Developing IT professionals in New Zealand using project-based learning

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BA (Public Policy), MComms (with Merit)

This thesis is submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

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August 2012
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submitted for the degree of Doctor of Philosophy.

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'I certify that I am the student named below and that the information provided in the form is correct'

Full Name: Nicholas Theodore Wempe
(Please Print)

Signed: ..........................................................

Date: 12 December 2012
I certify that the thesis entitled Developing IT professionals in New Zealand using project-based learning submitted for the degree of Doctor of Philosophy is the result of my own work and that where reference is made to the work of others, due acknowledgment is given.

I also certify that any material in the thesis which has been accepted for a degree or diploma by any other university or institution is identified in the text.

Full Name: Nicholas Theodore Wempe

Date: 8 August 2012
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To all others that have assisted me during this period, my thanks for your understanding and patience. Finally to Kim Baxter, the most patient librarian I know - thank you.

And finally to my wife, Maureen, for her undying belief.
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<thead>
<tr>
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<th>Full Form</th>
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<tbody>
<tr>
<td>ACM</td>
<td>Association for Computing Machinery</td>
</tr>
<tr>
<td>ACS</td>
<td>Australian Computer Society</td>
</tr>
<tr>
<td>AITP</td>
<td>Association of Information Technology Professionals</td>
</tr>
<tr>
<td>APNZ</td>
<td>Association of Polytechnics in New Zealand</td>
</tr>
<tr>
<td>ASET</td>
<td>Association for Sandwich Education and Training</td>
</tr>
<tr>
<td>ASP</td>
<td>Academic support person (Akoranga’s term for academic mentor)</td>
</tr>
<tr>
<td>AUT</td>
<td>Auckland University of Technology</td>
</tr>
<tr>
<td>BCS</td>
<td>British Computer Society</td>
</tr>
<tr>
<td>BIT</td>
<td>Bachelor of Information Technology</td>
</tr>
<tr>
<td>CCIE</td>
<td>Cisco Certified Internetwork Expert</td>
</tr>
<tr>
<td>CCSP</td>
<td>Cisco Certified Security Professional</td>
</tr>
<tr>
<td>EER</td>
<td>External Evaluation and Review</td>
</tr>
<tr>
<td>GIF</td>
<td>Growth and Innovation Framework</td>
</tr>
<tr>
<td>IBL</td>
<td>Industry Based Learning</td>
</tr>
<tr>
<td>IFIP</td>
<td>International Federation for Information Processing</td>
</tr>
<tr>
<td>IITP</td>
<td>Institute of Information Technology Professional</td>
</tr>
<tr>
<td>ITO</td>
<td>Industry training organisation</td>
</tr>
<tr>
<td>ITP</td>
<td>Institutes of Technology and Polytechnics (referred to as polytechnics)</td>
</tr>
<tr>
<td>ITPNZ</td>
<td>Institutes of Technology and Polytechnics New Zealand</td>
</tr>
<tr>
<td>ITPQ</td>
<td>Institutes of Technology and Polytechnics Quality</td>
</tr>
<tr>
<td>ITTC</td>
<td>Information Technology Training Committee</td>
</tr>
<tr>
<td>NACCQ</td>
<td>National Committee on Computer Qualifications</td>
</tr>
<tr>
<td>NCWE</td>
<td>National Council for Work Experience</td>
</tr>
<tr>
<td>NEQA</td>
<td>National Educational Qualifications Authority</td>
</tr>
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<td>NZCS</td>
<td>The New Zealand Computer Society</td>
</tr>
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<td>NZITP</td>
<td>New Zealand Institutes of Technology and Polytechnics</td>
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<td>New Zealand Polytechnic Programs Committee</td>
</tr>
<tr>
<td>NZQA</td>
<td>New Zealand Qualifications Authority</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>PAC</td>
<td>Program Advisory Committee</td>
</tr>
<tr>
<td>PTE</td>
<td>Private training establishment</td>
</tr>
<tr>
<td>SFIA</td>
<td>Skills Framework for the Information Age</td>
</tr>
<tr>
<td>SME</td>
<td>Small to medium enterprises</td>
</tr>
<tr>
<td>TEAC</td>
<td>Tertiary Education Advisory Commission</td>
</tr>
<tr>
<td>TEC</td>
<td>Tertiary Education Commission</td>
</tr>
<tr>
<td>TechNZ</td>
<td>Foundation for Research, Science and Technology: Ministry of Business, Innovation and Employment</td>
</tr>
<tr>
<td>TEI</td>
<td>Tertiary Education Institution</td>
</tr>
<tr>
<td>TUANZ</td>
<td>Telecommunication Users Association of New Zealand</td>
</tr>
<tr>
<td>Wānanga</td>
<td>Public tertiary institutions that provide programs with an emphasis on the application of knowledge regarding Māori traditions according to Māori custom.</td>
</tr>
<tr>
<td>WIL</td>
<td>Work Integrated Learning</td>
</tr>
</tbody>
</table>
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Abstract

This thesis investigates the efficacy of capstone cooperative education projects within an IT program at a New Zealand polytechnic. It is based on an investigation of students’ abilities to use and develop their technical and non-technical skills during their capstone projects conducted in IT workplaces. Although there is anecdotal evidence and some research on the success of cooperative education in academic programs, this thesis focuses on how students demonstrate such learning. It also considers whether or not project-based learning approaches have value, either to students or the IT sector, in terms of the development of skills required to be a future IT professional.

This thesis researches a specific group of students undertaking their capstone projects in a given year at a mid-sized New Zealand polytechnic. Their capstone projects formed the final course of their undergraduate IT degree. These projects are implemented cooperatively with IT industry clients, for whom a student, as part of a team, must design, develop and implement a solution or artefact comprising of hardware and software elements.

The research methodology used in the research for this thesis was qualitative. The thesis draws on a constructivist approach to identify and analyse demonstrations of students’ skills. This is achieved through content analysis of students’ journals kept during a project cycle, and through interviews with students, IT stakeholders, previous IT graduates, academic staff and the IT clients. Jarvis’s 1987 model of learning is used to explain and analyse the students’ learning processes.

The thesis shows that students demonstrated differing degrees of learning dependent on their level of clients’ technical knowledge and their projects’ work environment. Differences were found between a ‘half-way house’ workplace education environment managed by the polytechnic, and actual places of employment. The importance of non-technical skills, such as, communication and project management skills, to the success of a project was evident. The thesis reveals that there was disconnection between the academic intentions of capstone projects and the expectations of the IT sector employers and other stakeholders. It was found that although students gained skills required for entry to a career in IT, there was no direct
involvement by the IT sector to link these skills to professional practice. More broadly, it was established that there was limited IT sector involvement in shaping or informing polytechnic IT curricula. This thesis suggests a holistic model for sector engagement, from secondary education through tertiary to graduate placement and employment.
Chapter One: The Research Intent

Introduction

In 1998 I accepted a position as a tutor at my current institute, a medium-sized polytechnic in New Zealand, and began teaching information technology at certificate and diploma level. I had grown up in the city where this polytechnic’s central campus is based and was aware that the surrounding area was a predominately low skilled, working class area. The proportion of second chance learners was higher than the national average due to the downsizing of the local manufacturing base a decade earlier. The opportunity to pass on my IT knowledge to others made this change an attractive prospect.

As part of my academic professional development I enrolled in a Master of Communications that exposed me for the first time to theorists of communication and education. This program was the catalyst for my curiosity regarding the importance of a technological society to the economy and how I could contribute to these changes. The growth in information technology use for both business and leisure and the rise in government rhetoric around the knowledge economy caused me to think about how, as educators within the polytechnic sector in New Zealand, we were preparing students to engage and develop this technological future. Initially two questions became of interest to me. Although they are not the final research questions of this thesis they formed the initial basis of inquiry in my mind:

How does New Zealand increase the capacity of IT education to meet a likely increase in demand?

How do we as educators know that the curriculum provided to students remains relevant to current industry requirements?

A brief explanation of the New Zealand tertiary landscape is required before proceeding further. Since 1987 the New Zealand educational landscape has
altered dramatically resulting in policy changes in an attempt to develop a unified qualification framework in order to create a system of seamless education and training for all New Zealanders. One of the opportunities that arose during this period was the ability of the polytechnic sector to offer degree programs and it is in regards to one such degree program that this thesis is situated.

Since 2003 the organisation responsible for policy direction and funding of domestic students is the Tertiary Education Commission (TEC). The types of organisations defined as tertiary providers include Tertiary Education Institutions (TEI) which encompass the Universities, Institutes of Technology and Polytechnics (ITP) and Wānanga (public tertiary institutions that provide programs with an emphasis on the application of knowledge regarding Māori traditions according to Māori custom) as well as non TEI’s such as private training establishments (PTE) and industry training organisations (ITO). A full explanation of the tertiary education sector is continued in Chapter Two.

In order to minimize confusion I shall refer to the Institutes of Technology and Polytechnics as polytechnics or as the polytechnic sector unless referred to in quotations. I have also been requested by my institute’s research and ethics committee to refrain from directly referring to the institute by its official name. Therefore I will refer to my institute by a pseudo name ‘Akoranga’, a Māori noun with a variety of meanings including learning, discipline or profession.

In 1999 Akoranga obtained an established Bachelor of Information Technology. The program was obtained because of its robust structure and fit for our marketplace. While the framework of the program was not considered ideal the program allowed sufficient flexibility for further curriculum development. I was appointed to the role of program manager at that time. One of the features of this program is a third year industry project to be undertaken in cooperation with a ‘real world’ organisation. The purpose of this industry project, set as a 400 learning hour double course, is to extend the student beyond their classroom learning and develop an artefact for a ‘real
world’ client that will assist the client’s business. This type of course is often referred to as a capstone project and is a form of cooperative education. The concept was not new to polytechnic IT education as a compact version had existed within the earlier national advanced diploma curricula but the greater size of this capstone project allowed for unique learning opportunities to be undertaken. While utilized throughout the world as a process for enhancing the learning of students the capstone project is not without challenges. Skelton and McLay (2006) maintain that “In the New Zealand Institute of Technology and Polytechnics (ITP) sector, industry projects have grown increasingly important particularly within applied bachelor’s degrees” (p.249). Skelton and McLay contend however that there is need to look at a more comprehensive cooperative model within the capstone projects to greater enhance the opportunities for students to learn, both in a technical sense as well as a political and business sense. Skelton and McIay go on to say “Even the best of our IT students are limited in the professionalism of their finished IT product because of their isolation from professional peers, their limited experience and a lack of access to corporate resources” (Skelton & McIay, 2006, p.250).

It is important that the technical is not researched without reference to the business imperative. After all, it is the intent of the polytechnic sector to provide work-ready graduates for business. In conjunction with the need to review how models of cooperative learning can be developed there has been, from the IT sector itself, a growth in the understanding of IT as a profession. The New Zealand Computer Society, the IT sector’s governance body, promotes itself as a professional society and has in recent years become actively involved with the development of professional standards in a sector that may be viewed by some as the wild west.

By 2003 my initial two questions had developed further to the two questions that underpin this thesis. While there is evidence of the benefit of capstone projects, both in terms of the benefits to the student and client organisations, little had been researched in the area of how students learn through such
projects. What processes of learning are evident during a project cycle and does this contribute to a student’s understanding of the ‘profession’?

Research Question One: In what ways do students who undertake capstone projects demonstrate their learning?

The question sought to clarify the processes used by students that can be identified as learning through entries made in journals during capstone projects. Evidence of previous classroom education in areas such as application development or database design was sought for as well as evidence of students employing other sources of learning such as wiki sites, blogs or technical forums. Jarvis’s (1987) ‘model of learning’ was employed to help identify patterns of learning identifiable from student journal entries.

Research Question Two: How does a project-based learning approach assist in developing IT professional skills?

Given the relative newness of the IT sector and its rapid growth over more than thirty years, this question sought to identify how project-based learning, as carried out at Akoranga, assist in the development of IT professional skills. What involvement does the IT sector play in the development of polytechnics students toward becoming IT professionals in New Zealand is also examined.

While the two questions are researching seemingly quite separate aspects of the education process, learning and professional employment, they are linked by the intent behind capstone projects to prepare students by means of a group facilitated project to produce an artefact for a client just as they would if they were employed within the sector [Author’s emphasis]. Given such a close link it is important to research not only the learning behind the capstone project itself but also to review how the IT sector participates in this process and how professional IT skills are developed. While it is unreasonable to expect a student, upon graduation, to instantaneously become an IT professional, it is,
however, a reasonable expectation that a set of core skills have been developed toward that expected in an IT professional.

A better understanding of the education of an IT professional and thus how a student learns the craft of IT has become extremely important given the emphasis of IT as a solution to economic growth since the beginning of this millennium. The remainder of this chapter will explore the rise of IT as an economic force and the requirement for skilled professionals.

**Knowledge Wave**

Alvin Toffler’s book *Future Shock* highlighted technology as an agent of change. Toffler saw knowledge as change with technology driving an “accelerated knowledge acquisition, fuelling the great engine of technology, means accelerating change” (Toffler, 1972, p.38). This theme is continued in his next book, *The Third Wave*. Toffler writes that the computer, because of its ability to process and store large amounts of data “makes social memory both extensive and active. And this combination will prove to be propulsive” (Toffler, 1980, p.193). New Zealand is seen as a country of primary production, primarily agricultural. In the latter part of the last century there has been a push by government to develop other areas of economic enterprise. The new millennium has brought an increased rhetoric from respective governments in New Zealand for a change in the direction of our economy. The age of knowledge has begun and it has become increasingly important for economies to develop and grow knowledge-based businesses. The Organisation for Economic Co-operation and Development (OECD) released several reports highlighting the importance of a knowledge economy to nations. *The future of the global economy: Towards a long boom?* (OECD, 1999), *The creative society of the 21st century* (OECD, 2000) and *Knowledge, work organization and economic growth* (Arnal, Ok & Torres, 2001) have continued to suggest that technological advancement and the increase in technology literacy of the workforce is the way to economic growth and
prosperity. Programs of study such as the undergraduate degree at Akoranga offered education toward a profession that would underpin this new economy. In particular the program concentrated on producing application development, database development, networking and support personnel.

In August of 2001 the then Clark Labour government organized the first of two international conferences entitled ‘Catch the Knowledge Wave’, and invited delegates from Australasia, Europe and the US in an effort to gain early momentum in the building of a knowledge economy. While primary production remained the backbone of the New Zealand economy, with a little over four million people, the government embarked on a campaign to help make the economy less reliant on primary production and pushed the development of a knowledge economy. The debate on the knowledge economy was as intense in Australia as it was in New Zealand. Australia, being a destination favoured by many New Zealand professionals, also made a commitment to move toward the knowledge economy. With a healthier twenty plus million people and a seemingly inexhaustible wealth of minerals contained within the continent, in demand by a growing Asian economy, the government had also seen the need to make Australia a knowledge economy. ‘The Australian’ newspaper cited the Australian Council of Deans of Education warning that the then education system was “ill-prepared to meet the challenges of the information age” (Madden, 2001, p.22). This was not the only voice of dissension on the issue of education and the knowledge economy. ‘The Australian’ reported that “the capacity to train knowledge workers for an emerging knowledge economy seems bound to become the primary determinant of economic success, not just for individuals but also regions, nations and corporations” (Gilbert, 2001, p.15). The article went on to state that under current policies of the incumbent liberal coalition it was unlikely to become a leading ‘Knowledge Nation’.

The term ‘Knowledge Nation’ was coined from a 2001 report entitled The comparative performance of Australia as a knowledge nation by Considine, Marginson, Sheehan and Kumnick. The report, while focusing on Australia,
had resonance with the state of New Zealand’s economy at that time. The report focused on three areas identified by the OECD that form the index of ‘investment in knowledge’. The report stated, “its short-term economic capability is grounded in the longer-term development of national capacity in education, in research and development, and in information and communications technologies” (2001, p.1). More recently there have been those who have challenged the validity of the knowledge economy as a force of change in itself. Florida (2002) suggests that we live in an age of creativity rather than knowledge. Alheit (2009) also supports the idea of the technology as the enabler of an economy.

The knowledge of the information society is doing knowledge, [original emphasised] a kind of lifestyle that determines the structures of society far beyond the purely occupational domain and lends them a dynamic of ever-shorter cycles (p.119).

Garnham (2000) argues that the term ‘Information society’ is overused. He challenges the usefulness of the term when it is linked to a theory of human capital. He states:

The term ‘information society’ refers to a number of distinct trends and arguments that we need to uncouple. First there is Bell’s ‘Post-Industrial Society’ argument which as is now well known, argued that organized knowledge was becoming the key ingredient in value added and therefore in economic growth. It is important to stress that for Bell it was not information or knowledge in general that was the key but the application of Weberian rationalization to the production of knowledge itself. This is important because it then led on to his incorporation of the ICT revolution into his scenario as a technology that enhanced the planned nature of knowledge production and its productivity (p.141).
Similarly Young (2009) commented on the growth of the term ‘knowledge’ in educational policy documents. He asserts that the term ‘knowledge’ is also over used, or at least poorly used. “The meaning of knowledge is at best implicit [in reference to a lawyer whose new title was ‘Head of Knowledge’] and at worst virtually empty of content” (p.193). Regardless of whether the technology itself is perceived as the agent of change or simply the vehicle to achieve change, the technology will be developed and supported by individuals who will be the product of the current tertiary sector.

The effect of globalization

The impact of globalization has been well reviewed; the United Kingdom’s former Department for Business Enterprise & Regulatory Reform (BERR) refer to the beginning of globalization as early as 1870. BERR suggest that the effects of increased globalization have been with us since the mid-1950s. BERR also suggest that the latest wave of globalization has been driven by three main factors. These are:

The adoption of more open economic policies – which have increased international trade in goods and services, and cross-border flows of both capital and labour;
Technological progress – which has sharply lowered transport and communications costs and has increased the tradability of goods and services;
The emergence of developing, low-wage economies on the world stage –which has been led by China and India.

(BERR, 2008, p.2)

The first point identified by the BERR report highlights the cross-border flow between nations. Certainly in the last forty years there has been an increase in the migration from New Zealand to Australia of a large proportion of New Zealand’s skilled and unskilled workforce. The New Zealand Department of
Labour highlights the emigration statistics, up until 2006, suggesting that this emigration is of a greater concern for New Zealand than for Australia. The report stated:

In economic terms, New Zealanders working in Australia represent a labour and skill resource that is a larger ‘lost’ asset for New Zealand than a gain for Australia. The quarter of a million New Zealanders in 2006 represent a relatively small share (about 3%) of the total Australian workforce but a much larger share (about 17%) of the domestic New Zealand born workforce (BERR, 2008, p.9).

The table overleaf indicates a higher percentage of New Zealanders participating in the Australian workforce. The average participation rate among the five skill levels is 5.9%, greater than indicated by the Department of Labour report. Graduates from polytechnic IT degree programs are represented in the Australian and New Zealand Standard Classification of Occupations (ANZSCO) skill level 3.
Table 1.1 - Skills of the prime ages NZ born working in New Zealand and Australia 2006

<table>
<thead>
<tr>
<th>ANZSCO Skill level</th>
<th>New Zealand born</th>
<th>New Zealand born who work in</th>
<th>New Zealand</th>
<th>New Zealand Australia</th>
<th>Percentage of New Zealanders working in Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Highly Skilled)</td>
<td>352488</td>
<td>51125</td>
<td>7.89%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (Skilled)</td>
<td>79350</td>
<td>17900</td>
<td>5.43%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 (Medium-Skilled)</td>
<td>141702</td>
<td>31228</td>
<td>5.54%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 (Low - Medium Skilled)</td>
<td>208434</td>
<td>51171</td>
<td>5.07%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 (Elementary)</td>
<td>145899</td>
<td>31496</td>
<td>5.63%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(drawn from StatisticsNZ, 2010, p.30)

This migration has an effect on the amount of graduates identified in any given sector of employment, as this ‘loss’ needs to be compensated for through the requirement to educate a greater number of graduates than for just the New Zealand economy. Although Australia is the larger of the recipient nations of a skilled New Zealand-born workforce, many graduates also travel to other economies such as the UK, US and Canada.
Definition of the New Zealand IT workforce

The workforce is defined as those working in the engineering, technical, trades and sales roles in hardware and software, information technology and telecommunications occupations. The sector is often described as the ICT sector, the ‘C’ being communications. At Akoranga, the Bachelor in Information Technology is aimed at employment in IT rather than the wider sector. Throughout this thesis I will refer to the IT sector or IT, although quotations or government documentation may well refer to the wider ICT environment. IT differs from other sectors of employment in New Zealand as a large number of those employed in an IT related occupation work outside of the sector itself. New Zealand 2006 census figures indicate that only 40% of those employed in an IT role identified themselves as working in the IT sector. The remaining 60% were spread across other sectors such as manufacturing, research, finance tourism and public administration.

The IT occupations within the New Zealand economy can be identified using the following ANZSCO codes. As is evident from the list the roles classed as ICT are wide and varied often arising to confusion. For the purposes of this research the roles indicated are roles from which a graduate from Akoranga could conceivably gain employment. A full list can be found in appendix D.
<table>
<thead>
<tr>
<th>Writing Professionals</th>
<th>ICT Professionals cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>212415 Technical Writer</td>
<td>261399 Software and Applications Programmers</td>
</tr>
<tr>
<td><strong>Business, Human Resources and Marketing Professionals</strong></td>
<td></td>
</tr>
<tr>
<td>223211 ICT Trainer</td>
<td>262111 Database Administrator</td>
</tr>
<tr>
<td>225213 ICT Sales Representative</td>
<td>262112 ICT Security Specialist</td>
</tr>
<tr>
<td>232413 Multimedia Designer</td>
<td>262113 Systems Administrator</td>
</tr>
<tr>
<td>232414 Web Designer</td>
<td>263111 Computer Network and Systems Engineer</td>
</tr>
<tr>
<td><strong>Sales</strong></td>
<td></td>
</tr>
<tr>
<td>621211 ICT Sales Assistants</td>
<td>263112 Network Administrator</td>
</tr>
<tr>
<td><strong>ICT Professionals</strong></td>
<td></td>
</tr>
<tr>
<td>261111 ICT Business Analyst</td>
<td>263113 Network Analyst</td>
</tr>
<tr>
<td>261112 Systems Analyst</td>
<td>263211 ICT Quality Assurance Engineer</td>
</tr>
<tr>
<td>261211 Multimedia Specialist</td>
<td>263212 ICT Support Engineer</td>
</tr>
<tr>
<td>261212 Web Developer</td>
<td>263213 ICT Systems Test Engineer</td>
</tr>
<tr>
<td>261311 Analyst Programmer</td>
<td>263299 ICT Support and Test Engineers</td>
</tr>
<tr>
<td>261312 Developer Programmer</td>
<td><strong>Engineering, ICT and Sciences Technicians</strong></td>
</tr>
<tr>
<td>261313 Software Engineer</td>
<td>313111 Hardware Technician</td>
</tr>
<tr>
<td></td>
<td>313112 ICT Customer Support Officer</td>
</tr>
<tr>
<td></td>
<td>313113 Web Administrator</td>
</tr>
<tr>
<td></td>
<td>313199 ICT Support Technicians</td>
</tr>
</tbody>
</table>
Growth of the information technology sector

IT as a profession is relatively new. The emergence of the personal computer in the late seventies fuelled rapid growth in the industry. Many who began in the industry came from electro-mechanical engineering backgrounds although programmers in New Zealand were being trained by the polytechnic sector at this time, primarily for the larger government agencies such as the Inland Revenue Department.

In the late seventies and early eighties, videotext services allowing the access to databases via public switched telephone networks were available in the UK. It would take until 1984 until this technology was available in New Zealand. By the mid-eighties the companies like Digital Equipment Corporation (DEC), International Computers Limited (ICL) and International Business Machines Corporation (IBM) provided the solutions to larger corporate entities, government and academic institutions. Most small to medium enterprises continued without computerization until the cost of this new technology began to reduce in the late 1980s. The Internet was first introduced to New Zealand in 1989 and had become common use by 1995.

A diverse group of organizations established World Wide Web home pages in 1995 including law practices, public relations firms and the media, large companies like Fletcher Challenge and Pilkington Glass, and smaller organizations such as the Royal New Zealand Ballet and Sealord fishing company. In the public sector the National Library and the Treasury set up web pages (Toland, 2010, p.40).

The latter years of the 20th century also saw a growth in the areas of systems management, knowledge management, organisational change and the recognition of human and social capital. For many organisations at this time the information technology was seen as an addition to the business functions. A senior Gartner analyst warned of the state of Australian companies when it
comes to the implementation of technology. “There is a tremendous need for Australian companies to take plumbing much more seriously at the board level and in their strategic thinking. They just see it as a tool, they see it as an expense, they see it as plumbing” (Janz, 2001, p.30). This attitude was no different in New Zealand.

By 2002 businesses of all sizes were becoming aware of the importance of IT in their organisations and the need to develop and grow this resource began in earnest. The IT landscape had changed and the big players that provided support in the nineties were gone. DEC was sold to Compaq who in turn were merged with Hewlett-Packard. The Fujitsu Corporation purchased ICL and the American giant IBM had scaled down and reinvented itself. The IT industry now consisted of hundreds of smaller, leaner companies, each specializing in particular areas of IT, developing solutions for all business types.

The development of an IT Taskforce

In 2002 the then Prime Minister Helen Clark launched the Growth and Innovation Framework (GIF). Following policy developments in many western countries toward a knowledge-based economy, the GIF was created to develop the skills within an economy for innovation and entrepreneurial growth in New Zealand. The intent was to create a business and educational environment where collaboration between businesses and between tertiary institutes and business could take place.
Four areas of high potential growth were singled out with the creation of specific taskforce panels to drive the development of the framework.

- Biotechnology
- Information and communications technology (ICT)
- Design
- Screen production

The analysis and research into these four areas led to several innovation initiatives released in successive Government budgets including the creation of opportunities for secondary school students to experience work placements through the Gateway project and an increase in funding for apprenticeship training focusing on youth.

Unveiled by the then Minister for Information Technology and Communications, the Honourable Paul Swain, the taskforce had several criteria including setting a vision and developing a strategy for the ICT sector; developing a better understanding of NZ’s current ICT capability; identifying possible barriers to growth and the means to address these; identifying international ICT opportunities and trends; developing better focus and branding for the NZ ICT sector; developing a more strategic approach to export growth opportunities and identifying how the sector can contribute to the growth of other industries. The taskforce comprised of 11 IT entrepreneurs and recognized industry leaders which for New Zealand was a departure from government departments taking the lead in future development. In June 2003 a final paper was presented to the Cabinet Economic Development Committee.
The taskforce gave the following recommendations:

1. grow New Zealand ICT businesses that are globally competitive;
2. elevate the leadership capabilities of New Zealand ICT entrepreneurs to that of world-class entrepreneurial chief executive officers;
3. grow, sustain and retain a highly skilled ICT workforce;
4. build an entrepreneurial ICT culture that supports and celebrates business success;
5. government contribute to ICT growth by improving the regulatory environment, its purchasing policies and performance in research and development, so that ICT businesses can flourish; and
6. implementation proposals including an industry-led implementation body and improved statistics to measure progress.

(Office of the Minister for Information Technology, 2003, p. 4)

Demand for skills

New Zealand has a history of IT skills shortage, however, must be clarified on what basis the term ‘shortage’ is used. While IT remains on the list of long-term skills for migrants this skills shortage has never gained high priority status. In 2003 the ICT Taskforce, a sub-committee of the government’s Growth and Innovation Taskforce, reported that there was a need to aim for IT to deliver 10% of New Zealand’s GDP by 2012. One of the areas of concern was the ability to train and retain a skilled IT workforce.

The overarching recommendation of the taskforce report is that key stakeholders in the ICT sector should adopt a target of growing a further 100 ICT companies through the annual sales level of $100 million per company and develop and implement coherent plans to achieve this goal over the next ten years. This goal can also be expressed as lifting the contribution of the ICT sector to GDP from its current rate
of 4.3% to 10% by 2012. Achieving this goal will require an annual growth rate in the ICT sector of 13% per annum (assuming a 3% growth rate overall).

Risks include the ability of New Zealand institutions to supply sufficient appropriately skilled labour, the current lack of people with the necessary international marketing and sales experience and the availability of sufficient capital to drive accelerated growth over ten years. (Office of the Minister for Information Technology, 2003, p. 4)

The 2006 New Zealand Department of Labour report, *Information technology professional: Occupational skill shortage assessment (2006)* highlighted the following increase in the demand for IT professionals from 8,400 in 2001 to 28,000 in 2006. This is a rate of 27.3% per annum, with the national average of growth in other occupations at 2.8% (Department of Labour, 2006, p.1).

The demand for IT skills is not just a New Zealand phenomenon. Most western and emerging economies are also experiencing the same trends. The New Zealand Department of Labour report highlights the anticipated growth in both these economies. It states in relation to Australia that;

The Australian Department of Employment and Workplace Relations (DEWR) projects the employment growth of Computing and IT Professionals to grow by 4.5% per annum between 2005/6 and 2010/11. Computing and IT occupations is one of the five occupational groups with the highest employment growth rate prospects. DEWR considers that the growing importance of computer applications within businesses, including Internet and e-commerce, will result in future growth in demand. (Department of Labour, 2006, p.5)

And similarly for the US economy;
The United States Bureau of Labor Statistics (BLS) predicts that employment of IT professionals will increase by 4.0% per annum between 2004 and 2014. This is much higher than the forecasted 1.9% per annum increase for all professionals and 1.2% per annum increase for all occupation. (Department of Labour, 2006, p.6)

The New Zealand Department of Labour’s *Survey of IT Recruiters 2008* report investigated the level of difficulty that agencies have in obtaining candidates to fill specific roles both in IT and IT specializations. Thirty out of thirty-eight agencies participated in the survey. Although a small number, the responses do provide an important insight into the sector itself. An occupation is defined as being difficult to fill when at least 50% of the recruiters indicated that it was ‘very difficult’ or ‘difficult’ to find suitable applicants for vacancies in the last three months. The survey found that 36 of the 50 occupations surveyed were difficult to fill. Responses from recruiters indicated that all occupations within business and systems analysts and programmers were difficult to fill. Software engineers had the highest percentage of recruiters reporting difficulty (82%) followed by software and applications (81%), analyst programmers (79%) and developer programmers (79%). The last three occupations are of particular importance as this covers the occupations entered by students graduating from Akoranga’s Bachelor in Information Technology program. The general feedback from agencies indicated that one of their greater challenges in the recruitment of IT specialist “is finding qualified people who have good English and good communication skills” (Department of Labour, 2008, p.20). The report also commented on the lack of sufficient professionals from overseas for the roles and that IT should be highlighted as a career option.

Another challenge was the change in governmental educational policy in regards the polytechnic sector. Prior to 2008, the number of Equivalent Full Time Student (EFTS) funded places at institutions was open, allowing as many students to engage in study as a program of study could manage. This, colloquially referred to as ‘bums-on-seats’ funding, coupled with the
attraction of high wages in the IT industry resulted in the growth of many IT programs within tertiary institutions. Many polytechnics grew in capacity through the rapid growth of the international student market, initially predominately from China and more latterly from the rest of Asia and the sub-continent.

The rise in students interested in IT, due to both a peak in school leaving numbers and the hype surrounding Y2K or the millennium bug, may have led many polytechnics into a false sense of security. In the uncapped environment, full time student numbers within IT programs in the polytechnic sector and other tertiary sectors grew, however, this growth was short lived. Changes in government policy and governance, described in more depth in Chapter 2, coupled with the lack of clarity as to what a career in IT actually comprises, led to a downturn in graduates. The New Zealand Department of Labour’s *Information technology professional: Occupational skill shortage assessment (2006)* report highlights that the number of students enrolled in an IT degree program has declined 44% between 2001 and 2005.

The report noted:

> Since 2002 permanent and long-term migratory flows of IT professionals have made a small but positive contribution to the supply of IT professionals in New Zealand. Due to the on-going disparity between levels of supply and demand, the Department of Labour has assessed the IT professional occupation as experiencing genuine skill shortage” (Department of Labour, 2006, p.1).
The years 2003 to 2008 saw a trough in the number of school leavers corresponding to low birth numbers in the mid-eighties. In 2005, 1,300 degrees and post-graduate diplomas that have a major IT component were awarded across New Zealand. This was a 24% drop from 2003 when awards peaked. This is also in line with the downturn of IT as a career option within three years of the millennium. The following table highlights the peak. It should be noted that most undergraduate degree programs in New Zealand are three years in length, which coincides with the influx of students into IT programs shortly after Y2K. The ‘Enrolments’ refer to the number of enrolments in Degrees and Postgraduate Diplomas for a given year. ‘Achievements’ refer to the number of completed Degrees and Postgraduate Diplomas.

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrolments</th>
<th>Achievements</th>
</tr>
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<td>4739</td>
<td>1099</td>
</tr>
<tr>
<td>2001</td>
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<td>1208</td>
</tr>
<tr>
<td>2002</td>
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<td>2003</td>
<td>5125</td>
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<td>4464</td>
<td>1468</td>
</tr>
<tr>
<td>2005</td>
<td>3376</td>
<td>1272*</td>
</tr>
</tbody>
</table>

*Note: this figure was estimated by the Department of Labour because of incomplete data.

(Department of Labour, 2006, p.7).

**Scarcity of graduates**

There is a lack of students who are seeking a career in IT both in New Zealand and Australia although there is little evidence to suggest that a lack of education provided by the tertiary sector is the problem. An article published
in the New Zealand *Education Review* reported, “Too few students are enrolling in IT courses in Australian universities, forcing staff redundancies and in some cases faculty closures”. The article went on to assert that applications had fallen by up to 50% in most states “prompting the Australian Computer Society to ask the immigration department to curb the migrant intake of IT professionals” (Education Review, 2005, p3).

The situation in New Zealand was no different. Bell (2005) cites Alison Young, then head of Unitec’s School of Computing and Information Technology, interviewed in Computerworld magazine, suggested that the problem lay in the misunderstanding of an IT career.

There is a problem attracting students because of misperceptions about what a career in IT actually involves. Trying to get people in here [into Unitec] with IT not being the ‘flavour of the month’ any more is our biggest challenge. If you get a medical degree you’re going to be a doctor, if you get a nursing degree you’re going to be a nurse. But people still don’t quite understand what you’re going to get. (p.16)

Derek Postlewaight, then Director of IT services at the University of Waikato, concurs with Bell’s view as having seen a reduction in the number of people doing IT-related courses. Postlewaight, quoted in the same article by Bell, maintained that “(t)he film industry seems to be the new ‘sexy’ place people are attracted to, even though there aren’t many jobs”.

In 2006 the Australian newspaper the *Sun Herald* reported an upsurge in the numbers of students intending to enrol in IT courses.
The article stated that;

There has been a surge in demand from students eager to enrol in information technology courses at university next year. The revival comes after years of falling student interest following the dotcom crash of 2000 that forced many IT companies to go broke. Figures from the Universities Admission Centre (UAC) show a 60% increase in those wanting to enrol in IT courses for 2007 compared with this year (Edwards, 2006, p.45).

A study commissioned by the Australian Council of Deans of Science highlighted the problem with supporting statistics from the Department of Employment, Education and Training (DEET). The report shows that from 2002 to 2005, as overall university enrolments increased by 6.8 %, IT suffered an 18 % decline over the same period.

The report goes on to suggest an inability of the market to predict skill shortages. The report stated:

These statistics are an interesting commentary on the potential volatility of a market driven higher education system. It raises questions about the effectiveness of market signals when in 2007 there is considered to be a skills crisis involving among other things a shortage of graduates in information technology (Dobson, 2007, p.28).

Press reports in New Zealand relayed a similar state. In an article published in The Press by Law (2007), Alan McKinnon, Professor of Software and Information Technology at Lincoln University was quoted by Law “The number of students going into the IT industry has reduced. There's a major shortage. There are more jobs out there than we can supply good students for. The industry is crying out for people” (p.7).
This view of the scarcity in IT graduates is reinforced by Howard and Atkins (2006) and McCallum (2006). The Immigration New Zealand’s Long Term Skill Shortage report (2012) still retains IT as a major skill shortage.

Research context

IT is characterized by rapid changes to technology tools that often result in the knowledge gap between an expert and novice being small. Not enough is known about the learning relationship in this particular industry or how to develop mechanisms to accommodate the rapid change in both the industry itself and ultimately the academic institutions required to provide the graduates. As stated earlier, Akoranga is a polytechnic in New Zealand. Originally this type of establishment had engaged in predominantly pre-apprenticeship and applied learning programs of study designed for employment; however, the polytechnic sector has grown to award all levels of higher education, many to post graduate certificates and diplomas and a few polytechnics offering doctoral programs. The program of focus for this research is an undergraduate applied three year IT qualification known as the Bachelor in Information Technology and is one of six polytechnics in New Zealand who offer a program of study with this same name.

This commonality is because all six polytechnics have obtained and developed the Bachelor in Information Technology program from the same root program first promoted by Waikato Institute of Technology in the late 1990s. The particular attractiveness of this program was the inclusion of a third-year mentored industry-based course, known as a capstone project. Cleland, Snell-Siddle and Steele (2010) affirm that the inclusion of capstone projects were not uncommon in IT programs within the polytechnic sector. Many academic staff teaching IT in the polytechnic sector came from the IT sector itself. Continuing their contact with the IT sector has primarily included association through academic facilitated industry user groups, such as in Akoranga’s case, the DotNet [programming language specific] Users Group.
To refer to the ‘information communication technology industry’ can be confusing. It is very difficult to identify just what is ‘the industry’ as the genre includes artistic and creative arts through to engineering applications. Due to the diversity of skills that come under the heading of IT, the skill base focused on in this thesis is centred on software application development only.

This research has been conducted to investigate whether students who are engaged in a capstone project demonstrate learning and whether or not a project-based learning approach assists in the development of an IT professional. The context of this research is the analysis of a voluntary student group, who were undertaking their third-year capstone project in the second semester of 2006, they were asked to keep a detailed journal of their experiences during their respective projects and to submit these for analysis at the conclusion of the project cycle. The students who participated gave their insight to their particular capstone project journey through their journals. These insights included comments on how they participated in the projects and into personal triumphs and frustrations.

In semester two of 2006 the following software application development capstone projects undertaken by students at Akoranga were for the following project group types:

- Small to medium sized businesses
- Companies or government departments with internal software development sections
- Solutions or support providers
- Not-for-profit or charitable trusts

Interviews were conducted with other identified stakeholders involved in both the capstone projects and the education of IT students at Akoranga in general for their input into the value of capstone projects as a learning process and their input into the belief of project-based learning as a method for the development of IT professionals. These stakeholders have been separated into
two groupings, primary and secondary. The primary group consists on the students, the academics and project clients that are directly involved in the process of the capstone projects and therefore have a direct impact on the learning of a student. I also included within this primary grouping graduates of the program for their insight into the capstone projects undertaken and the value of these projects.

The secondary grouping includes all those who are instrumental in the demand and supply of graduates into the industry. These include academic management within institutions, policy makers and industry-based representatives of Akoranga’s program advisory panel for IT programs as well as the New Zealand Computer Society. While the focus is on one particular polytechnic in New Zealand, parallels between other tertiary providers, both in New Zealand and overseas, are explored.

This thesis has been constructed into chapters outlining the context in which Akoranga and the capstone projects undertaken by students exist. Chapter Two begins with a review of the tertiary landscape in New Zealand and focus down to the polytechnic sector, the Bachelor of Information Technology program and finally to capstone projects to provide a context for this research. Chapter Three comprises of a review the history of cooperative education, the educational theories behind cooperative education and the benefits of work-based learning and simulated work environments. The purpose of this chapter is to familiarise the reader with cooperative education of which capstone projects are a form. Chapter Four expands on the previous chapter by exploring how capstone projects can be expressed in a learning context by exploring learning theories that contributes to the understanding of learning in a cooperative education framework. This chapter explores the contributions of theorists to not only cooperative education but also introduces other theories that can contribute in the understanding of the project-based learning concept. Chapter Five outlines the methodological approach to the research including the reasons behind the choice of research method and the challenges that were encountered in the process of conducting this research.
The chapter also identifies the ethical issues involved within the research and how the challenges were mitigated. Chapters Six through Eight focus on the analysis of the narratives divided into primary stakeholders; then current students, graduates and academic staff. The analysis is divided into analysis of how learning is demonstrated (Research Question One) and analysis of the attainment of skills toward professional practice (Research Question Two). Chapter Six reviews a volunteer student group who participated in a project-based learning process using their project journals as source material. Chapter Seven reviews the narratives from a combination of graduate student interviews from the Bachelor IT program and an online questionnaire. Graduates were included in this research to validate the project-based learning approach as a preparation for employment. Chapter Eight is a review of the academic staff actively involved in project-based learning and their view of the project-based learning process, its benefits and challenges.

Chapter Nine analyses the narratives from the secondary grouping of stakeholders. These stakeholders include project clients, senior academic management, representatives of Akoranga’s IT program advisory committee (PAC) and finally interviews with the New Zealand Computer Society (NZCS) Chief Executive and NZCS Fellow. This stakeholder grouping, although not directly involved with the learning-based project process, has an impact on the direction of curriculum that develops the IT professional. Chapter Ten draws together the themes identified in Chapters Six to Nine and relates these themes back to the two research questions that form the basis of this thesis for final analysis. Other themes identified, not specifically relevant to the research questions but applicable to the context in which the capstone project at Akoranga operates, are also examined. In Chapter Eleven I present my final conclusions based on the themes developed during this research, their potential implications and possible opportunities for the polytechnic sector and the IT sector.
Chapter Two: Tertiary Education in New Zealand

Introduction

The purpose of this chapter is to outline the context in which Akoranga and the Bachelor of Information Technology program exists. The New Zealand tertiary education landscape has less demarcation of educational levels between the various TEIs. This lack of demarcation has led to a blurring of the lines with universities offering applied programs of study and other tertiary providers offering higher levels of education from undergraduate degree study through to doctorate. For example, polytechnics, like their university colleagues, offer masters, graduate diplomas and doctoral programs with private training establishments offering up to graduate diploma level programs.

New Zealand tertiary landscape: History and policy

The contemporary tertiary education environment is the result of major policy changes begun under the fourth Labour government after regaining office in the 1987 election. Between 1987 and 1989 three major reviews on the education system were undertaken and released. The first report, known as the Meade report, titled Education to be more (1988) was followed by the Picot report, titled Administering for Excellence: Effective Administration in Education (1988). These reports focused on primary and secondary education respectively. The third report was Hawke’s Report of the Working Party on Post Compulsory Education and Training (1988) targeted the tertiary sector. The Hawke report resulted in two policy documents, Learning for Life (1989) and Learning for Life II (1989), which included the representations of interest groups after the release of the initial report.

The Hawke report, convened by Professor Gary Hawke, then professor of economics at Victoria University in Wellington, recommended a major
departure from the autonomous structure enjoyed particularly by the university sector at that time. The report suggested:

A centralized Ministry which controls all [Author’s emphasis] education including universities (this requires the abolition of the University Grants Committee, just as the Picot report required the abolition of education boards mediating between central government and individual units).

A unified body, the National Educational Qualifications Authority (NEQA), for all credentials to subsume all existing awards and to validate degrees proposed by teachers’ colleges and polytechnics.

The separation of teaching and research such that the research component of university staffing would be ‘contestable’ by all tertiary staff. (Snook, 1991, p. 627-628)

The NEQA would cease in 1990 as the NZQA was formally established under the Education Amendment Act (1990).

Ten recommendations were stated in Learning for Life (1989) cited by Snook. Of the 10, two statements were directly applicable to the polytechnic sector.

The distinctions between education and training should be avoided. Education at a university, training at a polytechnic, on-the-job training at the workplace, and non-formal education at a rural location are of equal value in their personal, social and economic worth. Polytechnics would be able to offer degrees but unlike universities would have to get approval course by course. Polytechnics would, however, continue to focus on vocational education and training. Degree level courses
would be only a small percentage of the programmes offered (Snook, 1991, p.628-629).

Smyth, Hyatt, Nair and Smart (2009) suggest that one of the significant changes to tertiary education from the 1990 reforms was the right of polytechnics, colleges of education and private training establishments to offer undergraduate degrees. Smyth et al state “The rationale for these changes was that the qualification approval process should concentrate on the quality, the level and the focus of the qualification – rather than the type of environment in which the qualification is taught” (Smyth et al, 2009, p.4). By 2004 around 14% of all undergraduate degree enrolments were in the polytechnic sector.

The Labour government lost to the National (Conservative) party in the 1990 election. The next three government terms resulted in the implementation of Learning for Life II developed by the previous Labour government. The policy, while from a Labour government, was neoliberal in its approach and thus fitted well with the incoming National government.

The polytechnic sector embraced this new environment and the larger institutions began developing applied degrees with vigour. Polytechnics began applying to run degree courses in the early 1990s. Smaller institutes like Akoranga, by the middle to late 1990s, usually purchased their undergraduate programs from other more established institutes rather than creating their own. This was primarily spearheaded by nursing degrees at 15 institutions whose sector was gaining a professional status and moving toward a bachelor degree as a minimum requirement. “By 1997 nearly 15,000 bachelors and postgraduate students were enrolled in nearly one hundred different degree courses” (Dougherty, 1999, p.49). The growth of degree qualifications within the polytechnic sector coincided with the election of New Zealand’s fifth Labour government in 1999. This three-term government was to have a large impact on polytechnic sector in New Zealand. This Labour government was vastly different to the fourth Labour government being third way in its
political approach, an approach similar to the Blair administration in the UK. This political approach has been referred to as neoliberalism with a social inclination.

In 2000 the Labour government continued their review into the state of tertiary education in New Zealand. An independent commission titled the Tertiary Education Advisory Commission (TEAC) was tasked with the investigation. The aim of the commission was to develop the “(s)trategic direction for tertiary education that would meet the challenge of ‘an increasingly global economy, rapid technological change, demographic changes, and the need for New Zealand to move toward a knowledge-based society (TEAC, 2000, p.32)’” (Codd, 2002, p.31). The difference between the neoliberal approach of the 1990s and the mandate given to the TEAC by the new Labour government was a “much stronger recognition it gives to the social benefits of tertiary education in addition to the economic ones” (Codd, 2002, p.41).

The Tertiary Education Commission / Te Amorangi Matauranga Matua, (TEC) was established in 2003 under section 159C of the Education Act 1989. The TEC’s role is the implementation of tertiary education reforms in conjunction with the Ministry of Education and the New Zealand Qualifications Authority and is the leading agency for managing relationships with the tertiary sector and for policy development.
The TEC mission statement requires that:

The TEC works with the tertiary education sector et al to enhance the relevance of, foster excellence in, and enable access to tertiary education and training so that all can meet their full potential and on tribute to New Zealand’s on-going development and wellbeing (Tertiary Education Commission, 2007).

The then Associate Minister of Education, Steve Mahary, outlined the purpose of the TEC in the Ministry of Education’s document *Tertiary Education Strategy 2002-07*:

As a small nation with low economic growth at present, we will be continually challenged to do more with less and to spend the money we can afford wisely. We will face difficult policy co-ordination issues at both local and regional levels. We will be required to find a new balance between competitive and collaborative forces. We will need to balance a tertiary education system that has very successfully encouraged high levels of participation with the development of niche areas of specialisation and world-class capability. These challenges are also exciting opportunities to be innovative and to improve education outcomes (Ministry of Education, 2002, p.7).

By 2006 the number of graduates gaining an undergraduate degree in New Zealand had risen to approximately twenty-six thousand. Scott (2009) states that by 2006 “17% gained their degree from one of 35 non-university providers” (Scott, 2009, p.6). New Zealand is following many other English-speaking countries that have sought to revitalize their tertiary education systems within recent years. One of the most successful tertiary restructurings happened in Ireland, a country that was often held up as a shining example to be emulated by New Zealand.
Ryan and O’Brien (2000) suggest as follows.

The concern to democratise knowledge is taking place against a backdrop of globalisation. Over the past twenty years globalisation has contributed to a move towards an 'economy-centred' purpose across the field of education. Korsgaard attributes this emphasis to the growing influence of the OECD's philosophy which ‘... is based on a neo-liberal way of thinking, regarding education as an investment in human capital and human resource development’ (p.35).

It is with hindsight that one of the top educational performers of the new millennium, Ireland, waned during the financial crises commencing in 2007. Ireland’s recent economic failure has seen a large number of tertiary education graduates unemployed. The Tertiary Education Strategy 2002-07 states that part of the Tertiary Education Commission’s remit is a requirement to future-proof the New Zealand tertiary system. This has resulted in what is termed as future-focused strategies.

Increasingly, providers and ITOs will need to work with their external stakeholders to develop joint strategies that look ahead and focus on developing the skilled people New Zealand will require in the future, not just on the skills needed for today (Ministry of Education, 2002, p.19).
The *Tertiary Education Strategy 2002-07* stated that a mixture of off-job and on-job education through polytechnics, private providers and ITO’s would best respond to the skill needs of industry and employees. Scott (2009) stated that by 2006:

(w)hile ITP graduates made up 15% of bachelors graduates across all fields, their share was higher in the broad fields of health, creative arts, information technology, and architecture and building and lower in all other broad fields, in particular in the natural and physical sciences, and education (p.8).

Scott (2009) also states.

ITPs also had a strong focus on information technology degrees. Over 20% of all bachelor’s degrees in information technology were from ITPs, and information technology graduates made up 12% of all ITP degree graduates (p.8).

2008 saw the return of a National government and new policy. From 2008 any thought of a socialist agenda was dropped and the focus firmly set back to a neoliberal approach. The Ministry of Education released the *Tertiary Education Strategy 2010-15* with a change to a more capitalist rhetoric. The emphasis was now on the value of education to the economic growth of the country. “Tertiary institutions need to work more closely with business to ensure that research meets the needs of the economy” (Ministry of Education, 2010, p.7). The polytechnic sector was certainly in Government sights. The Government believed that there had been wastage in this sector and had indicated that the Government expected the polytechnic sector to concentrate on the applied nature of its qualifications for the development of the country’s economy.
This particular view had been carried over from the previous Labour-led administration which had indicated the need for change. “We [the Government] are also taking steps to reduce the proliferation of sub-degree qualifications. The number of qualifications has increased considerably, due to individual providers developing their own qualifications” (Ministry of Education, 2002, p.14). In an effort to manage this proliferation of qualifications and refocus the polytechnic sector in line with the economic requirements of the country, the *The Education (Polytechnics) Amendment Bill 2009* was passed.

The Ministry of Education *Profile and Trends 2009* report states:

> The Education (Polytechnics) Amendment Bill passed into legislation on 17 December 2009. The legislation enables the implementation of new governance arrangements for institutes of technology and polytechnics. These arrangements aim to improve the capability and effectiveness of polytechnic councils and to allow the Government to respond more quickly if polytechnics experience educational or financial performance risks (Ministry of Education, 2009, p.19).

This resulted in a change to the governance board of all institutions within the polytechnic sector. There are now a four Government appointees (including the chair and deputy chair) and no more than four institute selected appointees representing the local community. The *Tertiary Education Strategy 2010-15* outlines the role of the polytechnic sector.

Polytechnics have three core roles:
- to deliver vocational education that provides skills for employment
- to undertake applied research that supports vocational learning and technology transfer
to assist progression to higher levels of learning or work through foundation education. (Ministry of Education, 2010, p.18)

The strategy also gives clear expectations on what it expects the polytechnic sector to do.

These expectations are:

- enable a wide range of students to complete industry-relevant certificate, diploma and applied degree qualifications
- enable local access to appropriate tertiary education support
- students with low literacy, language and numeracy skills to improve these skills and progress to higher levels of learning
- work with industry to ensure that vocational learning meets industry needs. (Ministry of Education, 2010, p.19)

The governance environment in which education operates in New Zealand is highly structured. From 1988 successive Governments have imposed their ideologies on policies at all levels of education. A unit standards assessment regime has been introduced in the secondary education system to align curricula and allow pathways through to tertiary study with an increased focus on outcomes that translate into employment and growth for the economy. As mentioned earlier the ideology of third way politics and the neoliberalism of conservative government have similar requirements for partnership and flexibility, accountability and management.

Figure 2.1 (overleaf), drawn from Newman (2001), highlights the conflict of governmental ideology. Partnerships with those outside the education system require flexibility and an open systems model approach; the need to manage
and the perceived need by government for accountability of institutions suggests a contrary hierarchical model.

**Figure 2.1 - Newman’s Dynamics of change**


With regard to the New Zealand environment, successive policies suggest a greater requirement for accountability, both for the management of institutions and governance councils. Newman’s model, while UK focused, would apply in the New Zealand context, in that New Zealand also has a hierarchical approach to education. This, though, appears to be at odds with the previous statements from the TEC that suggest that flexible education and partnership are the way forward.
Newman (2001) states:

The elements of modernisation which implied the need for flexibility and local autonomy, however, tended to be subordinated to other priorities for a government anxious to exert strong control from the centre to ensure its policy agenda and political project were carried through (p.98).

Although Newman refers here to the New Labour movement in the UK, parallels can be seen in the New Zealand context. Newman also puts forward this diagram to explain the dynamics of partnerships.

*Figure 2.2 - Newman’s Dynamics of partnership working*

The intent of government legislation to encourage partnerships with industry, while in line with the aims of student project placements and links with industry, is at odds with the requirement to control and manage. The former, as indicated by Newman’s model, requires an open systems approach. Newman (2001) states in this approach that networks become “dynamic and fluid, held in place by network members rather than statutory requirements or incentives. Collaboration is entered into in order to deliver mutual goals (e.g. local economic development) rather than comply with government’s requirements or partnership demands” (p.116). Newman also cites Hardy, Turrell and Wistow (1992), suggesting that an open systems approach may be at odds with the aims of governance. Newman suggests, however, that such open systems may result in networks without connection to a parent organisation resulting in either the network developing a self-imposed structure - potentially at odds with a parent organisation, or being pulled back by the parent organisation itself.

**Higher education and employability.**

Knight and Yorke challenge the view that the push for higher education will increase the amount of skilled human capital in an economy. Knight and Yorke (2003) state, “In the UK higher education institutions (HEIs) are now charged with promoting graduate employability — contributing directly to the stock of human capital —and their performances are monitored” (p.3). They argue that the focus for employability is supportive of good learning. They state “The student learning that makes for strong claims to employability comes from years, not semesters; through programs, not modules; and in environments, not classes” (p.4).
The applied undergraduate Information Technology degree at Akoranga has developed and grown since its introduction in 2000. Courses are developed or altered within the framework of the whole program by the academic staff upon reflection, advice from the industry program advisory committee and from observing industry trends. Small adjustments such as a different scenario for an assignment within the team may be made to a course with relative ease. Any change that contributes to more than a 10% alteration of the stated learning outcomes of the course requires the Faculty’s Board of Studies approval and may require institutional Academic Board and NZQA approval.

While Knight and Yorke (2003) claim that higher education will increase the amount of skilled human capital in an economy, they claim that this does not, on its own, ensure that the economy will be able to employ or retain all of the newly created skilled human capital. Knight and Yorke also question empirical research into the employability of students.

Empirical research into ‘employability’ does not lead to consensus about what it subsumes. For example, Harvey and colleagues (1997) found that employers want graduates with knowledge, intellect, willingness to learn, self-management skills, communication skills, team-working and interpersonal skills, but the Association of Graduate Recruiters (1995) suggests it comprises ‘career management skills and effective learning skills’: self-awareness, self-promotion, exploring and creating opportunities, action planning, networking, matching and decision-making, negotiation, political awareness, coping with uncertainty, development focus, transfer skills and self-confidence. (pp.6-7)
This drive to develop economies has resulted in the development in educational policy to provide the knowledge economy workforce. Schröttner (2010):

Previously, the focus of the political and educational officials was the underpinning of national identity and the stabilization of social cooperation. Currently, there is a reorientation towards economically centered objectives and a demand for education reforms that respond to the intensification of international economic competition. (p.52)

The IT market by its very nature is constantly changing and upgrading as innovation in application development tools and industrial practice constantly evolves. While core skills, such as mathematics, database structures and basic programming principles do not change substantially, the knowledge of the applications used in any IT program must be reviewed every year. This is not in an effort to keep pace with industry trends but rather in an attempt to push the boundary of new knowledge in order that any graduate of a three-year degree will have more current skills, not skills that are three years old upon graduation. The challenge is to find a balance between core knowledge and new knowledge within the confines of teaching hours. To concentrate curricula on new applications may require the removal of core skill education in order that the program remains within its set credit or learning hour’s boundaries. Conversely, a change to reflect on non-technical skills (team work, time management, communication skills) requested by employers may reduce the amount of practical application and technology education. The balance is difficult to strike, however the program has remained relatively unchanged in its makeup of non-technical skills versus technical skills since 2005.

There has been a change to the employment patterns over the last 15 years. Those who may have gained a certificate or diploma qualification from a polytechnic pre mid-1990s would have been likely to have secured
employment in IT. Since the mid-1990s this has become far less likely. A Ministry of Education report states “(w)hile there was an adequate supply of people with diplomas in information technology, there was an unmet demand for people with bachelor’s degrees and above in this field” (Earle, 2009, p.9).

The report further states:

(i)ncreasing the number of people with bachelors and above qualifications may contribute to reducing skill shortages, but only if issues of quality and relevance of qualifications were also addressed. There was limited evidence that increasing the number of people with diploma-level qualifications would reduce skill shortages. (Earle, 2009, p.9)

Employment pay scales do not differ largely dependent on where a graduate gained their degree. A New Zealand Ministry of Education report by Smyth, Hyatt, Nair and Smart (2009) determined that the labour market in New Zealand does not appear to discriminate between a bachelor’s degree gained at a university or one gained at an polytechnic, although this is dependent on the particular field of study. Smyth et al (2009) suggest that:

- Whether a student graduates with a bachelors degree from a polytechnic or a university, their pay in their first job is likely to be roughly the same.
- Overall, by the fifth year, university bachelors graduates tend to be earning slightly more on average than polytechnic bachelors graduates. The upper end of the earnings range tends to be more weighted towards university graduates but the differences are relatively small for the majority of the graduates.
- In many areas where polytechnics have specialised – such as information technology, commerce, engineering and architecture – there is very little difference in the earnings of bachelors graduates from polytechnics and universities. In some cases in
these areas, the polytechnic graduates are earning slightly more than university graduates. (Smyth et al, 2009, p.3)

Smyth et al (2009) maintain there is a marginal difference in salary to those who completed their bachelor’s degree at university versus completion at a polytechnic after a five-year period. “Those who studied in society and culture, engineering and information technology at a university had a very small advantage” (p.11).

Loogma (2004) highlights an industry-specific issue when it comes to education. She states “Even inside the IT sector we can find different patterns of more institutionalized learning like training courses, conferences, workshops, etc.; the most dominating is self-directed learning while working” (p.579).

In many cases in the European context participation in formal learning is “limited by insufficient learning resources of employees, especially time for learning” (Loogma, 2004, p.579). This is also characteristic of the New Zealand experience with a majority of New Zealand IT businesses being classified as small to medium enterprises, the requirement for employees to self-study, with or without the support of their employer, becomes important if the employee wishes to continue a long-term career. Loogma also comments on the informal nature of web-based communities and club-type user groups being of crucial importance as learning forums. The Bachelor of Information Technology at Akoranga has also developed a user group concentrated around a particular product, Microsoft’s DotNet development framework, which underpins the latest suite of commercial Microsoft products. A typical meeting involved at best four students and the convener, usually an interested tutor or member of the advisory committee. A change to the format of the group, moving the location to outside of the polytechnic and a greater involvement of industry resulted in monthly meetings that regularly exceed twenty participants.
In these networks, everyone is a teacher and a student at the same time—learning from friends and acquaintances is a prominent informal way of learning, which at the same time gives a sense of solidarity and belonging. Most specialists identified themselves as ‘IT people’. It means that they feel free to move from company to company, from project to project, but staying in the field of IT. (Loogma, 2004, p.579)

The move to a site deemed ‘neutral’ by the sector allowed students and sector to meet and discuss changes in software, technical difficulties and solutions which, for those students who attended, would prove augment knowledge taught in the classroom. This particular user group ran from 2004 until 2008 when the academic staff member coordinating these meetings was promoted and the coordination of these meetings ceased.

**Applied polytechnic education in New Zealand**

Since the formation of the first technical school in New Zealand, the Wellington School of Design in 1886, the focus has been on the teaching of skills for the workplace. The aim of the polytechnic sector was to provide skills to school leavers and to train mature persons in areas that would gain them entry into the workforce. Subsequently the polytechnic sector developed programs to meet the changing needs of an expanding society to include automotive and plumbing technology through to office skills and accounting.
Polytechnics and institutes of technology and their predecessors have been in the forefront of educational innovation in New Zealand, from the creation of the first technical schools in the 1880s to the establishment of the 25 modern polytechnics and institutes of technology since the early 1960s. (Dougherty, 1999, p. 9)

Within IT, higher academic qualifications have become a conditional requirement of entry to many IT positions. Until the mid-2000s students completing level 5 and 6 Diploma programs were able to gain employment in IT. Many have maintained employment within the sector but are seeking to upgrade their qualifications, as they are unable to proceed to more senior positions without a degree. While computer science and information systems continue to be predominately taught through the university sector, information technology programs became by and large the domain of polytechnics. To put this in some context, information systems can be seen as the far left of a given spectrum with computer science and its respective disciplines at the far right. Information technology would sit at the mid-point of these two disciplines.

**Figure 2.3 – Technology skills spectrum**

(drawn by Wempe, 2012)
In Akoranga the Bachelor of IT program has focused on training graduates for the application development, database development and administration and networking support sector. The National Committee on Computer Qualifications (NACCQ), consisting of information and communication technologies departments of all polytechnics that taught IT-based programs, was founded in 1988 in an effort to develop standards of applied IT education. Unlike the US, the UK or Australia, the national professional computing body, the NZCS, did not take a commanding role in curriculum development.

The NACCQ was set up to:

Offer support and advice to the Institutes of Technology and Polytechnics in relation to the field of Computing and Information Technology.

Negotiate with the appropriate Government agencies on issues relating to the field of Computing and Information Technology.

Co-ordinate information relating to the field of Computing and Information Technology.

Promote the teaching, learning, research and development in the field of Computing and Information Technology.

Co-ordinate the partnership of Industry and the NACCQ sector in the field of Computing and Information Technology.

Maintain a high quality of graduates for industry in the field of Computing and Information Technology.

Contribute (on behalf of the NACCQ sector) to the development of prescriptions for vocational computing and information technology courses in New Zealand.

Contribute (on behalf of the NACCQ sector) to the maintenance of the relevance of developed courses to meet the changing requirements of the New Zealand Computer and Information Technology industry by suggesting timely changes to course prescriptions in response to industry developments. A full review of all programs to be carried out at least every two years.
Prior to 1989 the standard national computing qualification was a New Zealand Certificate in Data Processing. In 1989 institutes began to offer the new Certificate in Business Computing, placed at level five on the national framework and the Advanced Certificate in Business Computing placed at level six. In 1990 a third year, stair-casing from the existing second year, was added. This was the National Diploma in Business Computing, a level seven qualification. As part of this third year of a national computing framework qualification offered through polytechnics, a ‘real-life’ project course was offered, known as PJ300. This course was the first recognizable attempt to liaise with the sector by requiring a student or a group of students to develop and implement, using principles of software development, a solution for a client based on a real-life scenario. This capstone project required the student(s) to engage with the client using knowledge gained from all previously studied courses and is the first recognizable implementation of...
cooperative education. At this stage the courses offered were all competency assessed.

By the mid-1990s many of the larger polytechnics began to evolve their computing qualifications into undergraduate degree programs. In many cases these remained as a competency assessed curriculum. The reason for the change from a National Diploma to undergraduate degrees is unclear. In part it appears to be due to the streamlining of qualification levels amongst tertiary providers. Universities offered three year degrees in computer science and information systems but a three year diploma at level seven was not recognized by employers as having the same value. The development of polytechnic-based degrees were seen as a way of achieving ‘the thinking graduate’ on par with university graduates, but having had applied training. A further challenge in the change from diploma to degree qualifications was the requirement of the national academic body, the NZQA, to oversee degrees. Along with the creation of NZQA was the creation of the New Zealand Polytechnic Programs Committee (NZPPC) (to later take the name Institutes of Technology and Polytechnics Quality (ITPQ)), which was modelled on a system operating in the university sector. This organisation was granted delegated authority by the NZQA but operated independently by the Association of Polytechnics in New Zealand (APNZ). The APNZ later changed its name to the Institutes of Technology and Polytechnics New Zealand (ITPNZ). In 2009 six polytechnics chose to leave ITPNZ. The remaining polytechnics reformed as the New Zealand Institutes of Technology and Polytechnics (NZITP).

The challenge for the polytechnic sector began once the degree program was introduced. The process for those initial polytechnics was by no means easy and required a change in the philosophy of both the program and staff. Many IT academic staff had originated in industry and moved into an institution to teach the competency based applied program. The move to a degree required that staff upgrade their academic qualifications and engage in research to underpin the degree, a requirement of all degree awarding programs in New
Zealand in line with the rest of the world. It is a requirement of all undergraduate degree programs that staff must be qualified to at least one qualification level higher, or are in the process of obtaining, a higher qualification. Many institutes consisted of staff that had previously worked in the computing industry and were looking to teach in their own specific subject area, but had no real wish to academically up-skill. Many staff felt that this was in conflict with their need to remain current in their field of expertise. Those who choose to academically up-skill were suddenly challenged not only by the requirements of higher education, initially a Masters but later for some, a Doctorate. There was also the requirement to carry out research in an environment that, unlike the University sector, was limited in its research capability. This issue is highlighted in interviews with academic staff in Chapter Eight. Research, or rather the culture of research takes time to develop within an institution and when placed against the requirement for teaching contact hours can often result in conflict.

Societal Shift

While technology certainly plays a part in the creation of new economic activity, the change is in the social order of society. Jarvis, Holford and Griffin state, “changes in education did not take place in the social vacuum“ (2003, p. 13). If we accept this premise, education is in for a period of rapid change and development as indicated by the rapid social change currently taking place. The growth and social networking, collaboration online and flexible employment patterns will challenge the current tertiary education structure to provide graduates who are ‘work ready’. Both Lyotard (1984) and Foucault (1986) suggest that the belief systems of modern society are now being replaced by societies based on different principles.

Students collaborate and communicate using an increasing array of electronic media. Blogs, forums, social networking sites such as Facebook, MySpace and the more professional LinkedIn all allow connection for collaboration far
beyond what was conceived as little as ten years ago. These environments are instrumental in the creation of new societal norms.

Summary

In summary the restructuring of education began in the 1980s has resulted in a greater provision of tertiary education to New Zealanders. The changes have given access to higher education to many who previously would have been excluded. Akoranga has, since its creation in 1986, delivered opportunities to its community through clearer pathways from certificates to diplomas and onto undergraduate degrees.

That ability to gain access to higher education is now under threat through government policy that concentrates on the justification of government based funding. New policies that now fund institutions on a program of study’s completion and success statistics result in stricter entry criteria in programs, which in turn result in a lack of opportunity for the sector of society the polytechnic sector was developed to assist. A positive from this government’s policies is the requirement for polytechnics to seriously review their programs of study to ensure they meet the requirement to be applied programs of study and that they do in fact help place graduates in the industries to which a program purports to educate. The idea of a knowledge economy is yet to gain validity. Previously lauded economies such as Ireland have failed in spectacular fashion. Australia, now surpassing the US with a strong, albeit slowly growing, economy is largely dependent on its vast mineral wealth rather than knowledge driven growth. Opportunities for employment in IT are expected to grow with the expectation that the next ten years will see new employment opportunities created in areas not thought of, using technologies not yet devised. In the next chapter I review the literature surrounding cooperative education and learning through capstone projects.
Chapter Three: Cooperative Education

Introduction

This chapter explains capstone projects in their wider sense, as a form of cooperative education. While this thesis focuses on learning that occurs during a capstone project, models of cooperative education lend a great deal to the philosophic approach of the capstone project at Akoranga. The National Commission for Cooperative Education, a private non-profit American organisation, have defined cooperative education as:

(a) structured educational strategy integrating classroom studies with learning through productive work experiences in a field related to a student's academic or career goals. It provides progressive experiences in integrating theory and practice. Co-op is a partnership among students, educational institutions and employers, with specified responsibilities for each party (Retrieved February 23, 2007, from http://www.co-op.edu/aboutcoop.htm).

Jarvis and Wilson (1999) define cooperative education as:

US equivalent of the sandwich course in the United Kingdom, where a student spends blocks of time in an educational institution and blocks in the workplace. Courses of this nature are usually either at professional qualification or undergraduate level (p. 37).

The focus in both definitions is on the interaction with a place of work to reinforce classroom learning through practical endeavour.
Many larger IT companies also offer cooperative or internship opportunities for students. One such company International Business Machines (IBM) defines cooperative study as:

(a)n accredited four- or five-year college or university pursuing a bachelor's or advanced degree. You can work any time of the year, including part-time, and can be enrolled in either a technical or nontechnical discipline. Most managers prefer co-ops to work a six-to-seven-month period although there is flexibility within this requirement. (Retrieved 27 February, 2007 from http://www-03.ibm.com/employment/us/un_coop_intern.shtml).

Groenewald (2004) maintains that there is a “growing tendency to refer to work-integrated learning in order to give new meaning to the notion of cooperative education” (p. 20). Groenewald gives a number of other terms that he suggests convey a similar meaning. Although Groenewald’s list of terminology does not include capstone projects, such projects can and do include elements of cooperative education. There is a view that capstone projects are set ‘in-house’, within the polytechnic for example, without the participation of an external client. I would argue that while in early years of a program developing such ‘in-house’ projects are utilized to gauge and develop the project cycle and understand student capabilities, more mature programs strive for external client involvement. Groenewald cites Dressler (2003) who suggests both models of education require students to apply what they have learnt in theory. Groenewald (2004) states “(s)he [Dressler] suggests that cooperative education in inherently developmental in that students apply what they are learning as they are learning it” (p. 19).

While this description creates a basic framework from which to work from, Groenewald suggests that Ferris’s (1969) emphasis between theory and practice complements well.

First [is the] impact [of cooperative education] on the curriculum. It not only provides the occasion for making changes that have been
put off because they require too much work, time, and money, but once the program is going, a new kind of interplay is set up between campus and community that gives the curriculum a dynamic quality. Students bring something back into the classroom. They confront questions and problems that would not have occurred to them in the classroom alone and bring them back looking for answers and solutions. In the process, the gap between theory and practice narrows. And because practice keeps changing, theory is kept to the test. The second side advantage is that private industry is brought into the educational process in a meaningful rather than patronizing way (Groenewald, 2004, p. 18).

Current contact with industry in regards IT education is usually some form of project, often completed within the third year of study. The above descriptions would, on the surface, appear to be consistent with industry projects, except for the use of the word apprenticeship. For students involved in project work, this tends not to be in an apprenticeship framework. The period is defined and controlled and the student is usually not remunerated.

**Brief history of cooperative education**

Cooperative education is considered to have started in the United States by Herman Schneider, an engineering professor at the University of Cincinnati in 1906. Schneider was of the view “that many professional concepts and skills could not be learned effectively in the classroom but required practical experience for their understanding and mastery” (Sovilla & Varty, 2004, p. 4).

Schneider is attributed with coining the term ‘cooperative education’ to emphasis the cooperation between industry partners and academic institutions. In Schneider’s context the cooperative experience was the reinforcement of theoretical aspects of engineering that students learnt in the classroom. For the most part, the education establishment itself with support from the relevant
local industry controlled cooperative education. As a result, in the US arena, there was minimal expansion in cooperative education programs until the advent of Federal funding. From 1971 onward, direct Federal funding led to a huge growth in the number of programs available. “At its peak in 1986, 1,012 colleges and Universities, or roughly one-third of all US post-secondary educational institutions, reported having co-op programs” (Sovilla & Varty, 2004, p. 6).

Sovilla and Varty, however, highlight the challenges faced by cooperative education programs making it very clear that working with and within industry is not as easy as it sounds. They state that there remains the challenge for institutional administrators and even staff working on co-op programs to remember what the aim of a co-op program is, that of enhanced student learning. In the US many co-op programs have been merged with student career planning or student service centres, completely missing the point of student-centred education. Sovilla and Varty also review the costs associated with running a co-op program. To offer an effective co-op program is simply not a cheaper option than standard classroom education. Unless there is either good government funded support or industry financial support, preferably both, especially in the initial years of a program, it is unlikely to gather or build the momentum a program requires to continue.

Without faculty involvement or faculty champions, many newer programs could not develop support for any curriculum or structural modifications that could enhance co-op quality and effect its integration into the curriculum fabric. As a result, many co-op programs are layered on the periphery of the academic program (Sovilla & Varty, 2004, p. 11).

Sovilla and Varty note that over the last 25 years, changes in corporate practices have resulted in mergers and downsizing. An effect has been that many organisations no longer have internship or cadet programs.
In the UK the drive to embed cooperative education did not occur until the mid-1950s and only then as a reaction to the threat of the perceived technological advances in the Soviet Socialist Republic during the cold war. Tucker (1969) noted that in 1955 ten colleges of advanced technology were designated to become universities with co-op programs in the science and engineering fields, which lead to the development of sandwich courses in the UK.

Work-based placements and simulated work environments.

The United Kingdom’s National Committee of Inquiry into Higher Education (Dearing, 1997), referred to more commonly as the Dearing Report, argued for increased opportunities for students to undertake work-based learning as an answer for greater pre-employment skill acquisition. This argument was developed into Higher Education policy and universities began to develop an increasing number of cooperative education programs. Organisations such as the National Council for Work Experience (NCWE), created in 2002 in response to the 1997 Dearing report, and the existing Association for Sandwich Education and Training (ASET), created in 1982, worked toward establishing best practice.

Duignan (2003) maintains that a core assumption of many cooperative placements is that the benefits of work placement will be optimized and this is best achieved when the approach is integral to the program of studies. Expected benefits of placement are the opportunity to:

- Apply knowledge in a commercial environment while developing core competencies;
- Become familiar with professional practices;
- Raise graduate labour-market value;
- Develop workplace maturity (p. 336)
In addition, Duignan (2003) argues that placements in industry can have a positive impact on academic performance through other variables:

Greater motivation by students in their final year;
Improved performance as students apply skills learned in placement to such as project work;
Enhanced teaching as students return with more in-depth knowledge of the subject area;
Contributes to a student-centered approach to learning (p. 336)

The University of Ulster in Northern Ireland has considered the placement approach to be of benefit in educational practice for its students of international management. “An objective has always been to provide some practical exposure to the types of issues they will face when they pursue careers” (Scharf & Bell, 2002, p. 327). Scharf and Bell conducted a study on the benefits of twelve projects undertaken with local small to medium enterprises. Part of the study was to evaluate the benefits gained by the students in the terms of technical skills acquired as well as the development of non-technical skills.

From the preceding description and evaluation of the client-sponsored project it is clear that the students attach great importance to undertaking the research and perceive it to be an excellent learning opportunity. The nature of this learning is not restricted to becoming technically proficient in terms of conducting export research, but incorporates many other learning outcomes, particularly in respect to the development of ‘soft’ skills and other competencies which cannot be gained in a classroom setting alone (Scharf & Bell, 2002, p. 331).

Dressler and Keeling (2004) and Fletcher (1990) refer to increased self-esteem which allows for both technical and non-technical skills to be developed. Dressler and Keeling (2004) also refer to other benefits: the opportunity to
problem-solve in authentic environments, improved academic performance (see also Cates & Langford, 1999). Calway and Murphy (1990) highlight the increased employment opportunities for cooperative education students.

**Cooperative education in information technology**

Deakin University in Australia has a capstone course in the final semester for all students majoring in computer science, multimedia technology and information systems.

> Our capstone course has undergone a number of evolutionary changes over the past few years. It was restructured to provide more realistic experiential learning with the introduction of larger software development projects involving 'real clients (sponsors)' and larger student teams with a mix of students across disciplines (Goold, 2003, p. 26).

The project teams at Deakin University, with 10 to 12 members, are considerably larger than other capstone projects. Similar to other capstone projects the Deakin project is based around a unique and substantial computing project that results in the development of a software product. They are sponsored by clients and also have a member of faculty acting as a supervisor in much the same manner as the academic support person described earlier. Monash University in Australia runs a similar program titled Industry Based Learning (IBL). The program was created in 1998 as an initiative of the Business Council of Australia between IT sector and Monash University (2009). As part of a student’s program of study, they may apply to undertake an IBL program from the Business Information Systems, Computer Science, Information Technology and Systems or Software Engineering degrees. Students are interviewed and accepted or returned to take a more standard classroom-based program of study. Stein (2002) has also developed a
I began teaching our department's Capstone course to graduating senior CS [computer science] and CIS [computer information systems] majors. This class traditionally used small group (3-4 people) projects as a focus of the course” (p. 2).

This capstone project at Akoranga is a four 400 hour project-based learning course that requires the creation of an artefact or solution to a given business problem and carried out within an authentic work environment or as close to an ‘authentic’ environment as applicable. Preferably this environment is within the IT sector with an industry partner or may be within the institution within a simulated environment.

Capstone projects fall into the domain of cooperative education, although on the fringe of this domain. Cooperative education involves the active participation of a client or industry external to the institution where the majority of education is carried out. Education approaches such as Work Integrated Learning (WIL) and Internship have active client participation clearly defined. Capstone projects may be completed without the active participation of a client, however within my institution participation by the client is sought. Capstone projects with industry partners have been a feature of the New Zealand IT education landscape since the late eighties.

In 1988 the NACCQ Review Committee first considered what form an industry project might take. Bridgeman (1999) stated that:

(i)t seems they [the review committee] expected that the structure and practices chosen to monitor and manage the student projects would be drawn mainly from the then current industry practices (arising from the fledgling programme development methodologies) rather than research methodologies from education (p. 30).
Bridgeman also refers to the original 1988 prescription outlined by the Information Technology Training Committee (ITTC), the predecessor of the NACCQ.

Each student is required to complete a project, which will form 250 credits (ie. one quarter) of the qualification. Projects should be drawn from ‘real life’ situations and be of significant proportions, testing the students ability to apply the principles and skills they have gained to an original piece of work, while under supervision.

\[ ITTC, 1988, \text{p.E1} \] (Bridgeman, 1999, p. 30)

The prescription outlined four project phases:

a) How a student was to prepare a Project Proposal;

b) How the project was to be controlled;

c) How a formal Project Completion Review was to be carried out at the end of the project; and

d) How the project was to be assessed.

While ambitious in its size, it is clear that the project would be based on ‘real life’ scenarios. The project was eventually resized to a more academically manageable double-credit course. The genesis of all capstone projects in the polytechnic sector can be traced back to a course run under the NACCQ national diploma program, a double-credit project course identified as part of the NACCQ prescribed curriculum as \textit{PJ300}. Bridgeman describes the course as follows

The prescription of the project, as contained in the New Zealand Polytechnic Qualifications in Business Computing handbook (NACCQ, 1995) laid out quite clearly what was expected of the various groups involved: A student, (through completion of a project), was to show their ability to successfully undertake original work; demonstrate a professional attitude and the ability to
integrate the various disciplines required (Bridgeman, 1998, p. 11).

Bridgeman concluded that the prescription for the project-based learning course, when it was first promoted in 1988, outlined a process in which the IT sector could participate successfully with polytechnics. He believes however that in the ten years from 1989, with the change from competency-based diploma’s to undergraduate degrees in the late nineties; there has been a change in the methodology of projects to a greater educational influence on student projects.

As mentioned previously, it is arguable whether capstone projects with industry by institutes can be classed as cooperative education. I believe the current approach may require a hybrid approach in some projects rather than a true cooperative education program. By hybrid I refer to the creation of a constructed ‘real world’ environment, such as Akoranga’s development lab (DevLab), in place of an actual placement within an organisation. A hybrid environment cannot recreate all the characteristics of a workplace, being devoid of established culture, regimes, employment relations and so on. Fincher et al (2004) highlight the challenges of cooperative education in IT education. They state “Cooperative education in computing and information systems [include information technology – authors note] presents some particular challenges related to issues associated with the discipline. These can be characterized as the nature and construction of the discipline and the context of disciplinary practice” (p. 111). They refer to the nature of the discipline requiring the creation of artefacts for a purpose similar to other engineering processes. Information technology, they suggest, is not a traditional service industry, and suggest that the context of disciplinary practice:

(i)s largely within industry or business, means that more is involved in becoming an effective practitioner than just academic knowledge. Practitioners have to be able to understand the purpose
of, and elicit the requirements for, systems they build from clients who are (almost certainly) not IT professionals (Fincher et al, 2004, p. 111).

Fincher et al argue that the context of the discipline lends itself more toward a profession, much like law or medicine. However unlike law or medicine there is not a compulsory governing body. The practice of IT is more akin to that of engineering. Professional bodies for IT do of course exist worldwide. The British Computer Society (BCS) and counterparts in Australia and New Zealand have codes of ethics for their members. The BCS lists grades of professional membership and to move through these grades requires evidence of achievement of published standards. These standards include higher education courses.

Due to the complexities of IT education, it has been difficult for cooperative education models to develop. In Australia and New Zealand it is common for the size of an IT business to fall under the classification of a Small to Medium Enterprise (SME). Generally these small companies do not have the capability or flexibility to absorb an apprentice/intern; indeed, it is a risk to hire a new graduate who will have to be trained in the systems, methodologies, and culture of the company. As a result IT education has developed a number of hybrid cooperative models to cope with this challenge. Fincher et al highlight several models of ‘half-way houses’ hybrid solutions. The purpose of a half-way house design is the replacement of one of the three primary elements or students, customer (or developed product or solution) or workplace.

*Figure 3.1 - Cooperative education continuum*
The University of Sheffield has a student-run software house that provides consultancy and development services to external organisations. The aim of this student-run software house, known as Genesys, is to provide the opportunity “to learn how a small IT company is managed and to acquire experience in the legal and financial areas within which such companies operate” (Fincher et al, p. 114).

Similarly, the University of Colorado runs an Educational Technology House which students are introduced to in their first year and remain involved until graduation. The difference here is that all projects are supplied by the university and controlled within the boundaries of the university. Auckland University of Technology has a capstone project as part of its Bachelor of Information Technology.
This involves students working in teams to develop a product for an external client. In this case students do not leave the campus.

In order to manage the outcomes of projects and to control the working environment my institute developed a commercially based development laboratory, named the DevLab, to give the experience of working in industry, while managing environmental factors. The DevLab was established within the ‘Innovation Greenhouse’ business incubator centre in August of 2002. This was designed to be a multi-functional resource centre providing the opportunity for small businesses and large corporate industries to work with the polytechnic within a business environment. Locating the DevLab within the incubator allows greater business alignment and provides students and graduates with support for transition to the workplace, or into a business start-up to commercialise development (Chard & Wempe, 2004, p. 231).

The Auckland University of Technology (AUT) has had success with a full IT cooperative program, although the IT component is specific in its nature. The program uses a self-placement approach where students are required to obtain their own placement using clearly defined criteria. Each student is assigned a supervisor in a primary discipline and a second supervisor with a second required discipline.

An e-business placement, for instance, might have a heavy IT component in designing and procuring a web presence for the organisation, overseen by a principal supervisor from the IT discipline; but given the promotional dimensions of such a project, a secondary supervisor from the marketing discipline might also be assigned (Fincher et al, 2004, p. 116).

Fincher et al raise a number of challenges particular to IT education. In the development of software or hardware solutions, projects are generally
undertaken by a team of students. Such projects require mechanisms in place to assess individual contribution and achievement. A further challenge is the balance between the requirements of the expertise to complete a project to a reasonable standard versus the expectation of clients. As students are taught a generic skill base, expertise may be lacking to complete a project much beyond the prototype stage. The expectation of the client then has to be managed closely, as many clients may have limited IT skills. This becomes a challenge for the academic supervisors to develop the knowledge of the student team during the project cycle and manage the expectation of the end result. This requires the academic to become project mentor, sales and marketing manager, and often councillor. Fincher et al (2004) conclude:

(w)e believe that the forces shaping IT are unique; of necessity cooperative education in IT exhibits a wide variety of responses which have evolved to match the innate diversity of the fields of study classically known as ‘computing and information systems (p. 120).

Deakin University has a Bachelor of Business Information Technology (BBIT) honours program that uses work-placement as a major component. The final year consists of a research-based or applied research project by students who work closely with industry mentors, very similar to the capstone project undertaken at Akoranga. Smith, Mackay, Challis and Holt (2006) carried out research in 2005 to test three assumptions educators tend to make about the role of industry mentors when designing and running industry-based components of IT programs. The assumptions were drawn from prior interviews with University academics involved in the BBIT, as well as with students.

Smith et al (2006) state “(i)n work-integrated learning programs, such as the BBIT, industry mentors are often the nexus between the world of the university and the world of industry” (p. 2). The three assumptions were:
Assumption 1: Industry mentors will be committed to the notion of experiential/integrated learning, understand its salient characteristics and how, and for whom, it value adds.
Assumption 2: Industry mentors will be carefully selected on the basis of a shared understanding of the skills required and have the capacity to demonstrate these skills.
Assumption 3: Industry mentors will have a vision of what constitutes a meaningful/satisfying placement, their role in achieving this and have the capacity to structure and implement it. (pp. 2-3)

The research noted that while industry mentors could express the skills needed to perform their role and identify features desirable of a meaningful or satisfying work placement, mentors often struggle to articulate an overall vision of what constitutes this or their own role in achieving a desired outcome. Regarding the first assumption, industry mentors supported the intent of the projects but found difficulty in the concept of experiential learning. The second assumption proved often untrue with organisations resulting to pragmatic solutions, for example, supplying staff that were available. The third assumption also proved often false as many mentors struggle to understand what may constitute a meaningful or satisfying placement.

Academe’s perception is that from the IT industry’s viewpoint, industry based (or capstone) projects are a necessary requirement to prepare students for work in the ‘real world’. These projects are often frightening and overwhelming for a student because of the sheer size and complexity. The management of client expectations is a key role of a project coordinator. Bidois, Clear, Gates and Talbot (2004) state “(o)ften clients, (typically in small business contexts) may themselves have limited IT awareness, and either under or overestimate the students’ abilities, requiring that project scope and deliverables be adjusted to fit” (p. 25). It is the role of the coordinator and student mentors to manage this expectation in order that the project process
remains on track. Bidois et al suggest that the client expectations need to be addressed, managed, as there will likely be a number of obstacles such as lack of resource, whether human or physical that may demand an alteration of the project deliverables and timeline.

Skelton and McLay (2006) state that “(i)n the New Zealand Institute of Technology and Polytechnics (ITP) sector, industry projects have grown increasingly important particularly within applied bachelor’s degrees” (p. 249). They contend that there is a need to look at a more comprehensive cooperative model within the capstone projects to greater enhance the opportunities for students to learn, both in a technical sense as well as a political and business sense. They state, “(e)ven the best of our IT students are limited in the professionalism of their finished IT product because of their isolation from professional peers, their limited experience and a lack of access to corporate resources” (Skelton & McLay, 2006, p. 250). The final results may, as Skelton and McLay suggest, lack polish, but the learning gained in developing the product is the central point of the exercise, not the development of the artefact or solution.
The learning theories of Cooperative Education

Van Gyn and Grove-White (2004) identified a structure of orientations regarding perspectives on learning in education. Of particular interest are the orientations of Transaction and Transformation.

*Figure 3.2 – Structure of Orientations*

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Context</th>
<th>Educational Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission</td>
<td>Behaviorism</td>
<td>Rote learning</td>
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<td></td>
<td>Empiricism</td>
<td>Direct Instruction (lecture)</td>
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<td></td>
<td>Conservatism</td>
<td>Perspective feedback</td>
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<td></td>
<td>Competency-based education</td>
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<td>Design of learning outcomes</td>
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<td>Practice for transfer</td>
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<td></td>
<td>Content Mastery</td>
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<tr>
<td>Transaction</td>
<td>Cognitivism/Constructivism</td>
<td>Problem-based learning</td>
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<td></td>
<td>Liberalism</td>
<td>Inquiry-based learning</td>
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<tr>
<td></td>
<td>Economic</td>
<td>Cooperative learning</td>
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<td></td>
<td>Prosperity</td>
<td>Collaborative learning</td>
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<td>Active-participatory learning</td>
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<td>Experiential learning</td>
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<td>Observational learning</td>
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<td></td>
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<td>Modelling, Scaffolding</td>
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<td>Metacognitive strategies</td>
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<td>Prior learning assessment</td>
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<td>Learning for understanding</td>
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<td>Learning to learn</td>
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<td>Critical thinking</td>
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<td>Reflective practice</td>
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<td>Life-long learning</td>
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<tr>
<td>Transformation</td>
<td>Critical Theory</td>
<td>Critical dialogue</td>
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<td></td>
<td>Globalization</td>
<td>Reflective practice, Journaling</td>
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<td></td>
<td>Internationalism</td>
<td>Ethnographic analysis</td>
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<td></td>
<td>Social Justice</td>
<td>Service learning</td>
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<td></td>
<td>Feminism</td>
<td>Interdisciplinary study</td>
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<td></td>
<td>Diversity</td>
<td>Communities of practice</td>
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<tr>
<td></td>
<td></td>
<td>Critical pedagogy</td>
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</tbody>
</table>

(drawn from Van Gyn & Grove-White, 2004, Table 1, p. 31).
Contemporary pedagogies within education seem firmly rooted in the transaction orientation, much of IT education has remained in the transmission orientation with competency-based education and direct instruction common.

Eames and Cates (2004) cite Van Gyn, Cutt, Loken and Ricks (1997) who suggest that the traditional view of cooperative education is an effective training strategy rather than an educational strategy. Van Gyn et al suggest that co-op is seen as a “vehicle for training students to perform certain tasks in certain jobs. [transmission] rather than the more generalist knowledge/skill accumulation and development of thinking assumed to be the domain of classroom education, particularly in the university sector” (Eames & Cates, 2004, p. 38). The change to undergraduate degrees by the polytechnic sector in the late nineties has resulted in a more generalist knowledge / skill accumulation and a move away from the transmission aspect common in cooperative education programs. Cooperative education, in the main, has remained on the periphery of academe.

A report commissioned in 1985 by the Cooperative Education Association of America suggested three reasons for this lack of penetration into mainstream academe. They are:

Faculty do not recognize work as a vehicle for learning and, in fact, view cooperative education as anti-intellectual [original emphasis]. Co-op practitioners tend to see themselves as operational people concerned with logistics and administration – not educators, and cooperative education methodology for promoting learning is vague and underdeveloped (as summarised by Van der Worm, 1988, p.121) (Eames & Cates, 2004, p. 39)
Eames and Cates refer to several theories that influence cooperative education today, Piaget’s cognitive-development theory, Gagne’s conditions of learning, Atkinson’s model of achievement and Bandura’s social learning theory to name a few. Constructivist theories feature strongly throughout cooperative education. The work of Billett (1998), Mezirow (2010), Kegan (2010) all have transactional orientation. More recently sociocultural views of learning, which fit more within the transaction orientation, have been introduced. Eames and Cates refer to the work of Lave and Wenger and the introduction of the idea of communities of learning. Van Gyn and Grove-White (2004) state:

Transaction emphasizes learning rather than teaching, and learner-centred outcomes of the transaction perspective in education that continue to be highly valued in contemporary educational systems include critical thinking development, self-directed learning, and continuous learning processes (p. 30).

The challenge for IT education, especially in regarding cooperative education, is the move to the next orientation, the transformation orientation which includes such educational practices as interdisciplinary study and communities of practice, which become more prominent in a technological driven society. However, I do not suggest that the era of transmission is over; rather the next step to be added to the educational process is the adoption of transformational education practices. Van Gyn and Grove-White suggest that the transformation orientation in education is a departure from the previous orientations due to its influence largely from non-western traditions and a growing understanding of an ecological order. They state that this orientation “is a rich intersection of views and traditions from humanistic psychology, existentialist philosophy, and from post-modern and post-colonial theory” (Van Gyn & Grove-White, 2004, p. 33). Mezirow (2009) suggest that education in this orientation is concerned with how individuals can be empowered. Mezirow further suggested that this orientation is of an ideal society of communities of learners engaging in a continuing collaborative inquiry. Van Gyn and Grove-White also suggest that the transformation
orientation is underdeveloped in western orientated education systems. Although they suggest that this orientation has achieved a level of acceptance in the last 15 to 20 years there remains scepticism. Eames and Cates (2004) conclude that one explanation for the failure of a single theory that explains learning outcomes through cooperative education may lay in the simple fact that student learning is complex. They go on to state that “(i)n keeping with the sociocultural views of learning, it may be impossible to separate learning from the social process in which that learning occurs, therefore a simplistic approach to research in cooperative education will lead to inconclusive or erroneous results” (Eames & Cates, 2004, p. 45).

The risk of focusing on a single question, attempting to discover the manner in which students demonstrate learning (Research Question One), is the reason behind the second research question in this thesis which attempts to better understand the context in which the learning takes place.

**Research in cooperative education**

There is growing research into the application of theory to cooperative education practices, Coll and Chapman (2000b), Coll, Simons, Germans and Ruijters (2003) and Coll and Eames (2004), although there are differences in approaches between the United States of America and the rest of the world. In the US, cooperative education programs are managed by coordinators, rather than research-based academics, much of the data that have been collected focus on the mechanics of the cooperative experience, rather than the theory underpinning the experience. Bartkus and Stull (1997) suggested that a majority of the research completed in the last 30 years was “applied-descriptive and evaluative in scope” (p. 9). This was despite an increase in the number of doctoral theses in this area. Rick, Cutt, Branton, Loken and Van Gyn (1993) raise concern over the lack of scientific method however this is changing. Published research tended to lack strong hypotheses or an examination of causation. In defence, the very nature of variability of
cooperative programs often makes it difficult to standardize the variables to fit the domain of pure quantitative analysis and therefore much of the research published in this area has been more qualitative. Bartkus and Stull (1997) identify reasons for the lack of strong qualitative research. They contend that there are three reasons for the lack of research, either quantitative or qualitative. They cite a difficulty in obtaining funding research, the lack of graduate students undertaking research in this area and the situation of cooperative education practitioners. Eames (2003) refers to a survey by Egan and Weaver-Paquette (1993) that found fewer than 10% of coop practitioners held a doctoral degree and fewer than half of the remainder held masters.

The polytechnic sector in New Zealand in 1993 was by in large a pre-degree program environment. The rise of degree programs and the associated emphasis on theoretically based research has begun to see an increase in good quality research. Prior to degrees a majority of the staff was, in an academic sense, under-qualified. The statistics promoted by Egan and Weaver-Paquette (1993) would not have been unusual in the pre-degree environment. Over this last decade there has been an increase in the qualification levels of staff at a majority of institutions, certainly to the level of masters and in a few cases toward PhD but as is evident from interviews with staff in Chapter Eight, this change to a more academic process is still a difficult challenge for most staff involved in the education of IT professionals.
Benefits of work-based placements and simulated work environments.

Beasley (2003) also refers to the many benefits of such capstone programs. ‘First, a senior capstone course provides an opportunity for the student to ‘pull together’ virtually everything he or she has learned in the field of computing to produce a real-world software product for a real-world client” (p. 122).

Blackwell, Bowes and Harvey (2001) refer to the National Committee of Inquiry into Higher Education (NCIHE) claims on the benefits of work experience. They state:

The claims that are made for work experience, whether as a part of the school or higher education curriculum, can be summarised under the following headings:

Changing teachers’ attitudes.
A more relevant curriculum.
Informing employers.
An employability signal.
Motivating learners to achieve higher grades (Blackwell et al, 2001, p. 270).

At Akoranga we have received support from our local IT sector for capstone projects, as the projects are seen as a useful introduction in preparing students for work in the ‘real world’. From a student’s standpoint these projects are often frightening and push them beyond what is comfortable or familiar. This view is a consistent theme at an annual New Zealand educational computing conference coordinated by the NACCQ attended by educators from the ITP education sector. As a process to assess a student’s overall capability and as a tool to produce a portfolio of work, student projects are invaluable. Such projects have projected the capabilities of our students and the degree team in particular to ‘the industry’. In 2002 four of the projects were undertaken with the application development section of the New Zealand Defence Force. One
was a traditional work-placement and three were housed in a simulated work environment. The results from a client perspective were positive. The Chief Information Officer with the New Zealand Defence Force was interviewed for the trade magazine *Microsoft NZ .Net*, on the implementation of the then new programming framework Microsoft DotNet.

This year we looked at our project list and provided a selection for them to consider. All the projects were .Net and prior to commencing these projects, because of the newness of the technology, none of the students had worked on .Net. Today, we are looking at having three Web-based .Net applications and one desktop installed .Net application completed by the end of 2002 – all projects that would not have happened without these students and the speed at which they grasped .Net and its functionality (Microsoft, 2002, p. 26).

All project teams are assigned a mentor, who is knowledgeable in at least one area of the project, whether this is programming language, databases, networks or systems analysis and design. The student teams, through their mentor, have access to the other skill bases they may require. The students, however, own and run the projects. The mentor is there to ensure that the overall direction of the project is maintained and that the relationship with their client is also maintained. Placement of students for a portion of their education is not new. Many placements however are in large global organisations that have a history of internship. New Zealand has very few large global corporate and its business environment mainly comprises of small to medium enterprises that may not have the capacity or the structure to take on student placements.
The challenge for models of cooperative education is in establishing the benefit for students of this kind of education. Dressler and Keeling (2004) state “research supporting participation is often too anecdotal to meet the needs of our constituents, namely employers, university administrators, students, parents and legislators” (p. 217).

In an approach of education that is funded for specific outcomes by justifiable resource outputs, contact hours, budget, evidence of successful outcomes, it may prove difficult for cooperative education programs to justify its existence. This is due to the design of the programs and the mechanisms used to provide data on the benefits or otherwise of a program. In New Zealand the NZQA has embarked on an expansion of its External Evaluation and Review program into the PTE and the polytechnic sector. By 2011, only three polytechnics had proceeded through a full institutional review using the self-evaluation EER framework, Akoranga being one. IT programs at Akoranga were put forward for review and while this was a challenging process, it proved invaluable in assessing the strengths and weaknesses of the programs and highlighted the reliance on anecdotal data rather than hard data sources. This had led to an ongoing institutional review on how hard data can be obtained for the validation of a programs performance.

Weisz and Chapman (2004) stated that the business of educational institutions “is to stay in business and to provide students with the skills and confidence to succeed in which globalization, technology transfer, cross-functional knowledge and teamwork will play a greater role than ever before” (p. 247). Weisz and Chapman see the advantage of cooperative education curricula as beneficial not only as a tool for better preparation for students entering the work force but also as a marketing opportunity for individual institutions to promote the benefit of cooperative education programs. However, cooperative education programs are not without their own cost structures, which require a different approach to cost-benefit analysis than traditional classroom-based programs of study.
Cooperative education is seen to be more relevant than ever before in meeting these challenges and opportunities. However an educational institution faced with the cost of providing co-op may well ask questions such as how relevant is our co-op programs, how cost effective are they and what are the benefits of co-op to them as an education provider (Weisz & Chapman, 2004, p. 247).

A study carried out by Weisz (2001) found that 72% of students would have chosen to undertake a cooperative degree had one being available. The study also indicated that co-op graduates obtain employment, on average, in a shorter time span than non-co-op graduates.

One benefit of a cooperative model of education is the opportunity for engagement with industry. If the opportunity is taken, the academic staff become far more aware of their respective industries and are therefore, able to have influence on the curricula of a given program. The benefit for academic staff to stay in touch with the ‘real world’ should not be understated. The management of academic staff to allow the freedom to mix with industry and fulfil their academic work is, however, a great challenge for management. In particular, the IT industry is generally polarized by the problem of remuneration. It is not uncommon for IT professionals to earn salaries twice that of an academic so institutions find it difficult to retain valuable staff who are offered good positions in the industry. Certainly competing on salary is an impossible task for a majority of institutions, therefore, other such inducements as work-life balance or research opportunities need to be investigated.

Varty (1996) suggests that industry will show loyalty to cooperative education programs which is an indicator of employer satisfaction. Coll and Zegwaard (2002) carried out research into science and technology and business employers’ perspective of graduate success. Coll and Zegwaard felt it was important to clarify was definitions of terms such as ‘competency’ and ‘capability’ and cite Birkett (1993) who suggests that it is the relationship
between the contextual task performance and individual attributes that determines competence. For a definition of ‘capability’ Coll and Zegwaard cite Rudman (1995) who asserts:

capability as a precursor to competency, where an individual has the capability to perform a specific task because they have the necessary knowledge and skills, but they do not become fully competent in the task until they have had some experience (Coll & Zegwaard, 2002, p. 20).

Coll and Zegwaard (2002) conclude that “(t)he challenge for curriculum designers and practitioners is to help students maximize the opportunities provided by cooperative education programs to develop the critical competencies that they will need in the workplace from day one” (p. 25).

There has of course been a multitude of research using focus groups or interviews on student groups. Each individual discipline can result in quite different results. Responses from students engaged in the arts and humanities differ from students engaged in scientific-based professions. IT is a very structured discipline. Biglan (1973) describes the distinction between ‘hard’ and ‘soft’ as a matter of consensus. If there is a general consensus among educators about the content and the method of study then a discipline may be considered paradigmatic and therefore ‘hard’. Disciplines, which have fewer consensuses, would be considered non-paradigmatic, or ‘soft’. Becher (1994) suggests that Biglan’s idea of ‘hard’ and ‘soft’ is too simplistic. He suggests that there is a need to expand this idea to include the concepts of ‘pure’ versus ‘applied’ especially when attempting to interpret the effect on learning. Becher (1994) refers to the works of Biglan (1973) and Kolb (1981).

In each case these divisions are identified respectively with the natural sciences, the humanities and social sciences, the science based professions and the social professions. The coincidence of their analyses is significant,
given that Biglan's initial concern was with the nature of the subject matter of research, while Kolb's was with styles of intellectual enquiry (p. 152).

**Figure 3.3 – Becher’s Broad disciplinary groupings**

<table>
<thead>
<tr>
<th>Biglan</th>
<th>Kolb</th>
<th>Disciplinary areas</th>
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<tbody>
<tr>
<td>Hard pure</td>
<td>Abstract reflective</td>
<td>Natural sciences</td>
</tr>
<tr>
<td>Soft pure</td>
<td>Concrete reflective</td>
<td>Humanities and social sciences</td>
</tr>
<tr>
<td>Hard applied</td>
<td>Abstract active</td>
<td>Science-based professions</td>
</tr>
<tr>
<td>Soft applied</td>
<td>Concrete active</td>
<td>Social professions</td>
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(drawn from Becher, 1994, p. 152).

Becher suggests that within each of these disciplinary areas exist subcultures that further delineate groups. Becher cites Bucher and Strauss’s (1961) ‘loose amalgamations’ which are “more or less delicately held together under a common name at a particular period in history” (Becher, 1994, p. 152).

While there are comparisons that can be made when analysing the data obtained from this cultural group, I needed to be mindful of the discipline from which a comparison is being made and the context of the comparable research. Like Becher, I find the terms ‘hard’ and ‘soft’ far too simplistic. For the remainder of this thesis I shall refer to technical and non-technical learning to distinguish between IT specific knowledge and the more general knowledge skill areas such as communication or project management.

**Summary**
Cooperative education may be carried out in a variety of forms, from work integrated learning to sandwich courses through to, as in the case of the project-based learning at Akoranga, a capstone project. The mechanisms while varied have elements in common; the involvement of the student, the organisation and an external partner. It is this exposure to a greater or lesser degree to the external partner that contextualizes the learning experience and the benefits that may be derived by the student. Benefits to the employer are well documented with one of the major benefits being the ability to trial an individual in a given team or environment to determine their suitability for employment. There are also benefits to institutions that participate in cooperative education with contact with the industry a program serves and the opportunity for staff to maintain an avenue of contact. Challenges remain with running cooperative education programs. They tend to have a lower staff to student ratio than traditional classroom teaching and such programs often require a flexible approach to assessment, often making the programs difficult to monitor and measure against normal classroom practice. These challenges aside, the opportunities for robust programs of study are many and are well worth pursuing. In the next chapter I continue with the literature review on the theories and theorists that have influenced me in this research.
Chapter Four: Theories of learning applicable to capstone projects

Introduction

This chapter discusses the literature on learning and knowledge that is relevant to capstone projects. Theories of learning are proposed as a basis of identifying how learning occurs during a capstone project cycle. Prior to becoming a tutor I had given little thought to how individuals learnt. I grew up in a household that viewed learning as a skill-based activity and my employment initially in the construction industry and, subsequently, the IT industry reinforced that particular view.

It is clear from the mandate in the New Zealand Tertiary Education Commission’s document *Tertiary Education Strategy, 2010 to 2015*, vocational education is expected to play a significant part in the development of the knowledge economy and institutes like Akoranga are seen as instrumental in delivering such training. The polytechnic sector has at its core an emphasis on applied vocational learning. There is an opportunity for the polytechnic sector to develop curricula that enhances applied learning away from the traditional forms of classroom education for the benefit of the student, the sector and the institute.

The following theories presented in this chapter have been chosen due to their usefulness in contextualising the framework in which to view adult students engaged in IT project based learning. These theories of learning by Gagné, Illeris and others help identify the challenges of mentoring and facilitation rather than teaching in the traditional view. The theoretical views of the Gestalt school and systems theory reinforce the view, from an IT perspective, of capstone projects as a system in its own context, providing students opportunities of learning both from the engagement of creating an artefact and from the contextual environment in which this creation is carried out. The use of a constructivist approach to learning allows for the recognition of both
formal and informal learning. While it is possible that a smaller number of learning theories may have helped to focus this chapter I feel that all the theories presented within this chapter lend important elements to a project-based learning approach in IT and have chosen a wider rather than a narrower focus.

**Conceptualization of learning**

Learning is a term that is used in a wide variety of contexts and often with various definitions. Gagné (1965) asserts that “(l)earning is a change in human disposition or capability, which can be retained, and which is not simple ascribable to the process of growth” (p. 5). Bruner (1966) suggested that it was easy to explain the modifications of behaviour in any theory chosen as there were so many aspects of growth that “any theory can find something it can explain well” (pp. 4-6).

More recently Illeris (2007) defines four main meanings that he suggests appear most frequently in everyday language. These definitions are:

1. First, the term learning can refer to the outcomes of the learning processes [Authors emphasis] that take place in the individual. Learning, here, is used to mean what has been learned or the change that has taken place.
2. Second, the term learning can refer to the mental processes [Authors emphasis] that take place in the individual and can lead to such changes or outcomes as covered in meaning 1. These may be termed learning processes, and it is typically these processes that learning psychology is concerned with.
3. Third, the term learning can refer to both the interaction processes [Authors emphasis] between individuals and their material and social environment, which, directly or indirectly, are preconditions for the inner learning processes covered by meaning 2 (and which can lead to the learning covered by meaning 1).
4. Finally, the term learning is very often employed not only in everyday language, but also in official and professional contexts, more or less synonymously with the term teaching [Authors emphasis]. This shows that there is a general tendency to confuse the terms teaching and learning. (Illeris, 2007, pp. 2-3)

Illeris concedes that the above definitions are open and deliberately so. The underlined terms [original emphases] are there to avoid limitations. Illeris goes on to define learning as “any process that in living organisms leads to permanent capacity change and which is not solely due to biological maturation or ageing” (Illeris, 2007, p. 3). For the purposes of this thesis the emphasis is certainly on meaning one and meaning three; the “what has been learned or the change that has taken place” and “the interaction processes between individuals and their material and social environment”.

In the social environment, Eraut’s theories on informal learning provide insight into the wider context of learning. Formal education is linked with schools and training institutions; non-formal with community groups and other organizations; and informal covers what remains, e.g. interactions with friends, family and work colleagues. Eraut (2004) suggests that, “characteristics of the informal end of the continuum of formality include implicit, unintended, opportunistic and unstructured learning and the absence of a teacher” (p. 250). The capstone projects present students with the opportunity to learn from everything around them, not only from the formal assessment structure of the project but also the environment in which each individual project is situated, from professional workspaces to half-way emulation environments.

There are a variety of formal instructional methods applied to students on a capstone project. These include group [class] discussion, tutoring from a more knowledgeable peer or expert, mentor instruction through a project client and cooperative learning through the environment in which a project is situated. The placement with a client group lends to the project experience, a richer
environment from which to draw knowledge. In the capstone projects undertaken by students in Akoranga’s Bachelor of Information Technology, the initial focus is on identifying the problem, the proposition of a solution, and then developing outcomes required for the production of the solution, usually the creation of an artefact. In this type of project the tutor becomes the guide or mentor of the process, rather than an instructor of knowledge. The assessment of the project, therefore, becomes less concerned with identifying a right or wrong answer, but rather with identifying the processes involved in developing a solution. When capstone projects are considered, it becomes clear that there are many theories of learning that can be applied to either the projects themselves or the context in which they exist.

Gestalt school and systems theory

The Gestalt school of thought is rooted in the works of Goethe and Kant. Gestalt approaches the analysis of learning through the development of ‘insight’ that takes place through the application of problem solving. While rooted in Germany this approach gradually gained acceptance in the US. In 1965 Robert Gagné developed a typology to summarise Gestalt approaches in eight hierarchical learning types although there is criticism by Illeris (2009) that Gagné’s hierarchies do not adequately the true holistic understanding of Gestalt psychologists. Lewin conceptualised each individual as existing in their own life space in which many forces, environment, status, motivation all play an integral part in the individual. If one force presented itself stronger, then that contributed to the action of the individual. If an individual’s motivation to learn was stronger than the environmental or social factors, an individual could alter their state.

There is a degree of symmetry between Gestalt and systems theory. Both treat the learning within the mind and the system in which the learning occurs as a whole system. Systems theory originated with the work of Ludwig von Bertalanffy developed in the early twentieth century and is popular within the
IT community. Systems theory is based on the idea that all phenomena can be viewed as a web of relationships. These relationships have common patterns, behaviours and properties that, when identified, can develop a better insight into the behaviour of phenomena.

Systems theory has also been a common approach in application development and Gestalt psychology is a feature in the area of human – computer interaction design. Gestalt principles are used in the design of applications, for example, the layout of buttons and screen sizes to be ‘familiar’ with human perceptions. Alan Cooper, a recognised programming guru in application development, stated that he “prefers the term ‘interaction design’ over the term ‘interface design’ because ‘interface’ suggests that you have code over here, people over there, and an interface in between that passes messages between them” (Cooper, 1999, p. 23). Cooper suggests that this implies that the interface is separate to the application and its intended use. This disjointed approach of not taking into account the end use of an application at the time of coding an interface fails to see the development as a whole. This statement aligns with the Gestalt view.

Tolbert (2004) states “As Gestalt therapy was taking root, general systems theory was gaining acceptance. The idea that seemingly disconnected disciplines, including those focused on the study of human behaviour, could have something in common was another radical movement of the early twentieth century” (p. 8).

If a Gestalt or Systems theory approach is taken in relation to capstone projects then the symmetry between the two approaches becomes understandable. Capstone projects expose students to the theory of technically integrated systems but the outcome of capstone projects is heavily reliant on what skills the students individually bring to the project and their ability to problem solve solutions.
Constructivism

Constructivism is a psychological and philosophical perspective contending that individuals form or construct much of what they learn and understand. Constructivism is not a theory, but rather a philosophical explanation about the nature of learning, in which learners create their own learning. The assumptions of constructivist theory are that people are active learners and will construct knowledge for themselves. This knowledge not only comes from formal instruction but also from the environment in which the instruction takes place. As well as the formal instruction and the educational environment, the external or social environment in which the student exists contributes to the learning process. Vygotsky’s 1924 paper *The methods of reflexological and psychological investigation* in which he challenged the dominant use of learning struck a chord with the Marxist leadership at the time. This was shortly after the October Revolution of 1917 when the Marxist leadership was seeking to understand how to engender social change within the population. Vygotsky believed that social interactions are critical for knowledge to be constructed between two or more people. He believed that human development occurs to the cultural transmission of language and symbols. He is best known for the development of the key concept, the Zone of Proximal Development (ZPD).

ZPD is defined by Vygotsky in Shunk (2008) “as the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem-solving and adult guidance or in collaboration with more capable peers (Vygotsky, 1978, p.86). Eastern European cognitivist theories gradually became more widely known in the West. Luria, Vygotsky, and his contemporary Leont’ev led to Engeström’s (1987) view of learning. Engeström suggested that human activity can be understood within a framework of rules. Engeström (2009) states that any theory of learning must answer four central questions in order to qualify as a theory:
1. Who are the subjects of the learning — How are they defined and located?
2. Why do they learn — What motivates them to make the effort to learn?
3. What do they learn — What is the content and outcomes of their learning?

Engeström believes that the standard theories of learning are focused on a process or series of processes where an individual gains knowledge “in such a way that a corresponding, relatively lasting change in the behaviour of a subject may be observed” (Engeström, 2009, p. 58). A competent teacher who knows what is to be learned assists this process. He states that the problem with this standard view of learning is that this does not apply to many types of learning that occurs. People and organisations are often learning that which is not stable or even defined let alone understood ahead of time.

This is true of the constant development of technology within IT where applications or artefacts are developed on the basis of a roughly designed concept and subject to further development upon initial release to the market place. Engeström (2009) states that “we must learn new forms of activity which are not there. They are literally learned as they are being created. There is no competent teacher” (p. 58). As mentioned in Chapter One this is one of the greatest challenges within the IT industry where the teacher, or to use Vygotskyian phraseology ‘a significant other’, may have little more knowledge than the learner, simply due to the rapid pace of change of the application development tools.

Andragogy and life-long learning
Mezirow’s work in adult education is important when reviewing learning theories in the context of Akoranga which has a higher than average proportion of second chance adult learners. Mezirow (2000) defines learning as “the process of using a prior interpretation to construe a new or revised interpretation of the meaning of one’s experience as a guide for future action” (p. 5). Mezirow is influenced by the work of Jürgen Habermas and, like Habermas, Mezirow identifies two distinct types of learning, Instrumental learning, which involves “cause and effect relationships or learning through task-oriented problem solving”, and Communicative learning in which the learner is actively negotiating their way “through a series of specific encounters by using language and gesture and by anticipating the actions of others” (Jarvis et al, 2003, p. 40). Mezirow (2009) states “instrumental learning pertains to learning involved in controlling or manipulating the environment, in improving performance or prediction” (p. 91).

Like Habermas, Mezirow asserts that instrumental learning is used in those activities that require development and analysis, for example, designing cars, medical diagnosis, scientific and mathematical inquiry. I suggest that the creation of software artefacts also is an example of instrumental learning. Communicative learning activity “provides us with an epistemological foundation defining optimal conditions for adult learning and education” (p. 91).

These conditions are as follows.

- Have accurate and complete information
- Be free from coercion, distorting self-deception or immobilizing anxiety
- Be open to alternative points of view – empathic, caring about how others think and feel, withholding judgement
- Be able to understand, to weigh evidence and to assess arguments objectively
Be able to become aware of the context of ideas and critically reflect on assumptions, including their own
Have equal opportunity to participate in the various roles of discourse
Have a test of validity until new perspectives, evidence or arguments are encountered and validated through discourse as yielding a better judgement (Mezirow, 2009, p. 92).

Students engaged in capstone projects are required to develop solutions from their existing frameworks of knowledge in order to construct knowledge and develop skill sets for further endeavours. This requirement aligns well with the theory of constructivism.

Students at Akoranga consist of a high proportion of second chance learners, many over the age of twenty-one years and considered adults by the tertiary education funding system; therefore, applying adult learner pedagogy to learning is appropriate. These students bring a wealth of experience to their education from a variety of social and ethnic backgrounds. This experience plays a large part in their capabilities and adaptability to cope with the project. Rogers (1969) suggested that teaching was not about education but rather the facilitation. He defines the role of a teacher as one of a ‘facilitator of learning’ (p. 105). Tough (1979) advocated that adults in particular learn in a project mind-set. He suggested that individuals organised their learning around projects, each comprising of a series of episodes. These episodes result in an individual’s “total motivation is to gain and retain fairly clear knowledge and skill or produce some other lasting change in himself” (Tough, 1979, p. 6).

Figure 4.1 - Tough’s Relationship of benefits
Tough devised this flowchart of the relationships of the benefits that may expect from a project. While the flowchart is specifically designed for Tough’s view on adult education, it is noticeable that all episodes, ‘A’ through to ‘F’, result in the option for pleasure or self-esteem for an individual. I was interested that if I am attempting to determine how students demonstrate learning, then to note indications of an increase in their self-esteem or pleasure in completing a task may be a useful determinant.

Experiential learning

Usher suggests that there are four distinct quadrants that can be used to map experiential learning.

**Figure 4.2 - Usher’s Experiential learning quadrants**
Capstone projects are firmly rooted in the vocational quadrant. Students undertake the project as a ‘proof of ability’ to declare, much in the manner of an apprentice, their ability to become one of ‘the craft’. These students are seeking to gain vocational skills; they do not study for a lifestyle, although success in the vocation may provide a lifestyle far different from where they begin. As part of an applied degree the project is an attempt to mimic the ‘real world’, to provide a strong vocational base from which a career may be developed. Usher (2009) states:

Vocationalism then is designed to produce flexible competencies and a predisposition to change. This is allied to a critique of the dominant liberal-humanist academic curriculum and draws upon some aspects of progressivist theories of motivation and learning (process-orientation, cooperation, problem-solving, open-ended investigation). It argues, first, that the ‘real world’ (by which is meant the world of post-Fordism and flexible specialisation) is not subsumable under academic subject divisions, and hence the academic curriculum provides an ‘irrelevant’ education and preparation for this world, and second, that the didacticism and teacher-centredness of this curriculum does not provide the appropriate attitudes and capabilities (pp. 170-171).
While I agree with the initial definition of vocationalism, I cannot agree that academic curriculum provides ‘irrelevant’ preparation for employment. Student education pre-project is about the fundamental underpinnings of knowledge rather than the application of knowledge. The addition of capstone projects into curriculum allows for that underpinning knowledge to be refined and develop the appropriate attitudes and capabilities.

**Transformational learning**

The capstone projects are undertaken in a rigid framework of academic requirements. While the project is flexible in so far as the methodological approach or the artefact to be delivered, the project has strict criteria defined in a handbook, which ‘guides’ the group in what and how to develop and present. Individual experience, while an aid to a student’s ability to manage a project, is not taken into account. “Within vocational practices, what we see happening is the commodification of experiences – experience becomes a commodity to be exchanged in the marketplace of educational credit” (Usher, 2009, p. 176).

Students submit journals as a part of their assessment for the capstone project; the content of the journal is not used effectively as a source for identifying experiential knowledge to complete the project. Lave (2009) refers to the four premises of knowledge and learning in practice.

1. Knowledge always undergoes construction and transformation in use.
2. Learning is an integral aspect of activity in and with the world at all times. That learning occurs is not problematic.
3. What is learned is always complexly problematic.
4. Acquisition of knowledge is not a simple matter of taking in knowledge; rather, things assumed to be natural categories, such as

5. Wildemeerch and Stroobants (2009) see transitional learning occurring “when individuals are faced with unpredictable changes in the dynamics between their life course and the transforming context, and when they are confronted with the need to (learn to) anticipate, handle and recognise these changing conditions” (p. 222). In relation to the capstone projects, they are by their very nature, changeable. This potentially rapid changeability forces students to alter their perceptions based on previous knowledge and/or experience and to devise a new ‘truth’.

Transformation does not occur in a vacuum; rather transformation occurs when the experience is treated as a whole experience, both internally and externally. Again there are parallels with systems theory. Illeris (2007) states “(w)e experience things all the time, but what is important in pedagogical terms is – the quality of the experiences” (p. 126). Dewey refers to the benefit of a given experience to enhance an individual. Dewey (1965) states:

An experience arouses curiosity, strengthens initiative, and sets up desires and purposes that are sufficiently intense to carry over dead places in the future (and not) operate so as to leave a person arrested on a low plane of development, in a way which limits capacity for growth (pp. 33-38).

The intent of the capstone project is to exploit a students’ curiosity and mentor the desire to achieve a stated objective. The mentorship of the student through the academic process is to ensure that a result is achieved to which a grade can be awarded. Essentially however the process is not about the grade but rather the journey in which more than just learning is demonstrated, the student has enhanced a full range of skills, technical, non-technical and social.
Models of experiential learning

As part of the research I have investigated a number of experiential learning styles that best explained the learning processes of students engaged in the capstone project. Experiential learning involves the student applying skills and knowledge in a particular setting, such as a capstone project, to engage in the creation of a solution to a given challenge. The purpose for the attempting to identify a particular experiential learning style was to have a framework by which measurement may be applied. Learning styles have been applied in research around workplace learning. Smith and Lindner’s (1986) use of the Canfield Learning Styles Inventory to assess teaching delivery methods in a variety of programs resulted in the development of alternative teaching delivery methods. While the development of alternative teaching methods was unlikely given the small number of students that would be involved in my research into capstone projects at Akoranga, the identification of a learning style would be useful.

I was familiar with Kolb’s learning cycle and had read research that used Kolb’s Learning Style Inventory for the measurement of learning. Kolb’s experiential learning style suggests that a person carries out a particular action, sees the result of this action and from this gains understanding.

In some representations of experiential learning these steps, (or ones like them), are sometimes represented as a circular movement. In reality, if learning has taken place the process could be seen as a spiral. The action is taking place in a different set of circumstances and the learner is now able to anticipate the possible effects of the action (Smith, 2001, Retrieved 12 January 2012, from http://www.infed.org/biblio/b-explrn.htm).

**Figure 4.3 - Kolb’s Learning cycle**
Tennant (1997) suggests that while the four learning styles work well with different dimensions of the experiential learning style, it is too simple and cannot apply to all situations. Anderson (1988) also questions the validity of Kolb’s model as it takes little account of different cultures or experiences. Jarvis, focusing particularly on adult education, has a more encompassing approach to education. His learning model is useful to identify different stages of learning. While possibly appearing complicated the processes as described in the diagram below are useful in providing a framework by which to identify how a student demonstrates learning.

**Figure 4.4 - Jarvis’s 1987 model of learning**

Pragmatism
Perhaps the constructivist viewpoint that sits with me the best is that of pragmatism. William James (1907), writing from Dewey (1910, 1965, 2008), Bertman (2007) and Benson et al (2007) gave me confidence in the logical nature of pragmatism and, although not popular, as an approach to review IT education. Elkjaer (2009) describes, “a ‘pragmatist’ is someone who is focused on results, someone who gets things done and finds solutions to problems despite ideological or political differences” (p. 76). This view is a fairly accurate point of view of many who work in IT, focused on a solution, rather than the overall issues. Elkjaer suggests that, therefore, pragmatic learning is less a ‘if-then’ and rather a ‘what-if” approach. Dewey, Pierce and Mead in their respective approaches were pragmatists.

(a)nd if our schools turn out their pupils in that attitude of mind which is conducive to good judgement in any department of affairs in which the pupils are placed, they have done more than if they sent out their pupils merely possessed of vast stores of information, or high degrees of skill in specialised branches (Dewey, 1910, p. 101).

Robson (2002) states that pragmatism “seeks to achieve a detente between the different paradigms of a post-positivist approach within the empirical tradition on the one hand, and less thorough going versions of relativism found in some constructionist approaches on the other” (pp. 42-43). Robson cites Tashakkori and Teddlie (1998) who suggest:

(i)t does appear that the qualitative / quantitative debate, while it might have been necessary in the 1980s and early 1990s, has now become increasingly unproductive. Some argue that this is because it is now clear that there is a basic incompatibility between the two approaches, hence it is time to stop the talking and get on with one’s own thing (Robson, 2002, p. 43).
Creswell (2009) states seven axioms of pragmatism as an approach for mixed methods research. I have summarised these axioms below, which will set the framework for this research.

Pragmatism is not committed to any one system of philosophy and reality and draws from both quantitative and qualitative assumptions.

Individual researchers have a freedom of choice of methods and procedures.

A pragmatic view of the world allows for many approaches to data collection.

Truth is what works at the time.

“The pragmatist researcher looks to the what and the how. Research always occurs in multiple contexts including political, social and historical.

Pragmatists believe in an external world independent of the mind (Creswell, 2009, pp. 10-11).

Elkjaer (2009) stresses the difference between a pragmatist and philosophical pragmatism as the latter is “often associated with insufficient (theoretical) background” and is associated with “‘learning by doing’ or as mere ‘trial and error’” (p. 77). Capstone projects are ‘learning by doing’ and by identifying past learning experiences and the context of a given project at a given time a model of learning can be established.

**Definition of knowledge**

The term ‘knowledge’ is in itself a difficult term to use without a definition. Davenport and Prusak provide a definition of the complexity of knowledge: “(k)nowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and
incorporating new experiences and information. It originates and is applied in the minds of knowers” (Davenport & Prusak, 1998, p. 5).

Knowledge exists in rules and regulations, routines, both personal and organisational, and in documentation of every form. While such a broad definition does not assist to isolate the forms of knowledge that are gained or exchanged in industry-academe links, the statement does reinforce the holistic nature of knowledge. Garrick, Chan and Lai also concede the difficulty in defining knowledge:

Defining knowledge is frustrating, as it can be fuzzy and unpredictable. It is therefore hard to measure and manage. Knowledge is related to experience, concepts, values, beliefs and ways of working held by people and has the potential to be shared and communicated. Thinking of knowledge as an object is erroneous and this view has lead people to focus on databases, storage devices, owners, experts and “certainty”. Also from this view comes terms such as “knowledge transfer” which suggests that knowledge can be passed on – as if in a relay race (Garrick et al, 2004, p. 331).

Billett cites the work of Vygotsky and Scribner. “This latter view of cognitive development, emphasises the appropriation of knowledge through interpersonal social interactions (Vygotsky) as well as through guidance from more distant social and cultural sources (Scribner)” (Billett, 1998, p. 4).

Davenport and Prusak (1998) state “people search for knowledge because they expect it to help them succeed in their work” (p. 25). Each individual, however, has his or her own reason for sharing knowledge. Davenport and Prusak identified three possible reasons: reciprocity, repute or altruism. In the case of the student placements, both repute and altruism appeared to be the most common form of knowledge transaction. In altruism, students have a bond with one another and seek to assist toward their goal; the completion of
the project and, therefore, the awarding of their degree. In some projects, where there is an opportunity for employment, repute may come to the fore. A student wishing to impress a prospective employer may attempt to show himself or herself as a knowledgeable individual.

Billett similarly comments on the willingness of the workplace learner to engage in gaining or sharing knowledge. “Significantly, the degree to which individuals engage in effortful activity is based on their attitudes and values and ‘goals for life’” (Billett, 1997, p. 5). Each student has their own reason for their participation in the capstone projects. For some it will be a means to an end, a requirement of a program of study to obtain a qualification. For most, I suspect, as the project progresses toward its conclusion it is more about the individual challenges the project presents, what Tough (1971) refers to as episodes, and the challenges that each episode gives an individual.

Knowledge Transfer

Within any organisation knowledge is transferred and often the transfer is without a designed or controlled process. Students engaged in a project may discuss a problem with their academic mentor rather than seeking an expert within the organisation itself simply because that academic is familiar to them. Billett (1998) states:

Given the goals of educational programs are to provide students access to knowledge which is applicable in circumstances other than those where the knowledge is constructed, an understanding of the potential of knowledge to transfer is central to the considerations for instruction (p. 2).

Davenport and Prusak (1998) state that “People in organisations have always sought, used and valued knowledge, at least implicitly. Companies hire for experience more often than intelligence or education because they understand
the value of knowledge that has been developed and proven over time” (p. 12). The news media, when lamenting the IT skill shortage, refer to the lack of knowledge and experience to validate their claim that there is not sufficient experience available to meet job vacancies.

While formal meetings and training play an important part in the development of an individual, there is an argument for ad-hoc meetings and discussion to take place. Davenport and Prusak suggest that conversations that occur around meeting places such as water coolers or in cafeterias provide opportunities for knowledge transfer. For an academic staff member to solve a problem with a student or students the prime mechanisms that are employed at Akoranga was often a whiteboard, coffee and food. This environment provided the catalyst for free ranging discussions in which views from both the students and the mentor were freely expressed. This process emulates that which happens in the IT industry itself; however, it is only a part of knowledge process. Along with the imparting of specific knowledge, learning within industry requires the learner to acquire knowledge about the organisation itself and its own tacit knowledge. The capstone projects undertaken by students are an attempt to develop an understanding of the work environment awaiting a graduate. There is no formal classroom instruction as each project differs from another. Students are required to be actively engaged in identification of the problem and the creation of solutions. This may require the student to expand their existing knowledge, build on existing techniques of program development, and/or to pursue completely new avenues of knowledge beyond their educational or social framework. Knowledge is sought from a variety of domains, from their tutors, their peers, expert mentors, or from communities of practice both local and online.

**Communities of practice**

Smith and Sadler-Smith (2006) state:
Communities of practice and communities of learning are both important concepts within the context of a socio-cultural interpretation of learning. The understanding of them is an important aspect of professional knowledge and skill, especially if attempts are to be made to intervene in and manage the learning process therein (p. 38).

The term ‘communities of practice’ stems from the work of Lave and Wenger (1991). They suggest that a community of practice is a set of relations among groupings that exist over time and place and overlap with other communities of practice. “A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage” (Lave & Wenger, 1991, p. 98).

Lave and Wenger also assert that learning occurs through being part of a community of practice, rather than pure replication of a task outside of any community construct. They believe that the community of practice itself provides the framework of learning and knowledge: “Because the place of knowledge is within a community of practice, questions of learning must be addressed within the developmental cycles of that community, a recommendation which creates a diagnostic tool for distinguishing among communities of practice” (Lave & Wenger, 1991, p. 100). Often this community will debate the direction or management of a student group to assist in the overall progress of the project. While the community shares common knowledge it also possesses, in its participants, a large amount of unique knowledge and experience. This diversity emerges into a kind of ‘creative chaos’, a term coined by Nonaka and Takeuchi (1995). Nonaka and Takeuchi, consequently, see the value of having a larger pool of ideas within which to work that prevents it from reverting to routine decisions or problem solving.

O’Donnell, Porter, McGuire, Garavan, Heffernan and Cleary (2003) draw on Habermas to define intellectual capital creation as “simply as a socially
constructed dynamic process of situated collective knowing that is capable of being leveraged into economic and social value” (p. 80). They distinguish between teams and communities of practice in that communities of practice consist of groups formed on shared interest which then builds on the values and motivations of the members. O’Donnell et al refer to Wenger and Snyder’s description of communities of practice as “Groups of people informally bound together by shared expertise and passion for a joint enterprise” (O’Donnell et al, 2003, p. 81). It is important not to confuse teams with communities of practice. O’Donnell et al suggest teams are constructions of a system, brought together for a purpose. Billett (1998) sounds a note of caution that students may need to learn skills that are required in the workplace but not taught in an educational organisation.

For example, consider the activities that nurses engage in during their university-based training, compared with those in hospital-based training. Regardless of the value placed on either of these settings, there is a likely prospect of constructing knowledge differently in each setting (p. 14).

While studying within an institution, students begin to become exposed to communities of practice. Having graduated and entered the work force these communities of practice continue to grow as these former peers maintain connection and share information about their own particular areas of practice, for example, as database specialists, networking specialists or programmers in a particular language. They may be further connected to communities of practice via discussion forums, interest groups and interest blogs. Overarching specific communities of practice are communities of learning. Smith and Sadler-Smith (2006, p. 39) discuss a number of differing viewpoints: from Mitchell and Sackney (2000) who argue that a community of learning is a highly complex entity that has many facets, through to the observations by Eraut (2002) and Tosey (1999) who have attempted to identify the characteristics present in a community of learning. Communities of learning are constructed from the social and ideological views of individuals across