings from TROFLEI. The mean difference between the actual and the preferred scores (0.42) indicated that most students preferred to have more support from the teachers towards their learning. Three interview responses of John, Jason and Ross strengthened this quantitative finding.

Most of the tutors are really good at trying to get students engaging interactively. We have small classes here and I like that. It's one of the things I like about a polytechnic as opposed to a university; that you get small groups, you get more interaction.
John, Level 6 (Male)

The lecturer guidance is there and also they encourage individual initiative and problem solving and I like that.
Jason, Level 7 (Male)

The lecturer should choose groups. Because then otherwise the students will gravitate towards people they can relate to. So it would be like a group of younger people and a group of older people together working.

When in your group you've got a bunch of older people, then the ideas that flow are very different which makes your work quality improve.
Ross, Level 6 (Male)

However, on another note, William expressed his concerns about the need for teachers to be consistent in their approaches towards teaching.

Up to now I've done four papers. It's normal that people have different teachers in one paper and I think that students must communicate questions to teachers. I had a problem once with a lecturer and then I had a different lecturer…and…sometimes they are not consistent in their styles. They explain differently and give different exercises sometimes.
William, Level 6 (Male)

In the quantitative findings actual Teacher Support had a strong association with actual Involvement (0.50) and with Equity (0.46). Supporting these scores Kate expressed the point that her results improved with added teacher support. Ross' and Kate's comments indicated that the lecturers must be conscious of how students would benefit as a result of their individual and class support.

….Sometimes the lecturer will be talking at a higher level because they understand it already and as a student you may not know what they're talking about until another student explains it to you.
Ross, Level 6 (Male)

My grades were good, in classes where I got help from the lecturers.
Kate, Level 6 (Female)

Task Orientation

The mean for Task Orientation was quite high. Both actual (4.00) and preferred (4.46) versions of the quantitative findings showed very high mean scores. However, the mean difference (0.46) indicated that the students still preferred that there should be an improvement in the area of task orientation.

A theme came out through six interview responses to support this. John expressed the view that the students like the lessons to be more transparent, giving them a clear idea on emerging on courses like programming. Also Keith and Jason wanted more hands-on practice and activities in these courses.

> *I found that the software development tutors were not so good at presenting information. If you listen you get it, you can understand it, but it's just not made interesting. Try and come up with activities where you are creating things. I think part of the problem is that they don't go into enough practical stuff, like actual programming. I feel what they do here is teach software development and expect that the programming skills will come with it.*
> John, Level 6 (Male)

> *All of this is fairly new to me; I've only been here for the first three weeks. This is my first semester; I quite like the one lecture and one practical. It's certainly very handy.*
> Keith, Level 5 (Male)

> *…you are trying to affiliate in practical what you have learnt in theory.*
> Jason, Level 7 (Male)

Jack expressed the view that the students wanted the tasks of a course to be scheduled so that time management was not challenged. John also found time management problematic. Keith however tried to schedule his tasks to assist time management.

> *If each class has assignments and tests, the assignments should be given at the start. You get the assignments and as you go over them in class you can do them bit by bit. Rather than having to leave it to the end when you've got the tests and exams and everything at once.*
> Jack, Level 6 (Male)

> *Time management skills weren't so important in first year, but this year I've found that I need to get on with stuff fairly early. The other thing I've*

found is to leave a certain amount of time between getting work done and its due date. I have seen students who have really struggled to get stuff done at the last minute. I think it's a widespread problem. In any sort of study, there are a lot of students who just cruise and just cram at the last minute.
John, Level 6 (Male)

I work to my schedule. I have a day which I set aside and study, more like a day and a half really and the weekend as well. So I have two days which I give myself to catch up and study.
Keith, Level 5 (Male)

Investigation

There was a significant difference between actual and preferred means. The preferred (3.78) mean was higher than the actual (3.24) and showed a mean difference of 0.54 indicating that the students prefer this area to be improved. The following comment from Jason clarified it.

There is too much of a gap in the first and second years in Programing. It expects you to have a lot of prior knowledge in the second year although you have not accumulated much knowledge from the first year. It makes it difficult for me to start finding out about how to deal with programming in the second year.
Jason, Level 7 (Male)

Belinda said that it is good to do your own investigation of lessons, and expressed that teachers' explanations are equally important.

I like when the lecturers want us to research for things about the lessons on our own after the lesson is explained to our understanding.
Belinda, Level 6 (Female)

Chang expressed the notion that English language skills could be a barrier to learning.

Sometimes it is only a language problem. That was a problem for me sometimes. We have to improve our language skills.

Chang, Level 5 (Male)

Differentiation

The mean difference of the actual (3.06) and preferred (3.35) version of Differentiation was 0.29 which means that some students preferred more differentiation in their classes. This is further proven by the comment of John.

If I get something done quickly, I tend to wait for everyone to finish rather than there being some sort of extension that I can get on to. It's just something I thought of raising because of something I noticed in a questionnaire on 'differentiation'.

John, Level 6 (Male)

The response from Harry implies that students are happy when they can do things according to their preference and ability in their courses.

And when it comes to choice of things like, in my particular case, I am doing a project which enables me to select any area of my interest and I find that very useful and in that case the topic tends to initiate which area I need to study. And get help from the lecturers of course and guidance as to what is required.

Harry, Level 5 (Male)

Attitude to Computer Use

The mean score of Attitude to Computer Use had a high value (3.8) meaning that most students had a positive attitude to computer use. There were no significant negative comments presented during the interviews in this area of attitude towards computer use. John's response below reveals the same.

I do quite well with computers. They just behave well for me, I tend to understand quite well how they work so everything to do with just IT

skills I find quite easy. I do think that they are something that is quite useful, businesses are using computers more and more.
John, Level 6 (Male)

However, some students commented that they have noticed the uncertainty of the older students towards computers. Their comments indicated that the older persons who are probably new to computers found it somewhat harder to adjust to computers quickly, and therefore their attitudes could be different to the younger students who are more familiar dealing with computers.

I find with older people, they are a bit scared of using computers, while young people are a bit braver in doing what they need to do. The 'scaredness' is only because they are unfamiliar. The younger people grow up with computers; they are less scared and know more. So using the computers more gives more confidence to them and they are less scared of it.
Ross, Level 6 (Male)

I guess it's the thing with age. Younger people would be a lot more distracted by computers than an older group. But on the whole, theory would grab more attention and you'd learn more away from computers.
Belinda, Level 6 (Female)

Usefulness of Computers

I find computers useful. If you need to be using the computer in class to have it there but if there's no real use for the computer, if it's all theory mostly, then the computers are just a distraction really. And if it's like that it's probably best to have separate class times, one for theory, one for labs, like they have for most classes. It would help more because people don't get distracted by computers and all that.

Sometimes you can feel like you're sitting in class and asking 'how is this ever going to help me?' and 'is this even going to be useful in my job?' This can discourage you from learning something, if you don't know how useful it is. For example; we're learning what we're asked to do, but

specifically I don't really know if I am learning what I really need in the future. It would be really helpful if they showed you that.
Ross, Level 6 (Male)

I do most of my assignments and other work using the computers. They are really useful these days in every aspect of studying. I enjoy using them.
Belinda, Level 6 (Female)

According to the quantitative findings the actual scale of Computer Use showed a high mean score of 3.94. However, the students preferred (4.12) it to be further improved.

I do quite well with computers. They just behave well for me, I tend to understand quite well how they work so everything to do with just IT skills, I find quite easy. I do think that they are something that are quite useful, businesses are using computers more and more - quite a useful skill to have.
John, Level 6 (Male)

Usefulness of Course

In quantitative analysis, a mean score of 3.6 for Usefulness of computers indicated that most students felt that the courses they learnt were useful. However, since most students in computing tend to be kinesthetic learners, they preferred more practical work in their courses alongside theory. One such reaction came from John.

Don't do several weeks of solid theory and try to do practical afterwards. As much as possible, to put the two into the same class. Practical stuff helps you remember what you've just learnt. And a lot of people are kinesthetic learners. So, practical stuff works for kinesthetic learners.
John, Level 6 (Male)

The quantitative findings revealed that there is a very strong relationship between Academic Efficacy and Usefulness of Course (0.70). Strengthening this Belinda and a few others in their interviews expressed their views about this aspect.

> *I find most of my computer courses were useful and I am sure I will use the knowledge in my future career.*
> Belinda, Level 6 (Female)

Technology Adequacy

Although in the quantitative phase technology adequacy in these institutes was not measured it became evident through the interviews that the students were concerned about it. Lack of available resources for students led to stress among the students. It was also noted that the unavailability of software in some institutions which were needed towards students' learning created further frustrations.

> *It hasn't really been big problems with the technology here. It was quite good and reliable. But sometimes there is no classroom left for people to go and work on assignments. At the normal times all the classrooms are taken, you have to wait close to 5pm to get an open classroom and that. It's frustrating. As far as technology goes, that's the only real problem.*
> Ross, Level 6 (Male)

> *Another thing I like is the software that we can use in development in this institution. Before in my previous institute we used to just write everything! Before it was very hard to get any use of software, they wouldn't spend much money!*
> William, Level 6 (Male)

4.3.4 Qualitative Findings Contributing Towards the Teaching Framework

The student interviews were also examined in regard to Research question 4. Some of such views of students that can be deduced from their interview responses indicated that they need more hands-on practical work in their lessons after being exposed to the related theory.

Different courses have different learning styles. However, it's good to discuss a few things and then go to a hands-on activity. And if it's theory, we can have discussions of theory and applications….
May be they need to develop activities that really explain what we've done in the lecturer and the activities should be in line with the lecture.
Ross, Level 6 (Male)

Don't do several weeks of solid theory and try to do practical afterwards. And as much as possible, to put the two into the same class. Practical stuff helps you remember what you've just learnt. 1. And a lot of people are kinesthetic learners. So practical stuff works for kinesthetic learners.
John level 6 (Male)

The one thing that I like is the practical orientation related to the studies for two studies that I have been doing. They are assessed practically in the laboratory. …you are trying to affiliate in practicals what you have learnt in theory.
Belinda, Level 6 (Female)

Students preferred more exercises to help their future careers.

Doing exercises is what I really prefer instead of just theory reading and researching because we can really experience what will happen in the industry when we have graduated and finished our studies.
William, Level 6 (Male)

Theory first, Not too extensive, reinforce theory with practicals, further reinforce that with more theory. Then give full exercises to do to understand student knowledge of the lessons learnt. Practice on what is learnt is essential. General rules and guidelines must be stipulated; e.g.'what to do and what not to do."
Harry, Level 5 (Male)

There were students who indicated that the traditional methods of using pen and paper and also the white board to teach and learn IT could help as well.

I like using computers and I find them easy to use. But for some problems you cannot beat just using pen and paper. Ideally whiteboards are the best because you often want to write things out. So I think there are definitely still applications in IT for pen and paper. Some people think that we should be getting rid of that completely.
John, Level 6 (Male)

In one of my labs, there's only a group of six, so you can throw questions at the tutor and you find that he can give you a detailed answer. If you've got more in the class, and you ask five or six questions then the whole class slows down.
Keith, Level 5 (Male)

Students had concerns about having exercises where they could have fun and at the same time helping in their learning process.

If you do some fun exercises so that they can see the amazing stuff they can do if they pursue this further, they're going to be keener.
Jason, Level 7 (Male)

4.4 SUMMARY

Under the mixed methods approach followed in this study first the quantitative findings were analysed and discussed in this chapter. The validity and the reliability of the questionnaires were established before proceeding with analytical tests. The significant scales that contributed towards the research aims of this study were established from the findings of the analytical tests. Thematic content analysis was performed to analyse the qualitative data gathered through student interviews. It was observed that similar areas that were found significant during quantitative analysis came up as concerns of the interviewees during the interviews. Further, integrations of the quantitative and qualitative findings were performed in order to strengthen the findings and also aiming at possible answers to the research questions in this study.

The findings of both quantitative and qualitative analyses are used in Chapter 5, together with the learning theories and learning environment literature presented in Chapter 2 to produce answers to the research questions and also to propose a generic model for teaching computer courses in ICT rich learning environments. Also the teaching and learning models described in Chapter 2 will be used as the basis of proposing the generic model.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

This final chapter begins with an overview of the thesis. The next section of this chapter consolidates the findings which were reported in Chapter 4 and provides answers to the first three research questions. Then this chapter reports on the fourth research question which is the proposal of a framework to optimize teaching and learning in a technology-rich tertiary learning environments. Further, this final chapter covers the significance and the limitations of the study, followed by the implications of the study for future research. A final word concludes this thesis.

5.2 OVERVIEW OF THE THESIS

This study was focused on the Institutes of Technology and Polytechnics (ITPs) in New Zealand. Currently, there are 19 such institutes in New Zealand and they share the same attributes in the institutional frameworks and models of computing curriculum. The NACCQ (see Chapter 1) recently reformed as CITRENZ was a joint Industry/Polytechnic body that has developed national computing curricula for the ITPs. This body has played a major role in guiding the computing discipline in the ITP sector including conducting an annual computing education conference in New Zealand (Clear, 2000a, b).

Six out of the 19 ITPs in New Zealand participated in this study. The participants for the data collection were students in levels 5 through to 7 in the bachelor degree and the diploma programmes of the computing and/or information systems departments of these institutions.

A prime focus of the thesis was to investigate the perceptions and attitudes of students towards computers and computer courses. The other focus of the study was to investigate the student perceptions of their actual and preferred technology-rich,

outcomes-focused learning environments. The study also investigated the differences that existed among institutions, levels and genders. Through all the research findings and the literature search, the final focus of this study was arrived at, which is suggesting a framework to teach computing courses in ITPs.

Chapter 1 in this thesis sets the study in context by outlining issues in New Zealand education and the changes that have been taking place for the past 50 years. This study focused on New Zealand tertiary education and the different types of tertiary education providers that are current in New Zealand. Following this, the tertiary computer education in New Zealand was discussed followed by that of the ITPs which were the main focus of this study. The chapter then explored learning pathways offered in these institutions, explaining one such example of staircasing of computer qualifications.

The motivation for the study which emerged through my personal experience in teaching for many years in one ITP in New Zealand and my previous research were then discussed.

The aim and research questions that emerged from my preliminary observations and readings were then discussed, followed by the overview of the methodology which was used in this research. This section also briefly described the sample and introduced the three questionnaires that were used in quantitative data gathering. This was followed by an introduction of the significance and the limitations of this research. Finally, Chapter 1 concluded with a brief overview of the thesis.

Chapter 2 examined the existing literature in the areas of learning theories, learning environments and teaching and learning models particularly as they relate to technology-rich learning environments. Following the introduction in section 2.1, section 2.2 of this chapter reviewed literature relevant to learning theories which included traditional and progressive learning, behaviourist theory, cognitivist theory and constructivist theory. The applications of constructivism on science and technology learning, and issues in constructivist learning were then investigated. Finally, social theory of learning was explored in this section.

Section 2.3 of this chapter investigated learning environment concepts, culturally diverse learning environments and technology-based learning environments. Also,

the technology-based classrooms in ITPs in New Zealand which participated in this study were further investigated. This section then reviewed literature about online learning environments followed by assessing learning environments.

Section 2.4 of this chapter investigated various teaching and learning models focusing on firstly, the traditional teaching models, followed by student concepts of models, Bigg's learning model and finally technology-based teaching models. Section 2.5 summarised Chapter 2.

Chapter 3 started with the introduction in section 3.1, followed by types of possible research methods towards this study and the supporting literature in section 3.2. In this section, disciplined inquiry of education research was investigated followed by quantitative, qualitative and mixed methods research. Section 3.3 discussed the mixed methods approach used in this study. The type of mixed methods approach; quantitative phase followed by the qualitative phase, and the rationale for using this method was then justified.

Section 3.4 described the quantitative phase and first investigated questionnaire design in educational research. Then, the use of actual and preferred questionnaires was discussed. This was followed by describing the three quantitative instruments that were used in the quantitative data gathering in this study and the rationale for using them in section 3.5. The instruments described were; Attitude towards Computers and Computer Courses (ACCC), Technology-rich Outcomes Focused Learning Environment Inventory (TROFLEI) and Attitudes Questionnaire (AQ). Students' actual and the preferred learning environments that were measured by TROFLEI were then explained. Testing the validity and reliability of these previously designed and validated instruments in the New Zealand environment under this study was further discussed in this chapter.

Section 3.6 described the qualitative method used in this study. This included the description of the volunteering participants, the interview strategy and how the interviews were conducted.

In section 3.7 of Chapter 3, literature about sampling methods was first discussed. The quantitative sample and the qualitative sample from the six institutions that

participated in this study were discussed. Further, the validity and reliability of the samples were discussed.

Section 3.8 outlined the quantitative and qualitative data collection methods that were utilised in this study. The data entry method of the ACCC, TROFLEI and AQ into SPSS statistical software in the quantitative phase was explained in this section. In the qualitative phase, the interview strategy used for the data collection and how the qualitative data were handled were then described. This section also explained about the data storage of this research data.

Quantitative and qualitative data analysis were discussed in section 3.10 followed by section 3.11 where the limitations, issues and the validity of the research method was discussed. Finally, issues in generalising research findings were explored in this section. Section 3.12 described the ethical considerations, informed consent and possible risks to the participants.

Chapter 4 involved results and discussions. This chapter introduced and discussed the quantitative data entry into SPSS statistical software and the various analytical tests performed on the data. First, the validity and the reliability of the three questionnaires in the context of this study in New Zealand that were established were discussed. Then, the student responses to the actual and the preferred versions of the TROFLEI were established and compared. This was followed by explanations of investigations to identify the significant questionnaires scales which contributed towards the research study. Correlations between questionnaire scales were then examined and significant correlations between scales established. This was followed by examinations of differences, between institutions, levels and gender.

Section 4.3 described how the qualitative data were recorded, transcribed and later interpreted using thematic content analysis. Then, the integration of the findings of the quantitative data with the established qualitative themes was discussed, aiming at discovering the answers to the first three research questions. The qualitative data that possibly contributed towards the fourth research question together with the corresponding findings from the quantitative phase were then investigated.

Chapter 5, which is the final chapter, focused on the conclusions of the thesis which first provided an overview of the thesis followed by a summary of the findings from

the mixed methods approach to answer the first three research questions. The fourth research question which was the proposition of a generic teaching model was explained with the use of the quantitative, qualitative findings and the literature review from Chapter Two. Finally, the thesis is concluded after explaining the significance and the limitations of the study and the implications of the study towards future research. A final word concluded the thesis.

5.3 FINDINGS AND ANSWERS TO RESEARCH QUESTIONS

5.3.1 Introduction

The fundamental outcomes of this research study are to answer the first three research questions and propose a suitable framework to optimize teaching and learning in technology-rich learning environments in institutes of technology and polytechnics in New Zealand.

The combination of the quantitative and qualitative findings provided a good information base to fulfil the aims of this study. The findings of the quantitative and the qualitative phases reveal that each of the first three research questions cannot be treated in isolation as it was apparent that student perceptions of technology-rich outcomes focused learning environments and the attitudes towards computers and computer courses learnt in the context of this study were significantly correlated in various ways and the findings that were used to answer the research questions were impacted upon by each other (see Chapter 4). The findings rather illustrated the interwoven associations that exist between them. This also reflects the findings of the research conducted in this area (Newby & Fisher, 2006).

The answers to the first three research questions revealed the areas that needed to be focused on, in order to optimize teaching and learning in technology-rich learning environments and find a possible solution to the fourth research question.

5.3.2 Answering the First Three Research Questions

Investigations into the integrated quantitative and qualitative findings, as explained in Chapter 4, brought about the following responses with respect to the research questions.

Research Question 1

How do students studying computer courses in technical institutes and polytechnics in New Zealand perceive their computer learning environments?

From the findings it was revealed that students preferred to conduct their own individual investigations to find out answers to questions which arose in their lessons and to solve problems. This influenced the task orientation of the students and they wished to express their individual opinions and get more involved in discussions during the lessons.

Most students found engaging in team work helpful and favoured group projects. However, some students preferred to work on their own. Students found that more involvement and collaboration with peers and teachers and sharing knowledge are important factors to achieve their goals in computer courses. This resulted in more student cohesiveness and also helped students to be more task oriented.

Students felt their teachers showed a personal interest in them and helped them individually which contributed towards building up their confidence when they felt innocuous. They also felt that they were treated equally in their classes.

The use of technology to learn computer courses enhanced students' involvement in many ways. Students felt that technology helped them to perform their tasks using computers. This also facilitated cooperation with the teacher and the other students, through technology-based communication methods. Also, the use of computers and technology facilitated students to be more organised, plan and prepare their work to accomplish their goals in learning. Students also indicated that having access to adequate software and hardware and knowing how to handle it facilitated their learning to high degree.

On another note, some students felt that personal involvement during the class suffered to a certain extent when computers were utilised as the media to communicate with the students and the teacher, to access material and to submit assignments, as opposed to interacting with each other on a face-to-face basis.

Research Question 2

What are the students' attitudes towards computers and computer courses?

Students strongly felt that what they learnt in the computer courses was very useful and will be used in their future computing careers. Students enjoyed learning when there was less anxiety. When students were less anxious, they recognised more of the usefulness of computers, were confident in handling computers and new software to tackle unfamiliar problems.

Students favoured more student cohesiveness and collaboration among peers, sharing their work and resources with peers, engaging in team work and jointly carrying out projects.

Students were keen to investigate topics related to their lessons and solve problems that arose in their lessons on their own. Alternatively, they often wished to discuss their findings with peers and the lecturer and preferred more interaction with the lecturer. Students felt that when there is cooperation and collaboration with the students and the lecturer, they were able to accomplish satisfactory learning outcomes and also to be more oriented towards their tasks. Thus, students were keen to take the initiative to investigate and solve problems through class discussions.

However, students sometimes felt that involvement and interaction with peers and the teacher alone was not sufficient to achieve good grades. They felt that students' ability, intelligence and hard work were some of the other contributing factors towards their achievement.

Some students preferred working on their own. Such students did not find participation in class discussions, group work or interaction with the teacher was essential for their progress.

Most students felt that they received the same encouragement from the teacher as the other students did, and felt that they were treated equally. When students felt that they were treated as young adults, allowing them to be independent learners, attitudes towards their tasks improved.

Students felt that their personal involvement was reduced when computers were utilised as the communication medium to communicate with peers and teachers and to access material and to submit assignments.

Research Question 3

What are the students' perceptions of the actual practices that take place in their classes and what are their preferences of how often they wish that these practices should take place?

The answer to research question three was established using the responses to the actual and preferred versions in TROFLEI. The findings of the TROFLEI revealed that the students preferred to have more of each of the scales of the TROFLEI.

In particular, the scales of Student Cohesiveness, Teacher Support, Involvement, Task Orientation and Investigation showed a high variability in student responses between the actual and preferred versions, indicating that the students strongly wished their preferred learning environments to be more positive in the areas represented by these scales.

It was also found that the students were somewhat satisfied with the actual perceived versions of Equity, Computer Usage and Young Adult Ethos and only needed slight improvement in these areas according to their preferences.

5.3.3 Proposition of a Framework to Optimize Teaching and Learning:

This section addresses the research question four.

***Research question 4**:*

What is the preferred teaching model that can be recommended regarding the improvement of the teaching of computer courses in tertiary institutions?

Technology-learning in technology-rich learning environments IS impacted by the forever advancing technology in the world. Most ITPs and polytechnics in New Zealand tend to keep up with the latest technology in teaching of computer courses. However, no significant research conducted in New Zealand has been found to support the fourth research question directly. In this view, I attempt to suggest a framework to optimize teaching and learning technology courses in technology-rich learning environments which is based on the literature search and the findings of this study. Knowledge gathered from the answers to the first three research questions will be integrated with the findings of institutional differences, level differences, gender differences and the relevant literature from Chapter 2 to answer the fourth research question.

Directions built from the learning theories expressed in Chapter 2

No explicit learning theory has explained the complex learning processes that occur in students in learning technology. Duit and Treagust (1998) stated that there is a gap in the inclusive view of the learning theories independently presented by various researchers (p. 22). Supporting this, Chandra and Fisher (2006, p. 461) also state that much of the research has focused on characterising the learning environments and fewer investigations have attempted to refine the learning environments.

Learning technology in today's rapidly advancing technology-rich learning environments has imposed a swing from the behavioural approach towards the constructivist approach and integrated with the cognitive approach as well. These methods enable students to build powerful knowledge and facilitate them to be life-long learners. However, the literature search revealed that the behaviourist approach also was favoured to a certain extent in the students' technology learning process. This was revealed from the theory of Habermas' Three Worlds of Humans (see section 2.2.3) representing behaviourism which emphasises that the students preferred to learn from their environment and through their classroom communities.

According to the constructivist theory (p. 29), technology-based constructivist teaching, constructivist assessment methods, teaching and learning computer tools, using them in learning computer courses, and paradigm shifts of teachers are areas that impact on the fourth research question. This is further strengthened by the cognitivist theory (p. 27) which addresses Piaget's idea of intellectual development

or brain-based learning which occurs over the life span of an individual which aims at preparing students as lifelong learners. The Social Theory (p. 35) which expresses that learning occurs within a social context, where people learn from one another was also incorporated in deriving the framework. The classroom can be considered as a social system where group behaviour of students takes place when they interact with their peers, the teacher, and the physical classroom environment (p. 48). This involves the availability of adequate technology and how this is used in student learning.

The literature has reported that there is a gap in research on psychosocial environments at the higher education level despite the fact that the learning environments play a major role in students' performances (p. 40). Moos' three dimensional framework which include relationship dimensions, personal development dimensions and system maintenance and system change dimensions explains diverse psychosocial environments which could exist within these three dimensions (p. 63). Habermas' three worlds of humans (see Figure 2.2), the four holons of human behaviour (see Figure 2.1) are also incorporated in seeking an answer to the fourth research question.

Literature has revealed that the cognitive and affective learning outcomes of students were impacted by their social and psychological factors. Social-cognitive theory (page 61) states that motivation influences both learning and performance, which involves how people acquire knowledge, beliefs and strategies through interaction and observation of others (Shunk, 1995 as cited in Hartnett, 2010).

The findings of Land, Hannafin, and Michael (1996) of the concepts of the five foundations of learning environments; psychological, pedagogical, technological, cultural and pragmatic (p. 41) and the four elements of learning environments; enabling context, resources, tools and scaffolds (p. 41, 42) were also amalgamated into the proposed teaching and learning framework. The literature revealed that students' perceptions of their learning environments impacted on academic achievement and as a consequence the variance in their learning outcomes. The literature also revealed that students' preferred learning styles depended on culture, cognition, gender and teacher-student communication patterns (p. 41). In addition,

the technology teaching framework also takes into consideration the three types of communications which take place in online learning (p. 61).

Directions built from the learning models expressed in Chapter 2

The student learning model (p. 68) indicates that teachers using appropriate pedagogy strategies take responsibility to communicate the subject matter to the learner in such a way that the learner's understanding of the subject matter are strengthened. The learner also uses the classroom experience to make a mental model of the lesson. Here, the knowledge conveyed by the teacher through the delivery of subject matter and the interaction with the teacher impact substantially on the learner's knowledge construction. Also, this system of learning is comprised of individual, classroom, institutional and community systems and affect students' learning outcomes.

Bigg's 3P Model of Students' Meaningful Learning (p. 70) involves creating a deep structure, which depends on prior knowledge and can be reproduced in different forms later.

With respect to technology teaching and learning models, there is a gap that exists in research about the teachers' challenges in adapting to new technology. Also, most technology-teaching and learning processes have not changed according to the delivery needs of the advancing technology (p. 46). This has to be incorporated in the proposed learning model which addresses teachers delivering the lessons as well as students absorbing constructive learning.

Directions built through the quantitative and qualitative findings of this study

The findings of the study revealed that learning computer courses in ICT-rich learning environments was impacted by personal factors, course related factors, computer-related factors, student-teacher interaction related factors, gender-related factors and institute-related factors.

Students are considered the best judges of their needs and preferences towards their learning. Students wanted to have more hands-on experience to make their learning useful towards their future careers and prefer to have theory and practical integrated in their lessons. Students prefer learning strategies which include more interaction

with peers and involvement in collaborative group work. Students prefer adequate interaction with lecturers and expect teacher support. Students' preferred learning environments were taken into consideration in building the teaching framework.

The level differences in institutions revealed that, students at higher levels showed more familiarity and confidence using computers than did the students in lower levels. Students sought knowledge gathered through lower levels of study to be linked to the corresponding higher levels.

There were hardly any gender issues in their perceptions and attitudes towards their computer learning environments and computer courses. However the findings revealed that the males and female responses did not show much difference in most scales.

With regard to institutional differences, New Zealand's technical institutes and polytechnics who participated in this study, significant differences were revealed in Usefulness of Computers, Enjoyment, Attitude to Subject and Attitude to Computers scales. It was also revealed that some institution could have low ratings in Involvement, Differentiation and Academic Efficacy.

Furthermore, the students in some institutions recognized that they had to work harder than usual for better achievements. Students in lower levels of study showed more cohesiveness and were more involved with other students and the teacher. This was considerably low in level 7 students. Task orientation was high in level 5 students and was not very noticeable in levels 6 and 7 students. Also, students in higher levels were more involved in investigations than were the level 5 students.

The ICT teaching and learning framework

From the literature review and the findings of answers to the first three research questions, which emerged from the quantitative and qualitative findings of this study, the following framework for teaching and learning ICT in technology-rich tertiary learning environments can be deduced.

Figure 5.1. Student learning process in ICT.

Figure 5.1 presents the suggested main framework for student learning in ICT courses in technology-rich learning environments. The framework originally requires the teachers to set goals and deliver the functioning knowledge of the lessons to students. Subsequently, the students then build up their own knowledge which contributes towards learning new concepts in ICT. This process expects the students to use their prior knowledge as a foundation to further enhance their knowledge about a topic. The learning process of students then takes place where constructed knowledge is generated. This involves class activities, investigations, practical work, interactions with peers and teachers. This process should be facilitated by the teacher and should promote group learning as well as individual learning, which involves investigations that are oriented towards the students' tasks. Also, activities that

motivate students, reduce their anxiety in handling new programmes and enhance their enjoyment in learning should be incorporated in the teaching framework.

Teacher-student interactions, peer interactions which are directed towards student-centred learning, have to be aimed at in this type of teaching and learning framework to achieve expected learning outcomes.

Figure 5.2 presents one part of the suggested framework for teaching in ICT courses in technology-rich learning environments. With reference to the literature review and the findings, the framework primarily involves a paradigm shift of the teacher, in order to adapt to ever-advancing technology to deliver ICT courses in technology-rich learning environments. It is suggested that the teachers be subjected to professional development in technology training from time to time as required, in order to update their knowledge to deliver computer courses appropriately, to deliver the lessons and produce activities that are in line with new technology. This will help address the teachers' challenge to face ever-advancing technology.

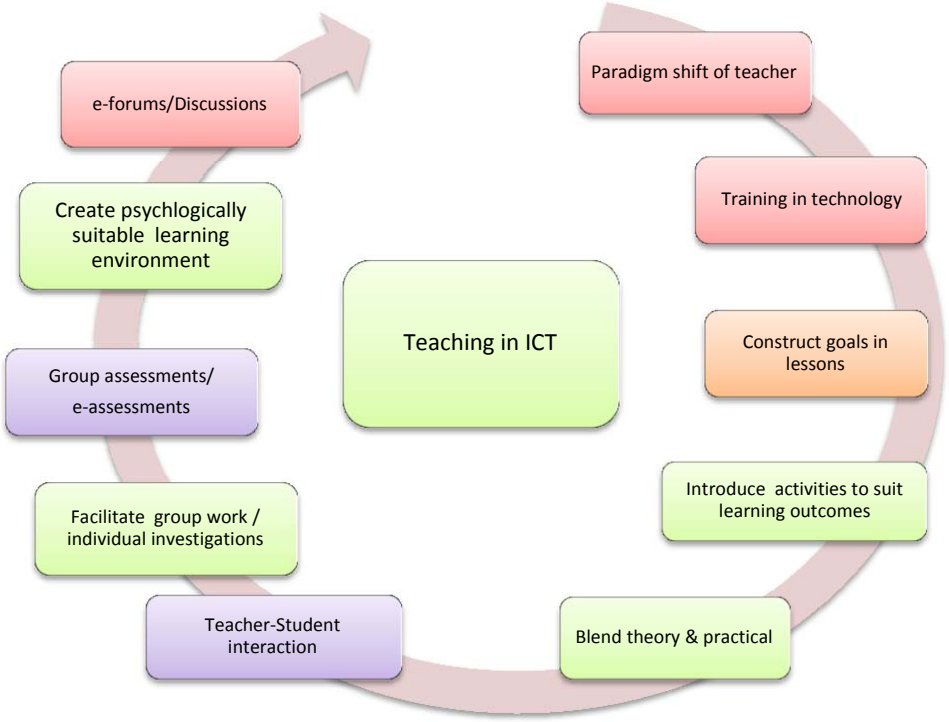


Figure 5.2. Teaching in ICT.

With reference to Figure 5.2, the course delivery begins with a teacher-centred approach, where educators construct achievable goals and introduce activities to suit the learning outcomes of the lessons. The educators must blend theory and practical in their delivery along with adequate teacher-student interaction. They must facilitate group work and also individual investigations. Group assessments, e-assessments could be introduced; e-forums and discussions could be conducted to help students acquire additional knowledge. Efforts must be exerted in creating psychologically suitable learning environments to students.

Thus, student learning can be summarised as; introducing the introductory knowledge of a lesson first which is teacher-centred, in order the students to achieve surface learning. The next step would be student-centred learning where deep learning is acquired by the student. This involves students' individual investigations, adequate communication between teacher and student, and also communication and interactions with peer students. The teacher facilitates student learning throughout this process. The students are guided towards peer interaction and group work, thus promoting learning from each other sharing knowledge towards their goals. Furthermore, the teacher also should encourage individual investigations. These contribute towards deep learning where pedagogical and content knowledge are accumulated by a student in technology-rich learning environments.

Students should be motivated towards their learning and also need to enjoy their learning according to the findings of this study. The learning in ICT must involve online learning where the web plays an important role in students' motivation and enjoyment in today's student community. The teacher facilitates the students to carry out necessary investigations with the use of current technological tools and the World Wide Web further expanding their knowledge towards the learning outcomes. The teacher takes responsibility to motivate students and promote a relevant psychosocial environment for their learning. One such method to facilitate this would be to have interactions between the students and teacher and also between students. Another would be to create online forums and discussions in which students participate and share ideas.

Theory and practical should be assigned collectively in the teaching plans and the students are appropriately guided towards these tasks by the teacher. What is learned

in theory must be applied in the practical lesson thus enabling students to strengthen their knowledge.

Assessment should be channelled to be in line with the technology learned, possibly using online assessments where appropriate. Also, individual assessments could be replaced by group projects and simulations where appropriate, where students can display their understanding of the learning outcomes practically. Where appropriate, re-submissions of the assessments according to the teacher's judgement could be made available to students. The idea behind which is to ensure that students master their learning however. This method facilitates the slow learners thus avoiding them being disadvantaged.

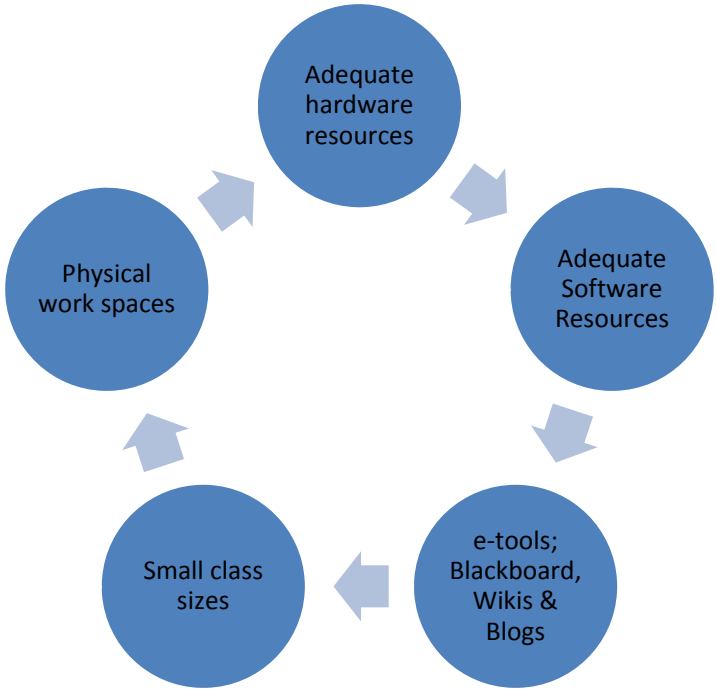


Figure 5.3. Resource adequacy for teaching and learning in ICT.

Making adequate resources available must be incorporated into the suggested framework. Delivering ICT courses need software and hardware resources that are compulsory. The institutions must make sure that such facilities are readily available to students. Facilities should be provided after class hours, including remote access of learning materials. The required e-communication facilities to handle wikis, blogs and blackboard programmes must be made available to student promoting e-

discussions, e-forums. These involve the teacher and the students exchanging ideas with regards to lessons and assessments.

Assessment in computer courses should be of a nature that allows students to display their achievements in learning accumulated through behaviourist, constructivist methods and also through social interactions in the class.

Tools such as Wikis, Blogs and Blackboard facilities should be available to students as part of their online learning and to conduct forums. Assessment tasks should be remotely accessible and electronic submissions be allowed where possible. Students should have access to their marks online.

Physical workspace also plays an important part and ergonomically suited tables and desks should be provided to students in classrooms. According to the findings students mostly prefer small groups in their learning environments and wherever possible this facility should be promoted for better achievements. The classrooms must not be crowded and the physical work spaces must be adequate. The number of available computers for the students to work after class hours should be adequate.

5.4 CONCLUSIONS OF THE STUDY

Conclusions of this study present the significance and the limitations of the study, implications for future research, followed by a final word which ends the thesis.

5.4.1 Significance of the Study

There are copious amounts of research in technology-rich learning environments world-wide. However, there is little research on New Zealand learning environments found in the context of this study. This study reports the findings of student perceptions of their technology-rich learning environments and their and attitudes towards computers and computer courses learnt in such environments in Institutes of Technology and Polytechnics in New Zealand.

This research has the potential to be significant for many reasons. First, the findings of the study are likely to provide information about students' perceptions of

technology-rich learning environments and student attitudes towards their computers and computer courses in New Zealand's ITPs and the polytechnics.

This study gave the opportunity for students to view their opinions anonymously to indicate the preferred learning environments they expect to have in their computer learning classrooms, which otherwise students would not have expressed. Thus, the study seeks information about classroom environments actually perceived by students and about their preferred learning environments. This study also provides information about how gender and level differences affected the research outcomes.

Furthermore, this study is likely to provide information on improving the teaching and learning processes in the technology-rich class rooms by suggesting a suitable framework. This research can be helpful to other tertiary computer educators by adopting teaching strategies according to the proposed teaching model. Consequently, the findings of this study encourage educators to take appropriate action to improve their teaching and learning environments and the delivery and assessment methods used in their courses. The suggested framework could be used by other countries in similar learning environments to promote similar changes.

The findings may be of practical interest to administrators and educators of Australian and New Zealand technical institutes and polytechnics to address the challenges in technology-rich, multi-ethnic classrooms where students from widely differing cultural backgrounds are present and where collaboration among these students is of importance towards their learning processes.

The results and the discussions of this research have the potential to widen the knowledge-base for professional practice overall. Future researchers are expected to benefit from this study and should be able to perform further research based on the findings of this study.

5.4.2 Limitations of the Study

The present study examined the perceptions and attitudes of students learning computer courses in institutes of technology and polytechnics in technology-rich,

outcomes focused learning environments in New Zealand. There are some limitations to the study and these are acknowledged.

First, the sample for the study was considered limited as it was drawn from six institutions out of the 19 ITPs in New Zealand. The sample was expected to be a representation of all the institutions concerned and can be considered relatively small when compared to the total student population of the computer departments of the ITP and polytechnic sector in New Zealand. The student sample size for the quantitative data collection was 325 students and qualitative data were collected from 22 participants in the interviews. Although the sample was considered adequate from a statistical point of view, it may not have fully represented the ITP and the polytechnic sector in New Zealand.

Second, the consistency of the sample from the institutes that participated in this research study may not have been homogeneous. It could have had an imbalance in terms of the homogeneity of the sample in terms of the total student numbers and types of students who participated from each of the institutes.

Third, the sample did not consist of evenly distributed populations according to gender. The number of females who studied the computer courses was considerably lower than the number of males, in all the participating institutes. This nature of inconsistency in genders could have created an imbalance of the findings.

Fourth, the sample in this study showed a dissimilar nature in the cultural diversity in the participating institutes. Depending on the geographic locations, the cultural balance of the participants varied. This could have had an influence on their perceptions of the learning environments and their attitudes towards the courses (see Chapter 2).

Fifth, the ambiguity of certain items in the questionnaires, limitations to accurate responses to those questions could have taken place. The wording of some items in the questionnaires gave the impression that the students are being tested for the course they were studying at the time the questionnaires were handed out. However, it was explained that their overall impressions of the computer courses mattered in giving their responses. Some participants failed to respond to certain items in the

questionnaires, which would have affected the results in some ways, although negligibly.

There would have been a risk about the generalizability of the interpretation of the findings in this study caused by the limitations as indicated. However, the responses in the quantitative and the qualitative methods used in this study would have complemented each other. The quantitative findings were expected to be supplemented by the themes discovered in the qualitative findings, thus giving a fuller and more detailed picture of the findings, enhancing the statistical findings overall, thus giving a more comprehensive understanding to the findings of this study.

Finally, possible human errors in data entry into SPSS software would have affected the accuracy of the analysis. However, the data entries were checked randomly and no significant errors were detected.

5.4.3 Implications and Directions for Future Research

New directions and comparative studies using the mixed methods approach using the same questionnaires used in this study would be worth pursuing in other countries in the areas of ICT education in the future.

First, the findings of this study can be used as an important source of comparative data for similar education research in other countries. It would be valuable to investigate the factors addressed in this study with similar groups of students in similar learning environments in other countries.

Second, research could be conducted in the future using the instruments used in this study, to see if the findings have changed over time and why this might have happened. This would provide longitudinal data of the perceptions and attitudes of students studying computer courses in ICT-rich learning environments. This will further help in understanding student perceptions in these learning environments and the findings could help improve student outcomes further.

Third, the sample size in this study was not too large compared to the total student population in all the institutes concerned, in New Zealand. The accuracy of the

comparisons made in different areas would have been thus affected. It is proposed that studies could be conducted, with larger samples.

Fourth, through the understanding I gathered conducting this research study, I would suggest that future researchers conducting research in technology-rich learning environments in tertiary institutes should consider adjusting the TROFLEI questionnaire scales and items to suit the particular research environments and the sample. The scales under question were; Young Adult Ethos which was questioned by mature older students who were not certain of responding to the items accurately and Computer Usage where the students would have obviously responded positively, being students learning computer courses. Also, the negative items in the questionnaires must be converted into positives, before administering the questionnaires to respondents in order to avoid confusion about the items and to bring about suitable responses.

Fifth, cultural elements should be considered and suitable questionnaires be used when conducting research in highly multi-cultural learning environments.

Sixth, it would be advantageous if the perceptions of academic staff of these learning environments were investigated with regards to teaching and learning. As cited in Goh (2005) academics' perceptions differ from students' perceptions (Ramsden, 1984). Also Trigwell, Prosser, and Waterhouse (1999) as cited in Goh (2005) state that academics' approach to teaching and students' approach to learning could be very different. Academics could be more teacher-centred while students have adapted to a surface learning approach.

5.4.4 A Final Word

The present study which involved New Zealand students from institutes of technology and polytechnics undertaking computer programmes began from my MSc study, and my interest in this particular area in students' learning, which is woven around my present career. This study progressed with examinations of the students' perceptions of computer learning environments in these institutions and attitudes of students towards computers and the computer courses learnt in their technology-rich learning environments. The study continued with investigating into student learning

approaches and their learning outcomes. Furthermore, the findings from the investigations have provided a clearer picture of student perceptions of their learning in their present learning environments and their preferred learning environments. This study also revealed that students' learning environments played an important role towards their learning approaches. The study was extended to examining various aspects that existed in these learning environments in terms of gender differences, institute differences as well as level differences.

This study has recommended that, in order to have positive ICT-rich learning environments that can produce worthy learning outcomes, the teachers in these ICT-rich earning environments should develop their own teaching and learning environments in their classrooms so that there will be favourable outcomes in their classrooms, in the learning aspects of ICT curricula. "To create a learning environment, it is perhaps less important to focus on developing extensive materials, and more important to provide your students with appropriate tools and resources to conduct their own inquiries"
(http://www.edtech.vt.edu/edtech/id/models/environs.html accessed 12-06-2012). To be successful in this paradigm shift, an important aspect that must be deliberated on is to exert conscious efforts to develop sound teacher-student relationships which aim at creating a relational understanding between the teacher and the student. To some students, adapting to a different environment which is ICT-rich and outcomes focused could be challenging and needs motivation. For some others, these learning environments could be a threat and they could face difficulties in adapting. It is noteworthy for educators to be alert to the differences of the individual students, play an important role towards motivating and guiding students, and be aware of their contribution towards teaching and learning in order to foster better learning outcomes.

The findings of this research could be of help for such pedagogical shifts. I suggest that it is necessary to find ways to enhance the ICT educators' knowledge which could be challenging but worth attempting for the benefit of students' learning. I hope that the findings of this study have supported the previous research in this capacity and will stimulate future development and channel further improvements to teaching and learning in ICT rich learning environments.

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Every reasonable effort has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

APPENDICES

Appendix A:

LETTER OF REQUEST TO HEADS OF DEPARTMENT

Kamani Gunawardena
Senior Lecturer
Faculty of Business, Computing and IT
Manukau Institute of Technology
Private Bag 94006, Manukau 2241
Auckland
Ph 968 8000 Fax 968 8701
Email: kgunawar@manukau.ac.nz
Date:.....
<First name> <<Last name>
<Job title>
<Institute>
<Address>

Dear <FirstName>,

Request for consent to approach students doing computer courses to participate in a research project

My name is Kamani Gunawardena and I am engaged in a Doctoral study through Curtin University, Perth, Australia. The project investigates students' (in their fifth, sixth and seventh year studying computer courses in the degree and diploma programmes) perceptions of their learning environments and their attitudes towards computers and computer courses and the influence of these on their learning.

I currently work as a senior lecturer in Computing and Information Technology in Manukau Institute of Technology. I would be grateful if you would consent to the students being approached to take part in this study. Please let me know the documents I must produce to apply for the ethical approval from your institute.

Thank you for considering my request and if you have any questions about my research I would like to explain those. You can contact me on the details given above.

Yours sincerely

Sgd; Kamani Gunawardena

Appendix B:

LETTER TO INSTITUTES FOR ETHICS APPROVAL

Kamani Gunawardena
Senior Lecturer
Faculty of Business, Computing and IT
Manukau Institute of Technology
Private Bag 94006, Manukau 2241
Auckland
Ph 968 8000 Fax 968 8701
Email: kgunawar@manukau.ac.nz
Date: .....

Attn; Ethics Committee, <Address of the institute>

Ethics approval for PhD research project

I am a PhD student at the Curtin University of Technology, Perth, Australia undertaking a study titled, *"Developing a framework to optimize teaching and learning in computing education: A Study in Technical Institutes and Polytechnics in New Zealand."*

This project has received ethical approval from Curtin University of Technology and is supervised by Professor Darrell Fisher. A copy of the ethics approval (Approval No: SMEC-14-09) from Curtin University of Technology is attached.

I wish to conduct the research between January 2010 and December 2010. I am seeking the ethics approval from MIT, which is named as one of the institutes under my study, to conduct my research. The research will be conducted with volunteering students in the department of Computing & IT.

The research involves administering two anonymous questionnaires to students. The questionnaires had been designed, validated and used by Curtin University of Technology. The questionnaires will be administered by a third party, outside normal teaching time. Prior to administering the questionnaires, a participant information sheet and consent form will be handed to the students and will be explained. The students are assured of no risks by participating in this study. Students will be informed that their participation is entirely voluntary and their confidentiality is maintained.

Interviews will be conducted by me with volunteering students individually, at a convenient date and time arranged. The interviews are intended in gathering more information addressed in the areas covered by the two questionnaires. The duration of an interview will be a maximum of 20 minutes, is of open ended nature. Confidentiality of the participating student will be maintained.

Thank you

Yours sincerely,

Kamani Gunawardena

Attachments:

1. Ethics Approval from Curtin University of Technology, Perth
2. Participant Information sheet
3. Consent form
4. ACCC Questionnaire
5. TROFLEI Questionnaire
6. Attitudes questionnaire
7. Interview structure

Appendix C:

PARTICIPANT INFORMATION SHEET

Curtin University of Technology, Western Australia
School of Science and Mathematics Education
Participant Information Sheet

My name is Kamani Gunawardena. I am a senior lecturer at the School of Computing & IT at the Manukau Institute of Technology, Auckland. I am currently completing this research for my Doctor of Philosophy- Science & Mathematics Education, at Curtin University of Technology, Perth, Western Australia, titled "Developing a framework to optimize teaching and learning in computing education: A study in Technical Institutes & Polytechnics in New Zealand".

Purpose of research

This study is done with several technical institutes and polytechnics in New Zealand. My aim is to investigate students' perceptions and attitudes towards learning computer courses and the perceptions of the learning environments. The outcome of the study aims to bring about suggestions to improve the ways in which the computer courses are delivered in these institutes and the students will be benefit from it.

Your role

You will have to fill in two questionnaires. Completing them will take about 25 minutes of your time. The questionnaires are;

Attitude towards Computers and Computer Courses (ACCC) consisting of 28 items and, Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) consisting of 80 items which has 'Actual' and a 'Preferred' column.

I also will be conducting interviews with volunteering students in order to expand and obtain further clarifications on selected questions from the questionnaires at a later date. Interviews will take less than 20 minutes of your time.

Consent to participate

You will be provided with a consent form to sign. Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your data in research.

Confidentiality

Your confidentiality will be maintained and you are assured of no risks by participating in this study. The information you provide will be kept separate from your personal details, and only I will have access to this.

The interview transcript will not have your name or any other identifying information on it and in adherence to the university policy, the interview tapes and transcribed information will be kept in a locked cabinet for five years, before it is destroyed.

Further Information

This research has been reviewed and given approval by Curtin University of Technology Human Research ethics Committee (Approval Number SMEC 14-09). If you would like further information about the study, please feel free to contact me on 0064- 09 968 8000 ext 7457 or by email: kgunawar@manukau.ac.nz. Alternatively you may contact my supervisor Prof. Darrell Fisher on 0061-8-9266 3110 or by email: D.Fisher@curtin.edu.au .

The contact details of the Human Research Ethics Committee (Secretary) are; Telephone 0061-8-9266 2684 or hrec@curtin.edu.au or in writing C/office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, Western Australia 6845), should you wish to make a complaint on ethical grounds.

Thank you very much for your participation in this research; your participation is greatly appreciated.

Personal Details:

Name: Kamani Gunawardena

Qualifications:

MSc (Science Education), Grad Dip Business (Information Systems), PG Dip Computer Technology, Advanced Certificate of Adult Teaching

Currently studying for Phd

Position: Senior Lecturer

School of Computing & IT

Faculty of Business

Manukau Institute of Technology

Auckland, New Zealand

Contact: kgunawar@manukau.ac.nz

+64 9 968 8000 ext 7457

Appendix D:

STUDENT CONSENT FORM

School of Science and Mathematics Education

Curtin University of Technology

Perth, Western Australia

Title of Project:

DEVELOPING A FRAMEWORK TO OPTIMIZE TEACHING AND LEARNING IN COMPUTING EDUCATION: A STUDY IN TECHNICAL INSTITUTES AND POLYTECHNICS IN NEWZEALAND

Statement of Confirmation:

- I understand the purpose and procedures of study.
- I have been provided with the participant information sheet.
- I understand the procedure itself may not benefit me.
- I understand that my involvement is voluntary and I can withdraw anytime without a problem.
- I understand that no personal identifying information like my name and address will be used and that all information will be securely stored for five years before being destroyed.
- I have been given the opportunity to ask questions.
- I agree to participate in the study outlined to me.

Participant Name:……..……..

Participant signature: .....

Date: .....

Witness Name:……..…..……...…

Witness signature: .....

Date: .....

Appendix E:

ATTITUDE TOWARDS COMPUTERS AND COMPUTER COURSES QUESTIONNAIRE

The completion of this questionnaire implies your informed consent to participate. Your responses will be confidential and you will not be identified in this study.

Instructions

This questionnaire contains 28 statements. Answer all questions. Neatly circle the response that best fits with your opinion.

Circle one

Gender: Male/Female

Your level of study: 5 / 6 / 7

		Almost Never	*Seldom*	*Sometimes*	*Often*	*Almost Always*
1	I think I will use what I learned in this class in the future.	1	2	3	4	5
2	I feel comfortable when a conversation turns to computers.	1	2	3	4	5
3	Studying about computers is a waste of time.	1	2	3	4	5
4	It is fun to find out how computer systems work.	1	2	3	4	5
5	This class provided me with skills I expect to use in the future.	1	2	3	4	5
6	I feel at ease when I am around computers.	1	2	3	4	5
7	My future career will require knowledge of computers.	1	2	3	4	5
8	I enjoy using a computer.	1	2	3	4	5
9	This class has increased my technical skills.	1	2	3	4	5
10	Working with a computer makes me very nervous.	1	2	3	4	5
11	I think getting a job involves using computers.	1	2	3	4	5
12	I think working with computers would be enjoyable and stimulating.	1	2	3	4	5
13	I gained few useful skills from this class.	1	2	3	4	5
14	I get a sinking feeling when I think about trying to use a computer.	1	2	3	4	5
15	Computers are an important factor in the success of a business.	1	2	3	4	5
16	The challenge of solving problems using a computer does not appeal to me.	1	2	3	4	5
17	The skills gained in this class are too specific to be generally useful in the future.	1	2	3	4	5
18	Computers make me feel uncomfortable.	1	2	3	4	5
19	The use of computers will increase in my discipline in the future.	1	2	3	4	5
20	I would like to work with computers.	1	2	3	4	5
21	This class helped develop my problem-solving skills.	1	2	3	4	5
22	Computers make me feel uneasy and confused.	1	2	3	4	5
23	All university students need a course about using computers.	1	2	3	4	5
24	I enjoy learning on a computer.	1	2	3	4	5
25	As a result of this class I feel confident about tackling unfamiliar problems involving computers.	1	2	3	4	5
26	I feel aggressive and hostile towards computers.	1	2	3	4	5
27	Knowledge of the use of computers will help me get a job.	1	2	3	4	5
28	Learning about computers is boring.	1	2	3	4	5

Appendix F:

TECHNOLOGY-RICH, OUTCOMES-FOCUSED LEARNING ENVIRONMENT INVENTORY

The completion of this questionnaire implies your informed consent to participate. Your responses will be confidential and you will not be identified in this study.

Instructions

This questionnaire contains 56 statements which belong to 7 scales. Each statement requires an actual and a preferred response. Think quickly and circle your answer. Answer all questions. Neatly circle the response that best fits with your opinion.

Your responses will be confidential and you will not be identified in this study.

Circle one

Gender: Male / Female

Your Level of study: 5 / 6 / 7

		ACTUAL					PREFERRED				
	Student Cohesiveness	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
1.	I make friends among students in this class.	1	2	3	4	5	1	2	3	4	5
2.	I know other students in this class.	1	2	3	4	5	1	2	3	4	5
3.	I am friendly to members of this class.	1	2	3	4	5	1	2	3	4	5
4.	Members of the class are my friends.	1	2	3	4	5	1	2	3	4	5
5.	I work well with other class members.	1	2	3	4	5	1	2	3	4	5
6.	I help other class members who are having trouble with their work.	1	2	3	4	5	1	2	3	4	5
7.	Students in this class like me.	1	2	3	4	5	1	2	3	4	5
8.	In this class, I get help from other students.	1	2	3	4	5	1	2	3	4	5
	Teacher Support	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
9.	The teacher takes a personal interest in me.	1	2	3	4	5	1	2	3	4	5
10.	The teacher goes out of his/her way to help me.	1	2	3	4	5	1	2	3	4	5
11.	The teacher considers my feelings.	1	2	3	4	5	1	2	3	4	5
12.	The teacher helps me when I have trouble with the work.	1	2	3	4	5	1	2	3	4	5
13.	The teacher talks with me.	1	2	3	4	5	1	2	3	4	5
14.	The teacher is interested in my problems.	1	2	3	4	5	1	2	3	4	5
15.	The teacher moves about the class to talk with me.	1	2	3	4	5	1	2	3	4	5
16.	The teacher's questions help me to understand.	1	2	3	4	5	1	2	3	4	5
	Involvement	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
17.	I discuss ideas in class.	1	2	3	4	5	1	2	3	4	5
18.	I give my opinions during class discussions.	1	2	3	4	5	1	2	3	4	5
19.	The teacher asks me questions.	1	2	3	4	5	1	2	3	4	5
20.	My ideas and suggestions are used during classroom discussions.	1	2	3	4	5	1	2	3	4	5
21.	I ask the teacher questions.	1	2	3	4	5	1	2	3	4	5
22.	I explain my ideas to other students.	1	2	3	4	5	1	2	3	4	5
23.	Students discuss with me how to go about solving problems.	1	2	3	4	5	1	2	3	4	5
24.	I am asked to explain how I solve problems.	1	2	3	4	5	1	2	3	4	5
	Task Orientation	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
25.	Getting a certain amount of work done is important to me.	1	2	3	4	5	1	2	3	4	5
26.	I do as much as I set out to do.	1	2	3	4	5	1	2	3	4	5
27.	I know the goals for this class.	1	2	3	4	5	1	2	3	4	5
28.	I am ready to start this class on time.	1	2	3	4	5	1	2	3	4	5
29.	I know what I am trying to accomplish in this class.	1	2	3	4	5	1	2	3	4	5
30.	I pay attention during this class.	1	2	3	4	5	1	2	3	4	5
31.	I try to understand the work in this class.	1	2	3	4	5	1	2	3	4	5
32.	I know how much work I have to do.	1	2	3	4	5	1	2	3	4	5

	Investigation	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
33.	I carry out investigations to test my ideas.	1	2	3	4	5	1	2	3	4	5
34.	I am asked to think about the evidence for statements.	1	2	3	4	5	1	2	3	4	5
35.	I carry out investigations to answer questions coming from discussions.	1	2	3	4	5	1	2	3	4	5
36.	I explain the meaning of statements, diagrams and graphs.	1	2	3	4	5	1	2	3	4	5
37.	I carry out investigations to answer questions that puzzle me.	1	2	3	4	5	1	2	3	4	5
38.	I carry out investigations to answer the teacher's questions.	1	2	3	4	5	1	2	3	4	5
39.	I find out answers to questions by doing investigations.	1	2	3	4	5	1	2	3	4	5
40.	I solve problems by using information obtained from my own investigations.	1	2	3	4	5	1	2	3	4	5
	Cooperation	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
41.	I cooperate with other students when doing assignment work.	1	2	3	4	5	1	2	3	4	5
42.	I share my books and resources with other students when doing assignments.	1	2	3	4	5	1	2	3	4	5
43.	When I work in groups in this class, there is teamwork.	1	2	3	4	5	1	2	3	4	5
44.	I work with other students on projects in this class.	1	2	3	4	5	1	2	3	4	5
45.	I learn from other students in this class.	1	2	3	4	5	1	2	3	4	5
46.	I work with other students in this class.	1	2	3	4	5	1	2	3	4	5
47.	I cooperate with other students on class activities.	1	2	3	4	5	1	2	3	4	5
48.	Students work with me to achieve class goals.	1	2	3	4	5	1	2	3	4	5
	Equity	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
49.	The teacher gives as much attention to my questions as to other students' questions.	1	2	3	4	5	1	2	3	4	5
50.	I get the same amount of help from the teacher as do other students.	1	2	3	4	5	1	2	3	4	5
51.	I have the same amount of say in this class as other students.	1	2	3	4	5	1	2	3	4	5
52.	I am treated the same as other students in this class.	1	2	3	4	5	1	2	3	4	5
53.	I receive the same encouragement from the teacher as other students do.	1	2	3	4	5	1	2	3	4	5
54.	I get the same opportunity to contribute to class discussions as other students.	1	2	3	4	5	1	2	3	4	5
55.	My work receives as much praise as other students' work.	1	2	3	4	5	1	2	3	4	5
56.	I get the same opportunity to answer questions as other students.	1	2	3	4	5	1	2	3	4	5

	Differentiation	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
57.	I work at my own speed.	1	2	3	4	5	1	2	3	4	5
58.	Students who work faster than me move on to the next topic.	1	2	3	4	5	1	2	3	4	5
59.	I am given a choice of topics.	1	2	3	4	5	1	2	3	4	5
60.	I am set tasks that are different from other students' tasks.	1	2	3	4	5	1	2	3	4	5
61.	I am given work that suits my ability.	1	2	3	4	5	1	2	3	4	5
62.	I use different materials from those used by other students	1	2	3	4	5	1	2	3	4	5
63.	I use different assessment methods from other students.	1	2	3	4	5	1	2	3	4	5
64.	I do work that is different from other students' work.	1	2	3	4	5	1	2	3	4	5
	Computer Usage	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
65.	I use the computer to type my assignments.	1	2	3	4	5	1	2	3	4	5
66.	I use the computer to email assignments to my teacher.	1	2	3	4	5	1	2	3	4	5
67.	I use the computer to ask the teacher questions.	1	2	3	4	5	1	2	3	4	5
68.	I use the computer to find out information about the course.	1	2	3	4	5	1	2	3	4	5
69.	I use the computer to read lesson notes prepared by the teacher.	1	2	3	4	5	1	2	3	4	5
71.	I use the computer to find out information about how my work will be assessed.	1	2	3	4	5	1	2	3	4	5
72.	I use the computer to take part in online discussions with other students.	1	2	3	4	5	1	2	3	4	5
73.	I use the computer to obtain information from the Internet.	1	2	3	4	5	1	2	3	4	5
	Young Adult Ethos	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
74.	I am treated like a young adult.	1	2	3	4	5	1	2	3	4	5
75.	I am given responsibility.	1	2	3	4	5	1	2	3	4	5
76.	I am expected to think for myself.	1	2	3	4	5	1	2	3	4	5
77.	I am dealt with as a grown up.	1	2	3	4	5	1	2	3	4	5
78.	I am regarded as reliable.	1	2	3	4	5	1	2	3	4	5
79.	I am considered mature.	1	2	3	4	5	1	2	3	4	5
80.	I am given the opportunity to be independent.	1	2	3	4	5	1	2	3	4	5
81.	I am encouraged to take control of my own learning.	1	2	3	4	5	1	2	3	4	5

Appendix G:

ATTITUDES QUESTIONNAIRE

	Attitude to Subject	***Almost Never***	***Seldom***	***Some times***	***Often***	***Almost Always***
1.	I look forward to lessons in this subject.	1	2	3	4	5
2.	Lessons in this subject are fun.	1	2	3	4	5
3.	I dislike lessons in this subject.	1	2	3	4	5
4.	Lessons in this subject bore me.	1	2	3	4	5
5.	This subject is one of the most interesting school subjects.	1	2	3	4	5
6.	I enjoy lessons in this subject.	1	2	3	4	5
7.	Lessons in this subject are a waste of time.	1	2	3	4	5
8.	These lessons make me interested in this subject.	1	2	3	4	5
	Attitude to Computer Use	***Almost Never***	***Seldom***	***Some times***	***Often***	***Almost Always***
9.	I'm good with computers.	1	2	3	4	5
10.	I like working with computers.	1	2	3	4	5
11.	Working with computers makes me nervous.	1	2	3	4	5
12.	I am comfortable trying new software on the computer.	1	2	3	4	5
13.	Working with computers is stimulating.	1	2	3	4	5
14.	I get a sinking feeling when I think of using a computer.	1	2	3	4	5
15.	I do as little work as possible using a computer.	1	2	3	4	5
16.	I feel comfortable using a computer.	1	2	3	4	5
	Academic Efficacy	***Almost Never***	***Seldom***	***Some times***	***Often***	***Almost Always***
17.	I find it easy to get good grades in this subject.	1	2	3	4	5
18.	I am good at this subject.	1	2	3	4	5
19.	My friends ask me for help in this subject.	1	2	3	4	5
20.	I find this subject easy.	1	2	3	4	5
21.	I outdo most of my classmates in this subject.	1	2	3	4	5
22.	I have to work hard to pass this subject.	1	2	3	4	5
23.	I am an intelligent student.	1	2	3	4	5
24.	I help my friends with their homework in this subject.	1	2	3	4	5