Science and Mathematics Education Centre

First-Year Programming Students' Perceptions of Their Tertiary Learning Environment

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

Signature: ……………………………………

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ABSTRACT

The purpose of this research was to investigate first-year tertiary programming students' perceptions of their learning environment, based on the subgroups of gender and "new arrivals" (immigrant and international students of diverse nationalities, culture and educational backgrounds).

The literature provides strong evidence that the nature of the learning environment for females studying computing can be uninviting and may be influential in the low rates of female enrolments and retention compared with males. Studies indicate that the cultural norms and artefacts of computing, the minority status of women in computing courses, attitudes, language, experience and institutional context all contribute to a learning environment that proves unattractive and can be detrimental for some women. In recent years, there has been an increased enrolment by New Zealand educational institutions of new arrival students. Research suggests that new arrival students, who leave their home country to live and study in a foreign land, experience difficulties in their learning environment and often have problems adjusting to living and studying in their host country.

This research used a mixed-method design to investigate first-year computer programming students' perceptions of their learning environment at three tertiary institutions in Wellington, New Zealand. A survey, the College and University Classroom Environment Inventory (CUCEI), was completed by 239 students, yielding quantitative data about students' perceptions of their Actual and Preferred learning environment. In addition, 28 students, selected to represent gender and new arrival subgroups, participated in interviews and 11 hours of observation were conducted in programming classrooms.

The findings from the survey indicated that students perceived their learning environment with some satisfaction but they suggested improvements relating to the innovation and individualisation dimensions of their learning environment. The perceptions of the student subgroups, defined by gender and as new arrivals were

investigated. Although the findings from multivariate analysis of variance of the CUCEI results did not identify differences between the subgroups the interviews revealed wider equity issues and concerns that highlighted differences amongst students of the sex and origin subgroups. Recommendations, based on the study's findings, include suggestions to improve institutional policy relating to the organisation of teaching practice and some cautions about the further use of the survey. The findings have important implications for creating a more equitable and positive learning environment for all students.

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CHAPTER ONE

INTRODUCTION

Research indicates that the cultural and social climate that students experience in the tertiary computer learning environment may be an influential factor in the low participation rate of women in computer science. The cultural norms and artefacts of computing, participation rates, attitudes, language, institutional context and experience all contribute to a learning environment which, for some students, proves detrimental to their studies. The under-representation of females in tertiary computer science and information systems programmes in many Western countries – usually less than one third of male enrolment – is cause for concern. A further reason for disquiet is that female enrolment has been declining in recent years and the number of females leaving computing after their first year of study is high (Margolis, Fisher, & Miller, 2001; Seymour & Hewitt, 1997). Females, therefore, form a minority subgroup in the computing learning environment. Another minority subgroup is one defined as "new arrivals" – international students who go abroad for study and immigrant students whose education has been mostly in their own country and are enrolled in educational institutions of their new country. These students are of diverse nationalities, culture and educational backgrounds.

In recent years, there has been an increased enrolment in New Zealand educational institutions of new arrivals. Research has shown that many of these students have difficulties adjusting to their new country as well as learning within an institutional context, which is usually different from what they have experienced in their home countries (Beaver & Tuck, 1998; Burns, 1991; Cobern & Aikenhead, 1998; Mills, 1997). Areas that have been investigated include cultural diversity and learning issues, quality concerns and language. To date little is known of how students belonging to this category view their computing learning environment and how that may affect their desire to continue with computing studies. The purpose of this study therefore is to investigate how the subgroups defined by gender and as new arrivals perceive their computing tertiary learning environment. As programming is a core course for higher education computing programs this subject has been selected for the focus of this study, thus providing a manageable area of research.

Background

Female Participation in Computing

Despite computing once attracting equal numbers of male and female students (Linn, 1985), women enrolling in computer science courses in New Zealand, and many other Western countries, form a minority subgroup. Frenkel (1990) notes that according to the executive director of the Commission on Professionals in Science and Technology in Washington, DC, while the number of bachelor's and master's degrees in computer science are dropping steadily for both men and women, the numbers of degrees awarded to women are dropping faster, so they are becoming a smaller and smaller proportion of the total. A cross-national analysis of women in computing, using data from UNESCO, found that the majority of the world's graduates completed their computing programmes in countries where the participation rate of women was falling (Wright, 1997). Wright (1997) notes that the percentages of women taking information technology and computing courses fell in 12 countries between 1985 and 1990, including the USA. In New Zealand, participation statistics for students enrolled in tertiary computing courses show a similar pattern.

New Zealand statistics (Ministry of Education, 2000) categorise a number of fields to denote qualifications in computing. In 2001 the New Zealand Standard Classification of Education (NZSCED) was introduced by the Ministry of Education. The new NZSCED system is derived from the Australian DETYA system and involves a three level hierarchy to classify tertiary courses. The new classification will more closely define the computing field which, up until now, has been loosely categorised and includes computing subjects from learning applications such as the Microsoft Office suite to computer science. Programming is offered as a core subject in computing qualifications from university computer science as well as business and commerce departments offering an information systems major or stream. New Zealand polytechnics are also providers of computing qualifications, ranging from certificate, diploma and degrees. These qualifications involve one year full-time study for a certificate, two years for a diploma and three years for a degree. Table 1.1 shows that enrolments for the period 1997 to 2000 for female participation in New Zealand computing degree programmes were less than one third that of male participation. The diploma level had about 75% enrolment for the three years prior to 2000 when females accounted for a reduced 50%. The certificate enrolments for the four years remained fairly steady just over 40%.

Table 1.1

Percentage of Formal[a] Female Enrolments in Computing by Qualification for the Years 1997 to 2000 (Based on New Zealand Ministry of Education statistics, 2000)

Year	Degree	Diploma	Certificate
1997	26	74	42
1998	27	76	47
1999	28	81	42
2000	28	50	43

[a]A Ministry of Education term to distinguish enrolments in computing courses from those offered via private companies that are usually of two to five days' duration and not formally assessed.

An interesting aspect of the statistics in Table 1.1 is the large difference in enrolment percentages between degree and diploma/certificate programmes. Female degree enrolments for the years 1997-2000 were the lowest of all the qualifications, ranging from 26% to 28%.

An explanation for women not enrolling in degree computing qualifications in large numbers, and for the poor retention of those women who do enrol, is that they do not find the tertiary learning environment a welcoming, supportive and encouraging place (Bernstein, 1991, 1999; Crump & Logan, 2000; Margolis & Fisher, 2002; Margolis, Fisher, & Miller, 2000). The characteristics and nature of the computing learning environment have been suggested as contributing to the disproportionate representation of females.

The Nature of the Computing Learning Environment

Studies that have examined the computing learning environment describe characteristics and attributes of the computing culture which contribute to the alienation of students, especially novice computing students. There is evidence that elementary computer programming courses prove difficult for programming novices (Ramalingam & Wiedenbeck, 1998) and this difficulty is compounded when women experience their learning milieu as “chilly” (Nightingale, 1995) and “alienating” (Sproull, Kiesler, & Zubrow, 1987). Researchers suggest that the context within which computing is taught influences the ambience, ethos and atmosphere of the classroom (Fisher, Margolis, & Miller, 1997; McLennan, Young, Johnson, & Clemes, 1999; Sproull, Zubrow, & Kiesler, 1986; Margolis, et al., 2001; Sproull et al., 1986).

The findings of in-depth interviews of 20 women working in the computing industry in Wellington, New Zealand, highlighted the dissatisfaction of the women who had learned programming from tertiary institutions (Crump & Logan, 2000). They commented on the lack of women lecturers teaching computing courses, the poor standard of lecturing, key concepts not being taught and assumptions made of their prior knowledge that they felt females, in particular, did not have. They also considered that lecturers were basing their teaching on the abilities and interests of the male students.

Over the past two decades gender-based differences have been suggested as an explanation for the under-representation of women in computing courses and for the high attrition rate of females in computer science courses, for example, differences in attitudes towards computing and its artefacts where males exhibit a love and fascination with the machine that females do not (Bernstein, 1999; Margolis, Fisher, et al., 2000; Turkle & Papert, 1990). The effect of the language of computing which uses violent words to describe systems and processes has been posited as another reason for the poor female participation and retention rates. Bernstein (1999) believes that language is a powerful medium for transmitting cultural values and is responsible for setting the mood and boundaries within which computing is learned.

Another construct suggested as transmitting cultural values is the masculine image of computing where the typical computer user is stereotyped as male, socially inadequate and isolated. Wright (1997) suggests that computing's masculine, occupational culture alienates women, causing many to decline to enter and those who do enter, to leave more often than their male counterparts.

Critical mass, where a minority group must attain approximately one third participation (Byrne, 1993), has been identified as important in order for that group to establish a sense of normality and continue with their computing studies. Byrne (1993) argues that minority groups do not have a level of influence and become a balanced and integral part of a class or institution until critical mass is achieved.

Teaching practices where prior knowledge was assumed and yet not stipulated as a pre-requisite for the course (Bernstein, 1994; Toynbee, 1993), teaching based on the abilities and interests of the male students, and lack of women lecturers teaching computing courses (Crump & Logan, 2000; Ryba & Selby, 1995) have been suggested as further reasons for women being under-represented in computer programmes.

The literature provides strong evidence that the computing learning environment for the minority subgroup of females is not always helpful and supportive. Another subgroup that often forms a minority in the tertiary computing learning environment is the new arrivals and little is known of their experiences within this educational environment.

The New Arrival Subgroup

New Zealand educational institutions have in recent years focused marketing efforts on attracting international students. This initiative has been very successful, resulting in a four-fold increase in international tertiary student numbers studying in New Zealand between the years 1994 and 2000 and "forming a $1 billion a year foreign exchange earner for the New Zealand economy" (Thomson, 2002, p. 9). In addition, many institutions have increased enrolments from students who have recently immigrated and gained permanent residence status. For many of these students, being in New Zealand will be their first experience of living and studying in a foreign country. For those who come from a non-English speaking background, language may be a problem for them. The New Zealand culture, of course, is often perceived as radically different from their own and it may be that the classroom climate is different also.

The Learning Environment

Moos (1979) believes that subgroups experience social environments (such as classrooms) differently and this experience impacts on and affects human functioning and development. Thus, the “atmosphere, tone, ethos or ambience” (Fraser, 1994, p. 493) of a classroom, teacher-student and student-student relationships (Fisher & Fraser, 1991), as well as the equipment and activities in which students are engaged (Ellett, Loup, & Chauvin, 1991), all contribute to the learning environment.

Over recent decades a considerable amount of work has been done on learning environments, much of it centred on the primary and secondary level and little at the tertiary level. It has been established that a positive educational environment is influential in student achievement and attitudes (Goh, 1994; Fisher, Henderson, & Fraser, 1995; Wubbels & Levy, 1997) and this environment is as important for tertiary students as it is for those in the earlier years of education.

Examination of the New Zealand tertiary computing learning environment will contribute to an understanding of how females and new arrivals perceive “the psychosocial milieu of the classroom” (Diekhoff & Wigginton, 1988, p. 2). This study investigates programming students’ perceptions of their learning environment with particular interest on how the subgroups based on gender and origin differ in their perceptions of their learning environment. Lecturers’ perceptions are also of interest and the specific objectives of the research are stated in the next section.

Research Objectives

This study investigates students' perceptions of their programming learning environment with specific objectives to:

1. investigate students' perceptions of their programming learning environment,
2. investigate how the student subgroups defined by gender and as new arrivals differ in their perceptions of their programming learning environment,
3. investigate lecturers' perceptions of their programming classroom learning environment,
4. make recommendations, where appropriate, to assist lecturers to make the learning environment more inclusive for all participants, and
5. examine the use of the College and University Classroom Environment Inventory (CUCEI) as an instrument to explore perceptions of the tertiary learning environment

Overview of Method

A mixed-method design (Greene, Caracelli, & Graham, 1989), incorporating both quantitative and qualitative approaches was adopted for this study. The combination of quantitative and qualitative data has proved useful in classroom learning environment research (Fraser & Tobin, 1991), providing different, complementary strengths as well as methodological triangulation. Multiple methods of data collection, using the CUCEI, observations of classrooms, laboratories and lecture theatres, as well as interviews with students and lecturers, enable a broader understanding of the institutional context and the perceptions of participants within the environment.

The target population of this study was students enrolled in first-year programming studies at three tertiary institutions in Wellington, New Zealand. A total sample of 239 students, representing 84% of the total first-year programming student enrolment at the three institutions participated, and of this number, 135 were male, 97 female and there were 7 incomplete survey forms. New arrival students, the majority of whom came from the Asian region, totalled 55 and were from 18 different countries. A purposive sample of 36 students comprised the sub-sample for interviews of which 28 students attended. Five of the 6 lecturers were interviewed and observations were made of the different learning environments at the three institutions over a period of three months.

Ethical approval was obtained from each institution as well as Curtin University of Technology and assurances given to all participants as to the confidentiality issues concerning individual participants, data collection and storage of data.

Data collection involved administering the CUCEI to students enrolled in different programmes at the three institutions, interviews with students and lecturers as well as observations of the different learning environments within which the students and lecturers participated. The CUCEI was completed over a period of four weeks, involving multiple visits to the three institutions. On the first visit to each institution, the purpose of the research and the voluntary nature of participation were explained, followed by students willing to participate in the survey completing the Actual Version of the CUCEI. Shortly after, a return visit was made when students and lecturers completed the Preferred Version. The semi-structured interviews were also conducted over a period of three months, as were the observations.

Analysis initially involved analysing the three data sets separately. Data from the CUCEI was entered into the computer programme SPSS and statistics generated to assess whether the questionnaire was a reliable and suitable instrument for this study. Further analysis provided an overview of results and the findings for the student subgroups defined by gender and as new arrivals were examined. The student and lecturer interviews were entered into the computer program QSR NUD*IST Version 4 (1997) (Non-numerical Unstructured Data * Indexing Searching and Theorizing) and themes organised into categories and subcategories. The observation notes were transcribed and organised into themes relating to the physical environment as well as themes relevant to student and lecturer interaction. Re-examination of all the findings provided an overall synthesis which sometimes complemented each other and at other times broadened understanding of the learning environment.

Significance

This research is significant because it is the first tertiary programming study with a focus on the perceptions of the subgroups of gender and new arrivals. This is important for a number of reasons. First, it has been established that a positive educational environment enhances student achievement and attitudes (Fisher et al., 1995; Goh, 1994; Wubbels & Levy, 1997) and increasing knowledge of how the tertiary computing environment is perceived will provide a basis for understanding what students consider are the positive and negative characteristics of the environment.

Second, studies have shown that the attributes and nature of the computing learning environment contribute to the low female participation and retention rates in tertiary institutions. There is recognition that many of the developed countries of the world now participate within an information society where computers and computing occupations are commonplace (Millar, 1998). If females are not part of this new information age, a large pool of potential talent and perspective in creating programs and systems which are influential in today's society will be lost to the workforce.

Third, the effect of the nature of the computing learning environment on another minority subgroup, new arrivals, has not been investigated. This subgroup has become an increasingly significant proportion of tertiary education enrolments over the past decade, so it is important that their perceptions of the learning environment be better understood.

Fourth, this is the first time the newly-modified and personalised form of the CUCEI has been used in New Zealand and the results will add to the body of knowledge relating to the use of this instrument.

Finally, for students enrolled in a tertiary computing programme, at least one programming paper is an essential course of study and success is critical to ensure continuation with the qualification. Students' perceptions of their learning environment "powerfully influence their approach to learning" (Booth, 1997, p. 205) and results from this research will help inform educators how first-year students and the student subgroups defined by gender and as new arrivals perceive their learning environment. Dimensions of the environment which students identify as unsatisfactory may be of interest to lecturers who wish to improve the learning experience of their students.

Overview of Thesis

The thesis has six chapters relating to this study's investigation of tertiary programming students' learning environments. The literature review, chapter 2, presents studies and discussion relating to female participation in computing programmes. The nature of the computer culture, involving attitudes towards computers by male and female students, the language used in, and the masculine image of computing are explored, together with discussion of studies of new arrival students in a foreign country. The chapter also introduces learning environment research and the contribution of instruments, such as the CUCEI, that have been used to measure learning environments.

In chapter 3, the study's mixed-method research design is presented and includes the objectives of the research, discussion of the quantitative and qualitative approaches and the five purposes of the mixed-method design. Sample selection, data collection and ethical issues are described and an overview of data analysis is provided.

The results for the CUCEI are submitted in chapter 4 beginning with an analysis of the measurement properties of the CUCEI. The results obtained for the Actual and Preferred Versions of the CUCEI including examination of differences for sex and origin conclude the chapter.

Chapter 5 reports results of the observations and presents an analysis of the student and lecturer interviews. The chapter concludes with a synthesis of the student and lecturer results.

The final chapter provides an overview of the study, a summary of the results, and the findings in terms of the research objectives. The chapter concludes with a reflection on the research design, presentation of the findings, discussion of the limitations of the study and concludes with discussion of implications for practice and future research work.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

Programming is an intrinsic, core and focal subject in computing study and might therefore be considered as representative of tertiary computing programmes. Students of the subgroups defined as gender and new arrivals who enrol in programming are the focus of interest of this study and bring their own unique attitudes and expectations towards their learning. The first part of this chapter presents a review of the literature relating to female participation in computing, explores the impact of culture and gender on the computing learning environment and the different attitudes which males and females bring to that environment. Studies are described that show that males and females view computer artefacts differently and respond differently to the language of computing. The literature relating to female and new arrival minority status within the programming environment, students' prior experience with computers and self-beliefs are also discussed. Overall, the masculine image and the institutional context within which computing takes place, contribute to a culture and a classroom climate, or learning environment, which can prove daunting and inhibit the learning of some students.

The second part of the chapter presents an overview of approaches taken to examine the learning environment and Moos' (1974, 1979) three domains and dimensions that provide the basis for many of the classroom instruments and the scales which have been developed. The CUCEI is described and its choice for use in this study is discussed.

Female Participation in Computing

The issue of gender has been the focus of interest in many studies of women's participation in computing. Low enrolment rates of women in computer science programmes have been reported for many Western countries. Statistics for Canada and the United States reveal that the number of women earning bachelor degrees in computer science peaked in 1984 and has been declining since (DiDio, 1996; Naval, 1998). In September, 2001 the British government launched a project with the aim of encouraging more girls to take science and technology examinations. This was in response to concerns about the "gaping sexual divide in students' subject choices" ("Making Science", 2001, p. 3). In the United Kingdom, 18% of the total number of students entering computer science courses in 1996 were women (Clegg & Trayhurn, 2000). This proportion fell to 11% for the software engineering courses for the same group (UCAS, 1997, cited in Clegg & Trayhurn, 2000). Computer science once attracted equal numbers of male and female students (Linn, 1985), but for nearly two decades women studying in Canada and USA have accounted for around 25 percent of all computer science degrees. In the United Kingdom, the numbers of women taking the Advanced Placement Computer Science tests from 1984 to 1996 have been consistently low (Stumpf & Stanley, 1997). Again, the proportion of women admitted to computer science programmes at the University of Lund, Sweden, during the period 1985 to 1995, varied between 5% and 10% (Brandell, Carlsson, Ekblom, & Nord, 1997).

The majority of participation statistics refer to enrolments for computer science programmes but there is evidence that female participation in information systems programmes is similar (Baroudi & Igbaria, 1994-1995). The literature does not generally differentiate between computer science and information systems but Baroudi and Igbaria (1994-1995) note the varied occupations and participation of women in the field of information systems as being 32% systems analysts, 18% project leaders and 14% development managers. These occupations are possibly more likely to attract information systems graduates than those completing computer science programmes and therefore it is reasonable to assume that women's representation in information systems programmes is also low.

In Australia and New Zealand the low participation levels of women are similar (Bradley, 1998; Mason, 1999; Ryba & Selby, 1995; Selby, Ryba, & Young, 1997) with enrolment and retention of female students in computer science and information systems programmes often below a "critical mass", that is, the number of females fall below 30% of enrolments considered essential for a level of influence within an institution (Byrne, 1993).

Table 2.1 reports numbers of students in formal computing public tertiary programmes of study as at 31 July, 2000 where programming is a core subject (Ministry of Education, 2000). The Ministry recognises “formal computing” as those programmes that have formal assessments. This term distinguishes these programmes from enrolments in short courses which are not assessed and are usually offered by private providers training in a specific programming language for perhaps a two-day seminar. G. Keble, the Ministry of Education’s Senior Data Analyst confirmed (personal communication, March 7, 2002) that the fields presented in Table 2.1 included programming, as a core subject, thus distinguishing these fields from the learning of general applications, for instance. The first field, which has a stronger business orientation than the second field, is Commercial and Business with its subfield of Business Computer/Information Systems. The second field is Computing with four subfields of Computer Programming/Analysis, Computer Science, Information Management and Introductory Computer Programmes. The fourth subfield of Introductory Computer Programmes has not been included in this table as this study is concerned with computing where programming is a core subject and the introductory programmes do not meet this criterion.

Table 2.1

Formal Enrolments by Level of Qualification, Field of Study, Sub field of Study and Gender (Based on New Zealand Ministry of Education Statistics, 2000)

	Certificate		Diploma		Degree	
Field and Subfield of Study	Male	Female	Male	Female	Male	Female
Commercial and Business						
Business Computing/	1,146	1,162	1,274	804	137	32
Info. Systems	50%	50%	61%	39%	81%	19%
Computing						
Computer						
Programming/Analysis	866	367	-	-	526	172
	70%	30%			75%	25%
Computer Science	-	-	105	63	1,367	518
			63%	37%	73%	27%
Information	78	80	180	745	314	210
Management	49%	51%	19%	81%	60%	40%

It can be seen that, proportionally, female enrolments tend to be lowest at the degree level. For all computing degrees, with the exception of Information Management, female enrolments are less than 27%, falling below the critical mass of 30% necessary in order for minorities to feel comfortable. The situation for females improves at the diploma level and again, at the certificate level. A reason for the deterioration in the numbers of females is that women drop out after the first year of study (Brown, 1994). For all subfields of study at the diploma level (except the Information Management subfield) females remain under-represented but just exceed the 30% critical mass necessary for a supportive environment. The reversal pattern for the Information Management Diploma where females account for 81% of the enrolments, and the higher number of female enrolments at the degree and certificate level for Information Management, could be because of the context within which computing is taught. Studies have found that when computing is taught in a broader context (such as within a business degree compared with a computer science degree) women were more positive and enrolled in greater numbers (McLennan et al., 1999; Sproull et al., 1987).

Culture, Gender and the Computer Learning Environment

Geertz (1973, p. 5) defines culture as "an ordered system of meaning and symbols, in terms of which social interaction takes place" and this definition is useful to describe the computing culture. The conditions which establish the artefacts, language and symbols that are identified with computing, together with the social interaction by players within the computing culture, combine to formulate the nature of computing. The computing culture contributes to the "social climate or atmosphere of a setting" (Moos, 1979, p. 81), affecting the experiences, perceptions, attitudes, values and behaviours of participants within the setting.

The members of a culture may be identified by subgroups. Common traits which identify subgroups are race, language, ethnicity, gender, social class, occupation, religion, etc. (Cobern & Aikenhead, 1998). Each subgroup brings its own unique subculture of shared beliefs, values and norms to which the individual members conform. They may be overt or covert, written or unwritten, vocalised or invisible and are, as Taylor (1996) says, extremely powerful. The beliefs and values of subgroups learning in the computing culture contribute to the way we do things. Students from different countries and cultures, and males and females, for example, can be viewed as belonging to different subgroups with different ways of doing things and with different values and norms. These are the subgroups of particular interest in this study.

Members of subgroups enrolled in tertiary computing programmes not only bring their own cultures but will learn the computing subculture. Sproull et al. (1986) believe the characteristics of this subculture learned by computing novices include the attitudes towards and values of computing, the kinds of people who compute, the social organisation of computing and the context in which computing occurs.

In 1994, a lecturer in the department of computer science at a New Zealand university, reported on her investigation of gender differences relating to computers in education (Brown, 1994). Brown was concerned that the first-year programming course attracted the smallest proportion of women of any course in the faculty and the withdrawal rates for women were approximately 50 percent. Reasons given for women finding the discipline unappealing were the image of computer science, the culture of the department, the approach to teaching with its focus on computer technology and neglect of social issues, as well as communication skills and people-oriented skills. Brown reported that for the previous five years the first-year programming course had changed considerably. Assignments changed from the development of programs for mathematical problems to gender-neutral graphical assignments, the laboratory environment was upgraded, the introduction of the course was slowed down and more laboratory instruction provided. Women laboratory instructors were specifically sought. Despite these efforts Brown (1994) reports that there has not been a major impact on retention. This finding was confirmed three years later when the retention and recruitment efforts were reviewed (Gale, Andreae, Biddle, Brown, & Tempero, 1997).

A qualitative study examined women's perceptions about a computer hardware and low level systems programming course which Brown taught. The computing culture, women's roles within the course, women's conscious and unconscious motivations and beliefs, were looked at. The second year computer science course had six females and 54 males. Davies (as cited in Brown, 1994) believed that these women had to adapt to the culture in order to succeed and they achieved because they successfully socialised and internalised the role of the computer science student. Davies also found that the women had a strong vision of their purpose in doing the degree.

The computing culture has been the focus of interest of a growing number of researchers. Attention has centred around the attributes of the computing culture which have been identified as the attitudes towards computing (Grundy, 1996; Ryba & Selby, 1995), users' relationship to computing artefacts (Bowers, 1988; Margolis et al., 2002), the language of computing (Bernstein, 1999), the masculine image of computing including stereotypes (Bernstein, 1998; Clarke & Chambers, 1989; Ryba & Selby, 1995; Toynbee, 1993; Zuga, 1999), critical mass (Byrne, 1993) and the institutional context (McLennan et al., 1999; Sproull et al., 1987). In the following section discussion focuses on how these attributes interact with gender in ways that contribute to the nature of the computing culture.

Attitude Towards Computing

The culture of the computing learning environment mediates students' computing experiences and there is strong evidence that gender-based attitudes towards computers contribute to this (Bernstein, 1999; Grundy, 1996; Sproull et al., 1986; Zuga, 1999). Males enrolled in computer science programmes have been found to have a different attitude to computers than females (Bernstein, 1999; Margolis et al., 2001; Margolis & Fisher, 2002; Turkle & Papert, 1990). Interviews of male and female computer science majors attending Carnegie Mellon University showed that women perceived themselves as being less passionate towards computers and did not share the same intensity of focus and interest that they saw in their male peers (Margolis et al., 2001). The researchers report comments made by a male teacher about the difference between male and female perceptions of computing. His email exchange with another high school computer science teacher began by discussing the low numbers of female students in his computer science classes:

> I have any number of boys who really really love computers. Several parents have told me their sons would be on the computer programming all night if they could. I have yet to run into a girl like that. A couple are Internet nuts but that's social, not programming. Where are the girls that love to program? My girls sit up and take notice when I talk about programming as a good way to make a living, but look at me funny when I talk about it as fun. The boys think money is nice but fun is where it's at. Why is this? (Margolis et al., 2001, p. 7).

Turkle (1986) agrees that males find a fascination and love of computers which most females do not experience. She hypothesises that males have a "relationship" with their computer, a relationship where the need to balance the need for mastery of skills and concrete materials with the desire to do things with people is not necessary. Thus, the "machine" is reassuring as it provides certainty and "protective worlds" (p. 366). While Turkle states that the computer experts do not think that it is "alive", lifelike properties can be easily projected on to computers, supporting the fantasy "that there is somebody home" (p. 367). The artefact supports an experience with it as an "intimate machine" (p. 367). This contrasts with Turkle’s description of females who are extremely competent in computer science studies and yet have interests and a distance from their computers that is not exhibited by many males.

The attachment to computers has been found to differ between the sexes and this phenomenon is explored in the following section.

Artefacts and Attachment

An important aspect of computing is how students view and assign meaning to the use of hardware and software. These objects, or "artefacts", assume importance and focus to which members of the computing culture attach value, develop norms for their use, acquire status in relation to their expertise with the artefacts, and develop attachment to others in the culture (Sproull et al., 1986).

Fisher, Margolis and Miller (2001) believe that "cultural artefacts" stand in the way of women feeling an immediate attraction and interest in computing. They describe the experiences of two students who evolved an interest in computers "over time" and an international woman student who explained her experience with computing as "an acquired taste" rather than "epiphany moments as described by the males" (p. 5). They are further concerned that the dissonance and estrangement described by 20% of the female computer science majors they have interviewed will influence these women in leaving the computing field for other disciplines.

Research shows women are more likely to describe computers as a "tool to use within a broader context" (Fisher et al., 2001, p.4). The context and connections of computing to other arenas are important to women students. They are more interested in what the computer can achieve rather than the "love" and fascination described by Turkle (1986). A study of undergraduate computer science women at Carnegie Mellon University found that most of the women talk more about the *uses* of computing than a personal connection to them (Fisher et al., 2001). Fortyfour percent of the women students (compared to 9% of the men students) contextualized their interest in computers in other fields such as medicine, space, or the arts (Margolis et al., 2001). Bernstein (1999) points out that women are concerned about the context in which the software will be used and they want their work to have a purpose beyond the specific program they write. This accords with other research where usefulness is cited as an important factor for retaining interest in studying computing (Crump & Logan, 2000).

The Language of Computing

Bernstein (1999) examined the role of the "language of computing" as a conduit for transmitting cultural values, noting that since computing began, words describing the processes and systems have been violent. Examples include "abort" or "kill" when a program does not work, "boot" to initialise the operating system on a computer, and "violation" when a user tries to access a file already in use and not assigned a "shared" status on a network. Tricker (1994) notes the role and importance of language in the computing culture when he says:

> Language is a primary feature in distinguishing cultures. We who design information systems and are managing information are, in that process, influencing and changing cultures (p. 342).

Technology's artefacts are not neutral in terms of accurately representing, at the level of the software program, the domains of the real world in which people live (Bowers, 1988). Bowers (1988) explains this by referring to how sexist language was framed, at a "taken-for-granted level" (p. 25). He describes Tannen's example (as cited in Bowers, 1988) of how a certain tone of voice may frame a conversation as serious, thus establishing the tenor of a conversation while also separating it from the surrounding background. The framing of a conversation "sets the mood, governs both its content and boundaries, and structures the relationship between the participants" (Bowers, 1988, p. 24). Language is a powerful determinant of the frame. Language constrains what is considered important, how actions are to be interpreted, and what is not considered or seen as relevant; in effect a controlling frame that influences the way in which we think and act.

The Masculine Image of Computing

The popular stereotype of the frequent computer user as one of a male, socially inadequate and isolated, persists and there is evidence that this stereotyped construct defines computing as a predominantly male occupation, affording it a degree of exclusivity (Brown, Andreae, Biddle, & Tempero, 1997; Clarke & Teague, 1994) (Ryba & Selby, 1995; Sturm & Moroh, 1994; Toynbee, 1993). Studies among high school and undergraduate students have found computing to have a severe image problem with the perceived isolation associated with using a computer being a critical factor causing students (especially female) to avoid using them (Clarke & Chambers, 1989; Durndell, 1990; Selwyn, 1998). The stereotyping of computing as a male "nerd" domain is a powerful perception which has served to discourage women from enrolling in computer science (McLennan et al., 1999; Selby, Young, & Fisher, 1997).

Media portrayal of computer use contributes to the stereotyping of computer users being male. Males are more likely to be portrayed as being involved with higher level computer functions (Clarke, 1990b; Russell, 1993) than females who often appear in passive clerical roles or as sex objects (Edwards, 1994). Computer games have also contributed to the stereotyping of computing as a male-oriented occupation with characteristics of gaming strategies almost always conforming to the characteristics desired by, and appealing to, boys (Miller, Chaika, & Groppe, 1996).

Researchers believe that the attributes of the computing culture are instrumental in many women choosing not to study computing. Women who do enrol in tertiary programmes are usually in the minority, fail to form a critical mass, thus perpetuating the "chilly" (Nightingale, 1995) environment and contributing to the poor retention rates of female computing students (Brown, 1994; Gale et al., 1997; Grundy, 1996; Margolis & Fisher, 2002). The following section discusses how critical mass impacts on the tertiary computing classroom.

Critical Mass and the Tertiary Computing Classroom

Critical mass forms the threshold beyond which a minority group needs to move in order to establish a sense of normality and for its members to continue, not to drop out, and to achieve without constraint. Byrne (1993) argues that for women and other minority groups to be seen as a balanced and integral part of the class or institution and for those groups to have a level of influence, achieving critical mass is essential.

A study of 23 co-educational computer science undergraduate degrees confirms the importance that critical mass has on female retention (Cohoon, 2001). Detailed qualitative and quantitative analyses of interview and survey data determined that the single strongest factor and most consistent finding of this gendered attrition study was that departments with higher female proportions of enrolment were more likely to retain women at comparable rates to men. This result echoed an outcome from an empirical study of enrolment and retention in the sciences where it was found that the more socially-similar peers students had in their major subject, the more likely students were to persist in a science, mathematics, or engineering major (Astin & Astin, 1992).

An analysis of women's roles in computing and explanation of why, when computers have so much to offer in terms of high remuneration and interesting career prospects, women are so under-represented in computing tertiary courses has been offered by Grundy, a lecturer in computer science in Britain. Grundy (1996, p. 4) explains that over a long period of time jobs have come to be “regarded to varying degrees as being more appropriate for one gender than the other”. She calls this “job-gendering” and states that the other half of the dual action is “gender-channelling” where girls are brought up to regard themselves as more suited to child-rearing, nursing, hairdressing and typing. While "job-gendering" and "gender-channelling" are no longer overtly apparent, it is argued that the culture of the learning environment, together with the low participation of women in computing contributes to the maintenance of a more covert form of "job-gendering" and "gender-channelling".

Byrne (1993) believes that perceptions of what is "sex-normal" (traditional) or "sex-neutral" (non-traditional) for occupations can vary, both according to culture and according to the prevailing dominant social definition of sex roles. No international or national finite definitions on classifications of a discipline or occupation as "non-traditional" or "traditional" have been established, but Byrne notes that in the United States of America, Sweden and the United Kingdom, if one sex is represented by less than about a third of those involved in an occupation or discipline, the latter is designated as non-traditional for the under-represented sex. Byrne (1993) reports that where girls and women were in a minority but still formed a relatively significant statistical group (approaching a critical mass of 30%), they have tended to be described as untypical and as a minority. This contrasts with a situation where girls and women are in a smaller minority (9-15%) and have been described as "abnormal rather than merely untypical" (p. 12).

The minority status of females in the tertiary computing classroom (Byrne, 1993; Zuga, 1999), and the alienating culture of the computing environment for many women (Bernstein, 1991, 1999; Brown, 1994; Brown et al., 1997; Margolis & Fisher, 2002; Ryba & Selby, 1995) contribute to female students experiencing the environment differently from males. A further factor which is believed to affect the climate of the computing learning environment is the context within which computing takes place and this is discussed next.

Institutional Context and the Computing Learning Environment

An interesting factor that appears to influence the nature of the computing learning environment is the institutional context in which computing is located. Four studies which have reported the impact of the social setting in which computing is carried out by members of the campus computing community are discussed below. The first is a 1986 study of two universities in the United States. The second is a 1999 study carried out in a New Zealand university, and the last two studies were conducted in 1997 and 2001 in the United States.

In 1986, results of a survey of freshmen attending two American universities found that students were more likely to report reality shock, confusion, control attempts, anger, and withdrawal in their computing courses than in other courses surveyed (Sproull et al., 1986). The researchers believed that the social setting where computing was carried out by members of the campus computing community made a significant impact and affected attitudes and socialisation of the computing students.

Comparisons were made between “student encounters with computing” (p. 262) at two universities. Students enrolled in University A had a strong computing culture, with the computer science department having a world class reputation. Introductory computing courses were taught by computer science faculty members "who might have been perceived as hostile gatekeepers by many students" (p. 273). This was in contrast to University B which was more professionally orientated with a newly created computer science department and where, at that time, "programming courses were taught by nontechnical faculty" who provided more pleasant and welcoming experiences (p. 273).

Results from a questionnaire showed that a higher percentage of students enrolled at University A reported more negatively on their computer science course experiences, compared with other courses, than those at University B. The effects of gender, prior experience with computing and college curriculum were examined for each group. It was found that women experienced higher levels of negativity in comparison with men. The researchers considered that differences in the pattern of results across the two universities could be explained by differences in the strength of the computing culture. The strong computing culture of University A was relatively alienating to the first-year computing students in contrast with the students of University B, suggesting that the cultural experience is very important. Thus, nearly two decades ago, Sproull et al. (1986) had confirmed that the context of teaching computing was an important factor in how students perceived the computing culture.

In a more recent New Zealand study, students of an introductory programming class at a small university (approximately 4,000) were surveyed to determine the student attributes associated with achievement (McLennan et al., 1999). A relatively large number of women (44% compared with 20% at another New Zealand university for the same year) were enrolled. The authors suggest possible reasons for the higher female participation rate. These include safe, clean computing laboratories which have been identified as very important to female students (Moses, 1993; Ryba & Selby, 1995); female role models who taught computing; mentoring; and helpful academic staff.

Another important factor suggested by McLennan et al. (1999) is the context in which the programming course is situated. These researchers hypothesise that a possible reason for the relatively large number of female students enrolled for their course is that programming is not taught under a "computer science" umbrella. The programming course taught at their university is located within a business environment culture, a culture without the attributes and perceptions associated with computer science and which have been identified as contributing to the dissonance women feel towards learning computing.

In 1997 the rise and fall in the female proportion of computer science bachelor's degrees in the United States between 1981 and 1994 was documented (Camp, 1997). Camp notes that this variation was affected by the type of college (engineering/nonengineering) in which a computer science department was located. More recently, Cohoon (2001) expanded Camp's timeframe to the most recently available data, confirming the temporal changes in female representation and supporting the contention that context or departmental characteristics influence retention rates of women studying computing. Departmental factors associated with equal retention of male and female computer science students were identified. These were:

> when the faculty included at least one woman; was stable, valued, mentored, and supervised female students; enjoyed teaching; and shared responsibility for success with their students; the department had above average support from its institution; graduating seniors had access to a strong local job market; and perhaps, high starting salaries; and there were sufficient numbers of female students in each class for them to support each other (Cohoon, 2001, p. 2).

In 1986, Sproull et al. were prescient in saying that, "The effects of gender …on socialization to computing may not be transient", warning that "structural discrimination" (p. 274) can result. In this new 21st century, just as in the final decades of the last, women are less likely than men to be interested in taking tertiary courses in computing, thereby closing women out of many career options. The context in which computing is taught contributes to the nature of the learning environment and can have particular influence on women and other minorities. The subgroup, new arrivals to Wellington, which is a focus of this study, is another minority which may well be impacted by the computing environment. Discussion of issues relating to this subgroup follows.

New Arrivals to a Foreign Country

Education today is a global business. In recent years many Australian and New Zealand universities have experienced an increase in both immigrant and international student numbers who come from all over the world to study (Harris & Jarrett, 1990; Chalmers & Volet, 1997). The Australian and New Zealand governments encourage and support "export education" (Beaver & Tuck, 1998; Maharey, 2000), recognising the significant positive economic contribution (Bartlett, 2001) made by international students.

Statistics for New Zealand show the strong momentum of the internationalisation of tertiary education in that country. The number of foreign, fee-paying public tertiary students increased from 3,945 in 1994 to 11,498 in 2000 (Ministry of Education, 2001). These figures do not include immigrant students or students who were born and educated overseas and have permanent residence status. International and immigrant students contribute diversity and richness, socially and culturally, to the country and institutions chosen for study, but these students often face significant cultural, social and language adjustment. Their perceptions of the classroom environment may differ from New Zealanders' perceptions and it is therefore important that the views of this subgroup are known. As educators, we need to be aware of how this increasingly large multi-cultural subgroup perceives the learning environment.

While the internationalisation of tertiary education has been the theme of some overseas research, there has been little reported in New Zealand. Studies have investigated cultural diversity and learning issues (Atwater, 1994; McLaren & Estrada, 1993), quality concerns (Walker, 1999), language issues (Barnard, 1998; Franken & Haslett, 1999) and the experiences of overseas students in Australian universities (Burns, 1991; Mullins, Quintrell, & Hancock, 1995). However, only one New Zealand study with a focus on international undergraduate students' interactions in classes at a New Zealand university has been found (Mills, 1997) and there is none which relates to new arrival students studying computing. How this subgroup perceives their learning environment, therefore, forms an important part of the study. Beaver and Tuck (1998) undertook one of the few New Zealand tertiary studies to evaluate the adjustment of overseas students at a tertiary institution. A questionnaire developed by Burns (1991) was used with 104 Pakeha (a Maori term for European-New Zealand people) students with English as a first language, and 37 Asian and 13 Polynesian students with English as a second or other language. The findings of this survey were similar to one in Australia by Burns (1991) involving first-year overseas students, mainly from Singapore, Malaysia and Hong Kong, and Australian students of mainly British and European origin. The New Zealand study found that Asian students had more frequent concerns with interactions with lecturers and making friends than the Pakeha students and rated themselves as less competent in some study skills. Beaver and Tuck (1998) speculated on the reasons for differences between the groups of Pakeha, Asian and Pacific Island students. As well as identifying "elements of self-interest and individualism in the position of the Pakeha students" they suggested, disturbingly, "the possibility of elements of racism" (p. 177). This was a similar finding to the results of a study by Mullins et al. (1995), where it was reported that two thirds of the Asian students at three Australian universities identified prejudice or racism as a problem.

An anthropological perspective that contextualises learning in a cultural milieu for science education has been posited by Cobern and Aikenhead (1998). They reviewed literature on multicultural and cross-cultural science education where students have "studied in non-Western countries or in indigenous societies, or with students who comprised minority groups within Western countries (i.e., groups under-represented in the professions of science and technology)" (p. 40). Research of the experiences of these student groups has found that they have more problems, and experience them to a more serious degree, than students of the home country.

Both females and new arrivals are minority groups studying within a cultural milieu: the computing culture. Gallard, Viggiano, Graham, Stewart, & Vigliano (1998) distinguish between voluntary and involuntary minorities, agreeing with Ogbu (1992) that involuntary minority students have the least amount of success in school and society. Involuntary minorities are “people who were originally brought into the USA or any other society against their will” (Ogbu, 1992, p. 8). Pitts (as cited in Gallard et al., p. 942) lists 11 categories of minorities and extends the definition by saying that “although females represent approximately 50% of the population in any given country, often they are treated as second class citizens or as an involuntary minority.”

The new arrival and the female students form voluntary minority subgroups. Some new arrival students have chosen to study in this country and will return to their home country; some have immigrated and made New Zealand their home. All bring to their learning their own cultural background and influences. They will experience the learning environment from a multi-cultural and cross-cultural perspective while studying within the computing culture as a minority group. Many of these students are academically very successful (Gallard et al., 1988) but some will find the shock of a new culture detrimental to their learning. They will each be coping with their own “border crossings” (Cobern & Aikenhead, 1998) into the computing culture.

Programming: Experience and Beliefs

The foregoing sections have described the nature of the computing learning environment and how the attributes impact on learners within that context. In order to scope this research within a manageable boundary, programming, a subject which epitomises computing, was chosen as the subject of study. This was based on the status of programming as a core paper and a pre-requisite for any career-oriented computing qualification. First year programming courses usually aim at teaching basic programming concepts, data and control structure, and good programming style (Malik, 2000) and "are well known for their low retention rate and for the perceived difficulty of programming to novices" (Ramalingam & Wiedenbeck, 1998, p. 377). Two variables which have been shown to influence learning computing and which may contribute to improving the retention rate and ease the difficulties experienced by novice programmers, are previous computer experience and feelings of self-efficacy.

Previous Computing Experience and Self-Efficacy

Agreement as to the extent of benefits of previous computing experience to students learning computing is mixed. The two-universities' study by Sproull et al. (1986) in America found that being male and having previous computing experience contributed to the probability of positive computing experiences when coupled with the contribution made by generalised ability. A study of Australian tertiary students entering a compulsory introductory course in computing indicates that the benefits of prior computing experience are short-lived and the greater male confidence resulting from this experience is misplaced (Clarke, 1990a). These results confirmed Kay's 1986 finding (cited in Clarke, 1990a) that males who had entered computer science courses with considerably more computing experience outperformed their female counterparts in the early stages. However, once the female students had the opportunity to gain a minimum level of hands-on experience, sex differences in achievement disappeared.

Bernstein (1997) is unequivocal in her belief of the importance of prior computer exposure, stating "The greatest predictor of success with computers is prior exposure: mucking about, playing around, experimenting" (p. 3). However, McLennan et al. (1999) state that females have traditionally done as well as males in a compulsory computer literacy paper and hypothesise that success in this paper may have encouraged females to enrol in the programming paper. The researchers further found that the results of logistic and ordinal regression models used to determine the student attributes associated with achievement found that prior experience in programming and experience with computers in general had "no apparent association with achievement" (p. 27).

Lack of prior programming experience is cited as a critical factor related to the withdrawal rate of students in the first-year programming course at a New Zealand university, thereby confirming the importance of prior experience (Brown, 1994). Fisher et al. (2001) found in their survey of computer science students at Carnegie Mellon University that there was a significant gap between male and female prior experience. They reported that 40% of male respondents had prior computing experience and were therefore exempted from enrolling in the introductory level computing class. This contrasted with all of the females who were required to enrol in the introductory class. A correlation was found between female students' sense of feeling less prepared and their actual experience with computers prior to attending university. The researchers note that despite many of the female students entering the computer science department with very little computer experience, they do well, thereby countering the suggestion that prior computing experience is necessary to do well in undergraduate computer science. However, they warn that the success of these students is not without cost. Students report they "often go through a very difficult period of adjustment, facing tremendous self-doubt and feelings of isolation and inadequacy" (p.108).

Despite the ambivalence as to what the benefits are of prior computing experience, there is evidence that positive self-efficacy is a desirable trait of computing students and that low self-efficacy is malleable in the first year of a computing course. For all students, self-efficacy, or belief in one’s ability and judgments of one’s own capabilities to organize and execute courses of action, is critical for academic success (Ramalingam & Wiedenbeck, 1998). Students who have positive and successful experiences with their first computing courses are also likely to have high self-efficacy, being more confident and more likely to continue with this success (Bernstein, 1994; Sproull et al., 1986).

An important factor in self-efficacy beliefs is that they have been shown to be malleable, especially in the early stages of skill development. As predicted by theory, and confirmed by Ramalingam and Wiedenbeck's (1998) novice programmer self-efficacy survey, the

> self-efficacy of beginning students of programming was highly responsive to performance accomplishments in the early stages of skill attainment, and this was particularly true of initially low efficacy students (p. 379).

The researchers further found that “gender in itself does not have an important effect on the self-efficacy beliefs of novice programmers when both males and females have similar experience on which to base their self-efficacy judgments” (p. 379).

McLennan et al.'s (1999) study of introductory programming corroborates this finding. The researchers note that most students had previously passed a compulsory computer literacy paper, thus coming to the programming class with similar prior computing experience. They believed that success in the first year paper might have encouraged females to enrol in the programming paper. It is suggested that this success would also contribute to students' positive self-efficacy.

For females, a belief in one's ability and success in computing may help to dispel the "we can, I can't" paradox (Sanders & Stone, 1986) which has been noted by researchers examining gender differences in perceptions of computer self-efficacy. In a study of 15-year-old Japanese students it was found that there was a tendency for females to be unsure of their own individual ability to use computers, but the students felt that women as a group are as able as men in this domain (Makrakis, 1993). Young (2000) confirmed this finding by reporting two studies (Sanders & Stone, 1986; Siann et al. 1990, cited in Young, 2000) which also noted that although there was a tendency for females to be unsure of their own abilities to use computers, they believed that women, in general, are as capable as men in their use.

In a Singapore study of Asian undergraduate business students' learning approaches, results showed that self-efficacy predicted the deep learning approach which had a consequential impact on desirable feedback-seeking behaviours in the learning environment (Ng, 1998). Deep learning students attempted to make sense of and understand class material and relate the ideas and concepts to their personal experience. Students with high self-efficacy were confident and tended to participate in class compared with those with low self-efficacy.

As first year programming is the early stage of skill development it is very important that students perceive a positive learning environment that can contribute to increasing their sense of self-efficacy. For students coming to a first programming course with low self-efficacy, it is possible for their self-efficacy to be modified to become more positive, increasing the likelihood of achievement in their programming studies. A learning environment which increases self-efficacy would likely lead to the positive behavioural results of a greater willingness to take on challenging tasks and encourage persistence to achieve as predicted by self-efficacy theory.

The previous sections have provided evidence of the low participation rates of females in tertiary computing courses and how the nature of the computing learning environment impacts on this subgroup. Cultural issues facing the increasing numbers of international and immigrant students enrolling in New Zealand's tertiary institutions and their "border crossings" (Cobern & Aikenhead, 1998) into the new cultures of country and computing have also been discussed. The impact of previous computing experience and the self-efficacy of these students contribute to how they experience the programming learning environment. The next section provides a brief history of learning environment research, the nature of the instruments that have been used to measure learning environments and discussion of the chosen survey instrument, the CUCEI.

Approaches to Measuring the Learning Environment

Moos (1976) suggests that social environments impact on human functioning and development and that these environments may be experienced by groups and subgroups differently. The social environments may limit behaviour, enable the occurrence of activities, and actively stimulate some forms of activity which may suit one group but not the others. In addition, social environments may provide the conditions where there is selective favouring of preferred modes of adaptations, thereby facilitating the development of some individuals over others. This could create stressful conditions, which retard development. Moos (1979b) believes social environments can be evaluated and changed and that a major mediator of the influences contributing to an environmental system is social climate.

Social climate is the fourth domain of environmental variables which Moos (1979b) believes affect an environmental system. The other three domains are the physical setting, organisational factors and types of people present. Moos (1979b) recognises the importance that Pace (as cited in Moos 1979b) places on the social climate of a college or university as a means of understanding what is really important to participants within these settings. For example, Pace notes that only certain information about a college or university is commonly available (such as location, degrees offered and so on) and that the social climate created by continuous and consistent "discrete events" such as valuing neatness, maintaining an appointment system for students to consult with lecturers, and so forth, contributes to the atmosphere and ethos, thus establishing the social climate. The social and the physical environmental variables are influential for students, and "can affect their attitudes and moods, their behavior and performance, and their self-concept and general sense of well-being" (Moos, 1979b, p. 3). Earlier discussion of the nature of the computing learning environment has identified factors and attributes which impact on students' attitudes, behaviour, self-concept and sense of well-being. Assessment of the social climate was therefore considered important to this study in order to gauge how student's perceived their programming learning environment.

A Brief History of Learning Environment Research

The social-ecological environment is a term used by Moos (1979) to emphasise the "inclusion of social-environmental (for example, social climate) and physical-environmental (that is, ecological) variables, which must be considered together" (p. 4). The study of educational environments from a social-ecological perspective was not well established until the early sixties. Prior to that time the basic interest of the researchers was the interactions between student and student and between student and teacher. Towards the end of the 1940s, interest in classroom climate research became based on the work of several researchers: Lewin, Murray and Thelen (as cited in Chavez, 1984). Lewin recognised that both the environment and its interaction with personal characteristics of the individual are significant determinants of human behaviour (Fraser, 1998). Murray (as cited in Fraser, Fisher & McRobbie, 1996) extended Lewin's approach by using the term "alpha press" to describe the environment as assessed by a detached observer and "beta press" to describe the environment as observed by those within that environment. Thelen developed an educational dynamics model based on work at the Human Dynamics Laboratory at the University of Chicago into group relations research and learning (as cited in Lipgar, 1997).

Withall’s study (as cited in Chavez, 1984) that explored the interactions between students and students and students and teachers in classrooms identified a group phenomenon, defined as the "social emotional climate". Withall's definition illustrates "phenomenological activities that are emotional and intellectual on the one hand, and individual and social on the other, where all activities are interactive within the classroom" (Chavez, 1984, p.240). Seven categories were developed to describe the social climate in terms of teacher behaviour and Withall suggested these could be used to measure the socioemotional climate. These categories were validated by Withall and Thelen (as cited in Chavez, 1984), and heralded "a trend that developed throughout the late fifties and early sixties in classroom climate research in which the concomitant classification of nonverbal behavior and classroom social structure would be measured" (Chavez, 1984, p. 242).

In the early 1950s, a new instrument, the Activities Index (AI) was developed (Stern, 1970) and modified a few years later when environment indexes were constructed. The indexes were questionnaires that aimed to measure the different environmental aspects of high schools, colleges and evening colleges, which helped to give them their unique cultural atmospheres, thus establishing the social climate or atmosphere of the setting. In the following years, further instruments were constructed that focused on the social climate, in an attempt to capture the psycho-social environment of the classroom from the teachers' and students' viewpoints (Moos & Trickett, 1986). The evaluation of the Harvard Project Physics included the development of an instrument to assess learning environments in physics classrooms. This resulted in the Learning Environment Inventory (LEI) (Walberg, 1968), designed to measure the social climate of learning in a classroom as perceived by the pupils (as cited in Chavez, 1984). The LEI was used in several studies and in 1969 Walberg affirmed that student perceptions of the classroom learning environment could be measured reliably with an instrument such as the LEI, and that environmental measures were valid predictors of learning (as cited in Chavez, 1984).

Around this time, as a result of research in a diverse range of environments (prisons, school classrooms, hospital wards, military companies, university residences and work milieus), Moos (1979a) and his colleagues found that "vastly different social environments can be described by common or similar sets of dimensions conceptualized in three broad categories: relationship, personal growth or goal orientation, and system maintenance and change" (p. 82). These three categories, known as domains, encapsulated dimensions which characterised, and contributed to, the "climate" of the varied environments (Moos, 1979a); "the 'blooming, buzzing confusion' of a natural social environment" (p. 80). Moos (1979a, 1979b) believes that the classroom environment is one of the most important influences on a student's personal and academic development and that the social climate of that environment is a major mediator. The domains of this climate are:

1 Relationship (the extent of involvement, support, nature and intensity of personal relationships of people involved in the environment)
2 Personal growth or goal orientation (assessing personal growth and self enhancement)
3 System maintenance and change (assessing "the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change") (Moos, 1979b, p. 139).

Moos (1979a) asserts that the three domains can characterise the social environments of varied settings and that "all three domains must be evaluated to obtain a reasonably complete picture of the social environment of a setting" (p. 19). Moos and his colleagues developed social climate scales which dimensionalised the relationship, personal growth or goal orientation and system maintenance and change domains. The scales have been found to be relevant and appropriate in measuring different environments (Moos, 1979a). Table 2.2 provides an overview of scales that dimensionalise Moos' (1979a) three psycho-social domains and the instruments that have been developed to assess the various educational environments (Fraser, 1998). The table shows the name of each scale in each instrument, the educational level for which each instrument is suited, the number of items contained in each scale, and the classification of each scale according to Moos' (1974) scheme for classifying human environments.

Table 2.2

Overview of Scales Contained in Nine Classroom Environment Instruments (LEI, CES, ICEQ, MCI, CUCEI, QTI, SLEI, CLES and WIHIC) (from Fraser, 1998, p. 531).

			Scales Classified According to Moos' Scheme		
Instrument	Level	Items Per Scale	Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation	Order and Organisation Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8-10	Helpful/Friendly Understanding Dissatisfied Admonishing		Leadership Student Responsibility and Freedom Uncertain Strict
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher Education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	Secondary	7	Personal Relevance Uncertainty	Critical Voice Shared Control	Student Negotiation
What Is Happening In This Classroom (WIHIC)	Secondary	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity

Fraser (1994) describes the change from traditional research and evaluation in science education, which tended to rely heavily on the assessment of academic achievement and other valued learning outcomes, to the social and psychological approach of "conceptualizing, assessing, and investigating what happens to students during their schooling" (p. 493). Fraser (1994) compares this traditional approach to the work done over many years by Walberg (1979) and Moos (1973, 1974, 1976, 1979a, 1979b, 1986) where environments are viewed as social settings, characterised by dimensions which participants within that environment can judge. This work has been acknowledged by Fraser and Chavez in their reviews of the theoretical underpinnings of classroom environment research (Chavez, 1984; Fraser, 1994, 1998)

Nature of the Instruments

The view that educational environments, along with many other varied settings, are social settings, characterised by dimensions that participants within those environments can judge, is now widely accepted. A reflection of this view is in the nature of the instruments that are used to evaluate classroom environments in primary, secondary and tertiary classes. These instruments are based on Moos' (1974, 1979) social climate domains and are listed in Table 2.2. The majority are appropriate for use at the secondary level but a questionnaire designed for use at the higher education level, and thus perhaps more suitable for this study, is the CUCEI.

All of the instruments in Table 2.2 seek to assess participants' perceptions of the social climate of their learning environments and focus on general psycho-social characteristics. Many studies have drawn on scales and items in existing questionnaires to develop modified instruments to better suit a particular research purpose (Fraser, 1998). The scales vary, as do the number of items relating to each scale for each form. Most items have a four or five response rating, for example from *strongly agree* to *strongly disagree*. The majority of the instruments in Table 2.2 have two forms, one for assessing the actual environment and one for assessing the preferred environment, as perceived by the participants. These two forms use parallel sets of items, but the Actual form asks respondents how they perceive the environment as it is, whereas the Preferred asks respondents how they would like the environment to be. A recent development has been for the newer forms to assess the individual's perceptions rather than how the individual perceives the class as a whole. The forms are designed for use by practitioners as well as researchers and research-practitioners. Fraser (1998) provides an extensive background of science learning environment instruments.

The CUCEI is one of the instruments listed in Table 2.2 and is designed specifically for use at the higher education level. It has been reported as a valid and reliable questionnaire (Fraser, Treagust, Williamson, & Tobin, 1987; Nair & Fisher, 2000a) and as instruments for assessing the tertiary learning environment are few (Nair & Fisher, 1999) it was considered suitable for use in this study to provide a measure of students' perceptions of their computer programming environment. The earlier part of this chapter has presented research that has described the computing learning environment as being problematic for some student subgroups (for example, females) and it was felt that data from the CUCEI would contribute to a broader understanding of what was happening in their classrooms. The next section describes the nature of the CUCEI and explains the recent modifications and personalisation of the instrument (Nair & Fisher, 2000a).

The CUCEI

The CUCEI was originally developed and validated in 1986 as an instrument for classroom environment research at higher education levels (Fraser et al., 1987) and specifically for use with small classes of approximately 30 students (Fraser, Treagust, & Dennis, 1986). The questionnaire has both a student and instructor version for assessing the actual and preferred environment. The Actual Version measures the participants' perceptions of their actual classroom learning environment, that is, as they experience it, whereas the Preferred Version measures the students' and/or instructors' perceptions of their preferred learning environments. Each form has 7 scales with 7 items per scale, making a total of 49 items. Students choose from a range of response alternatives of *Almost Never, Seldom, Sometimes, Often, Almost Always* (see Appendices 2A and 2B for students' versions and 2C and

2D for instructors' versions). The scales, as shown in Table 2.2, are based on Moos' (1979) three domains of Relationship, Personal Development and System Maintenance and Change, covering the social climate scales found to epitomise educational environments.

Assessment, therefore, of the dimensions of the three social climate domains provides an important perspective on how students perceive their environment. The microsettings in which students spend most of their time are meaningful and important and the use of an instrument such as the CUCEI enables a way to evaluate students' social environments, thus providing a basis for changing and improving the educational setting (Moos, 1979).

The original CUCEI has also been reported to be a valid and reliable instrument for use at both secondary and tertiary institutions. Two studies with sample sizes of 372 in 30 college and university classes (Fraser et al., 1986) and 742 students in 62 classes (Fraser, Williamson, & Tobin, 1987) provided validation data for the original forms of the CUCEI. Information about each scale's internal consistency (Cronbach's alpha reliability) and discriminant validity (mean correlation of a scale with the other six scales) suggests that each CUCEI scale displays satisfactory internal consistency for a scale composed of only seven items. The mean correlation of a scale with other scales ranged from 0.34 to 0.47 for the Actual Version and from 0.32 to 0.42 for the Preferred Version for the first sample, and from 0.23 to 0.49 and 0.30 and 0.48 for the second. This indicates satisfactory discriminant validity and suggests that the CUCEI measures distinct although somewhat overlapping aspects of the learning environment.

The instrument has been used to assess students' perceptions of their actual and preferred environments in an Australian second year university education program. Discrepancies between actual and preferred environments were identified and used to guide improvements (Yarrow & Millwater, 1995). Researchers of higher education learning environments in the USA and Spain have adapted and validated the CUCEI (Marcelo; Winston, Vahala, Nichols, Wintrow, & Rome, as cited in Nair & Fisher, 1999). The CUCEI was also used for the first time in an undergraduate nursing program and reported to be an effective tool in assessing the environment in a nursing education classroom (Fisher & Parkinson, 1998). As a result of feedback from student perceptions, the environment was changed to one that was more preferable to students.

The CUCEI was also used in a participative action research study of first-year psychology students at Victoria University, Melbourne, Australia. The research goal was to evaluate student attitudes toward their higher education learning environment and explore the potential for a staff development intervention (Bruck, Hallett, Hood, MacDonald, & Moore, 2001). Students perceived their actual experiences of the classroom environment as significantly below their preferred ratings. Staff explored aspects of their teaching practice and following the intervention there were significant increases in student levels of satisfaction with their tertiary course experience. The quantitative aspect of the study was complemented with qualitative data from focus group interviews with the researchers noting the level of congruence between the outcomes derived from these approaches.

The questionnaire was used in three research applications at the senior high school level (Fraser et al., 1987). These studies involved an investigation of associations between student outcomes and the nature of the classroom environment, a study of differences between students and instructors in their perceptions of actual and preferred classroom environment and an evaluation of alternative high schools. The results from the first study suggested that the nature of the classroom environment affects students' outcomes. Evidence from the second study indicated that both students and instructors preferred a more favourable classroom environment than the one actually present and that instructors viewed classroom environments more favourably than did their students in the same classroom. The third study revealed differences in the classroom environments of alternative and conventional high schools.

The Modified and Personalised CUCEI

In 2000 Nair and Fisher modified and personalised the CUCEI (Nair & Fisher, 2000a). They changed the CUCEI so that individual student perceptions of his/her classroom environment were elicited rather than the perceptions of the class as a whole. The earlier class versions of the instruments were limited in their ability to investigate differences in the environment scores of different subgroups of students within a class (for example, students varying in gender, ethnicity or socioeconomic status) (Fraser, Giddings, & McRobbie, 1992). Fraser and Tobin (1991) pointed out that this is potentially a major problem when differences between subgroups need to be identified. The perceptions of persons from different perspectives could lead to different interpretations of the environment and the new version of the CUCEI provides a means of uncovering these perspectives.

Personalised instruments have been used successfully in different studies (Fraser, Fisher, & McRobbie, 1996; Fraser, Giddings, & McRobbie, 1995), enabling more meaningful and sensitive investigations of the environment. As the primary focus of this study was on the perceptions of individual students within the subgroups of sex and new arrivals, and the differences between the subgroups, the personalised version of the CUCEI was considered to be appropriate for this purpose. A comparison of Nair and Fisher's (2000a) newly-personalised items with the "whole class" items of the original CUCEI Actual Version (Fraser, Treagust, et al., 1987) is given below for the Personalisation Scale:

Original "whole class" CUCEI: *The instructor goes out of his/her way to help students.*
Personalised "individual" CUCEI: *The instructor goes out of his/her way to help me.*

Examples of the Preferred Version for the same scale are:

Original "whole class" CUCEI: *The instructor would go out of his/her way to help students.*
Personalised "individual" CUCEI: *The instructor would go out of his/her way to help me.*

Nair and Fisher (2000a) also modified the CUCEI by replacing two scales with the Cooperation and Equity Scales. They viewed these two new scales as indicating important aspects of the senior secondary and tertiary classroom environment and as being relevant to contemporary educational concerns. It was considered that because of the focus of computing research studies over the past two decades on equity issues at the secondary school level (Clarke, 1990b; Jones & Clarke, 1995) and more recently on the computer science learning environments at the tertiary level (Bernstein, 1997, 1999; Camp, 1997; Cohoon, 2001; Grundy, 1996; Margolis & Fisher, 2002) this newly-modified CUCEI would also be suitable for this study. The Equity scale enables measurement of the extent to which instructors treat students equally and the inclusion of this scale will enable students' perceptions of this aspect of their environment to be gauged.

The second scale which Nair and Fisher (2000a) incorporated into the CUCEI was the Cooperation Scale. They believe that there is considerable support for the cooperative model in learning environments (Linn & Burbules, 1993; McLoughlin, 1998; Vahala & Winston, 1994) and that cooperation is an important dimension of the learning environment. Johnson & Johnson (1991) have researched the classroom climate, and conclude that "the more frequently that cooperative learning is used, the more that students perceive the classroom climate as being both academically and personally supportive and enhancing" (p. 72). Students who accessed the Australian gifted and talented programme during 1996-1997 via telematics, using audiographic conferencing, also valued the distance classroom climate as collaborative and cooperative (McLoughlin, 1998). They "saw learning as organised around sharing and refinement of ideas, collaboration and construction of ideas through group discussion" (p. 32).

An important feature of the seven scales of the CUCEI is that they ensure a more even distribution of Moos' dimensions. Three scales (Innovation, Individualisation and Equity) represent the System Maintenance and System Change dimension. Personalisation and Student Cohesiveness are classified under the Relationship dimension and Task Orientation and Cooperation are included in the Personal Development classification. Table 2.3 lists the seven scales of the CUCEI used in this study, together with a scale description and classification according to Moos' dimensions.

Table 2.3

Descriptive Information for the Modified CUCEI

Scale Name	Description	Moos' Classification
Personalisation	Extent of opportunities for individual students to interact with the instructor and on concern for students personal welfare	*Relationship*
Innovation	Extent to which the instructor plans new, unusual activities, teaching techniques and assignments.	*System Maintenance and System Change*
Student Cohesiveness	Extent to which students know, help and are friendly towards each other.	*Relationship*
Task Orientation	Extent to which class activities are clear and well organised.	*Personal Development*
Individualisation	Extent to which students are allowed to make decisions and are treated differently according to ability, interests and rate of working.	*System Maintenance and System Change*
Cooperation	Extent to which students cooperate rather than compete with one another on learning tasks.	*Personal Development*
Equity	Extent to which students are treated equally by the teacher	*System Maintenance and System Change*

The social climate scales (Moos, 1974) have been shown to reflect the experiences of participants within a learning environment and are determinants of learning and academic success. Fraser (1998) reports that numerous research programmes have shown that "student perceptions account for appreciable amounts of variance in learning outcomes, often beyond that attributable to background student characteristics" (p. 542). Recent studies examining the impact of educational environments have shown that students express greater satisfaction in classrooms characterized by high student involvement, by a personal student-teacher relationship, by innovative teaching methods, and by clarity of rules (Moos, 1979a).

Application of the Modified and Personalised CUCEI

The first study with the modified form of the CUCEI compared students' actual and preferred perceptions of their classroom learning environments at the senior secondary and tertiary levels of education with a sample of 504 students participating, 130 of whom were followed from senior through to tertiary level (Nair & Fisher, 2000b). The study also examined differences in perceptions according to the students' sex. The comparison of means and differences for the Preferred and Actual Versions of the CUCEI for male and female students indicated that "both males and females perceived their environment almost identically" (Nair & Fisher, 2000b, p. 445). However, though female and male students did not perceive any difference in the level of cooperation in their actual classroom environment, female students indicated that they desired greater cooperation in their preferred classroom environment. Generally, students perceived their classroom more negatively when they transitioned from the lower level of studies to a higher level. Nair & Fisher (2000b) noted that these findings replicate results from previous studies of students transitioning from secondary to tertiary education. At the time of writing, this research is the second study to use the newly-modified and personalised CUCEI.

The literature review has demonstrated that female participation in tertiary computing programmes in many Western countries is low and retention is poor. The impact of the computing culture together with the masculine image and the institutional context within which computing takes place have been shown to contribute to a social climate of the learning environment that can inhibit the learning of some students, especially minority subgroups. The learning environment, therefore, is influential in student achievement and attitudes. Females and new arrival students often form minority subgroups in computing classrooms and to date there have been no reported studies of how these students perceive their programming learning environment. The overall objective of this study is to investigate students' perceptions of their programming learning environment and, where appropriate, make recommendations for a more inclusive milieu. A mixed-method research design included the CUCEI to provide a quantitative measure of students' perceptions and interviews and observation afforded the qualitative data. These methods are discussed in the next chapter.

CHAPTER THREE

METHOD

In this chapter the research design is presented, followed by discussion of the mixed-method design adopted for this study and a description of the sample selection. The types of instrumentation, data collection approaches and ethical issues and safeguards are then described, followed by discussion of the administration of the CUCEI and description of how the observations and interviews were conducted. The chapter concludes with an overview of the data analysis.

Research Design

The objectives for this study are to:

1. investigate students' perceptions of their programming learning environment,
2. investigate how the student subgroups defined by gender and as new arrivals differ in their perceptions of their programming learning environment,
3. investigate lecturers' perceptions of their programming classroom learning environment,
4. make recommendations, where appropriate, to assist lecturers to make the learning environment more inclusive for all participants, and
5. examine the use of the College and University Classroom Environment Inventory (CUCEI) as an instrument to explore perceptions of the tertiary learning environment

A mixed-method design (Greene et al., 1989) combining qualitative and quantitative approaches was adopted to guide the design and implementation of the study. The two approaches were viewed as complementary and, in some instances, one approach yielded data which expanded and informed the study that the other did not, thus providing a more comprehensive understanding of the students' perceptions of their learning environment. The following section presents a brief background to qualitative and quantitative approaches followed by discussion of the five purposes of the mixed-method design adopted for this study.

The Mixed-Method Design

Studies of classroom learning environments involving both qualitative, ethnographic methods and quantitative information obtained from the administration of classroom environment questionnaires, have proved fruitful (Fraser & Tobin, 1991). The two approaches have different, complementary strengths, and in some areas are overlapping, enabling a study which is more comprehensive (Neuman, 2000). The combining of the two approaches overcomes some of the weaknesses, biases and limitations of a single approach (Denzin, 1988; Mathison, 1988; Patton, 1990). Mixed-method designs are defined as:

> those that include at least one quantitative method (designed to collect numbers) and one qualitative method (designed to collect words) where neither type of method is inherently linked to any particular inquiry paradigm (Greene et al., 1989, p. 256).

Greene et al. (1989) developed a mixed-method framework from the theoretical literature which was further refined through an analysis of 57 empirical mixed-method evaluations. They identified five purposes for mixed-method designs: Triangulation, Expansion, Complementarity, Initiation, and Development. They found from their review of the mixed-method evaluations, common misuse of the term triangulation where a triangulation purpose was stated but the study did not employ an appropriate design. In addition, relatively few evaluations incorporated in their review integrated the different quantitative and qualitative approaches at the level of data analysis. The researchers recommended that "thoughtfulness be given to the design and implementation of mixed-method studies" (p. 256) as well as careful planning and defensible rationales.

The major intent of this study is to investigate students' perceptions of their programming learning environment and the following discussion will describe how each of Greene et al.'s (1989) five design purposes contributed to the research design.

Triangulation

Triangulation is a practice used by sailors and surveyors to determine a location by studying the intersection of three points (Chenail, 1997). The intersection or "convergence" principle has been applied to research studies by combining several research methods. Thus, triangulation may be achieved through combining quantitative and qualitative methods and has been seen as a way of supporting "a finding by showing that independent measures of it agree with it or, at least, don't contradict it" (Miles & Huberman, 1984, p. 235). In this study, the triangulation intent of the mixed-method design sought convergence through the collection of data using a questionnaire, interviews, and observations. Mathison (1988) includes multiple data sources as a component of triangulation and this study incorporated student and lecturer data as well as data which resulted from observation fieldwork. The perceptions of the participants in the learning environment in this study were measured through collecting and analysing the findings of the quantitative and qualitative results to check convergence. In addition, the observational data provided an overall understanding of the physical learning environment as well as human participation and involvement. The finding of convergence, inconsistent or contradictory results will all allow an expanded understanding of participants' perceptions.

Expansion

Greene et al. (1989) note that "a study that aims for scope and breadth by including multiple components" (p. 260) uses both quantitative and qualitative methods and these methods provided the expansion element of the mixed-method design. The multiple methods of this study incorporated data, time and space (Denzin, 1988). Different methods provided different data from the participants (students and lecturers) of the learning environment. The time element was achieved by data being collected over a period of three months and analysis of the findings extended over time. This meant that the data from the CUCEI were the first to be analysed, followed by the interview and observation data. The initial analysis of the CUCEI provided a guide to formulating specific interview questions that would possibly not have been thought of had this not been done. Analysis of the interviews was expanded beyond the scales of the CUCEI to include additional categories and themes. The space element was achieved through data collection in separate locations: lecture halls, classrooms, computer laboratories and lecturers' offices. Observation of the environment and the participants contributed to an overall appreciation of the learning environment. Through the expansion element of the mixed-method design, a better and deeper understanding of the students' perceptions of the learning environment could be obtained.

Complementarity

In this study the complementarity intent of the mixed-method design was met by using qualitative and quantitative methods to assess the different study components of lecturer and student perceptions. The qualitative student data was obtained through interviews of a purposive sub-sample of students based on the subgroup categories of gender and origin. These data were complemented by the lecturers' interviews. The CUCEI provided the quantitative data. This provided broader content coverage as well as alternative levels of analysis (Greene et al., 1989).

Initiation

The initiation intent of this study's design, resulted in the emergence of fresh perspectives rather than constituting "a planned intent" (Greene et al., 1989, p. 260). The perceptions of the new arrival and gender subgroups were sought and it was considered important that the participants were given the freedom to express what they felt. This was done primarily through the semi-structured interviews whereas the CUCEI provided responses focused on the dimensions considered important to an educational learning environment (Moos, 1979a). The discrepancies in some of the qualitative compared with the quantitative findings were then intentionally analysed and to provide fresh insights "invoked by means of contradiction and paradox" (Greene et al., 1989, p. 260).

Development

The development intent relates to the sequential timing of the implementation of the different methods, thus one method informing the other. The administration of the CUCEI and initial analysis of the quantitative data began the study and these early results informed the construction of the semi-structured interview questions. While most of the questions were focused on the scales of the CUCEI thus providing the opportunity for quantitative data to be corroborated or discrepancies identified, additional questions were asked. This approach allowed broad issues to be understood as well as to remain focused on aspects of the learning environment.

The survey, together with observation and interviews provided a mixed-method approach for this study. The data sets were used together to enhance understanding of the programming learning environment as perceived by the students. This provided a richer and more insightful analysis than could be achieved by any one alone.

Sample Selection and Description

The target population of this study is students enrolled in their first tertiary year of programming studies in Wellington, New Zealand. Students were enrolled at three of the five institutions within the Wellington region. The tertiary institutions included two polytechnics (Institutions B and C), and one university (Institution A). Institution A had operated as a polytechnic for over 30 years prior to merging with a university three years ago. Qualifications the programming students could be enrolled in at Institution A are the Diploma in Business Computing or a Bachelor of Business Information. Institutions B and C offer the Certificate of Business Computing, the Diploma of Business Computing and a Bachelor of Information Technology. Regardless of the qualification, students enrolling in first year programming papers will all experience similar programming courses.

The goal for the sample completing the CUCEI was to include all tertiary students enrolled at the three tertiary institutions in first year programming courses, irrespective of qualification. A further aim was to interview a sub-sample of 36 students and conduct observations of the different learning environments (lecture theatre, classrooms and laboratories) at all three institutions. In an effort to meet these objectives, the institutions were visited at the times recommended by the lecturers. The times and dates varied over several months and necessitated multiple trips to each institution when students had classes scheduled. This resulted in a total sample of 239, representing 84% of the total first year programming student enrolment at the three institutions. All of these students completed at least one version of the questionnaire, making a total of 135 male and 97 female students who participated in the survey and seven others who did not report their sex.

Fifty-five new arrival students contributed to the total sample, 24 from Institute A, 15 from Institute B and 16 from Institute C. The new arrival students came from 18 different countries, the majority (38) from the Asian region. It is recognised that Asian is not a term that defines a homogenous group but this word is used loosely to indicate students who originated from the broad geographical region known as Asia. Eight students were from European countries, one each from Bahrain and Egypt and six from the Pacific Islands and Indonesia.

Student numbers for the subgroups of sex and origin are shown in Table 3.1. Female participation in the survey, as well as in the programmes of enrolment, is less than that of males for all three institutions and the number of new arrival students is less than that for New Zealanders. This makes the sample proportionally representative.

Table 3.1

Sample Sizes for Student Subgroups of Sex and Origin

	Sex		Origin	
Institution	Male	Female	New Arrivals	New Zealanders
A	40	32	24	51
B	56	33	15	75
C	39	32	16	56
Total	135	97	55	182

Note. Seven students did not report their sex and 2 students did not report their origin

Table 3.2 reports the ages of male and female students participating in this study. The sample comprised 140 students from the three institutions between the ages of 17 and 24 with 78 students older than 25 years. The sample from Institution B had the highest number of 17-24 year olds (62) with Institutions A and C having 34 and 44 respectively. Two interesting distinctions of Institution B were first, the number of males under 24 years (47) compared with 15 females and second, there were more than twice the number of females than males in the over-25-year age group. The other two institutions, although having lower female numbers, were not as disproportionately represented in the male/female ratio as Institution B. At Institution A, 49% of the male students were between 17 and 24 years of age compared with Institution C having 56% male students within the 17-24 age bracket. The ratio of male to female students aged 25 years and over was not as great as for the younger age group.

Table 3.2

Numbers and Ages of Students from the Three Institutions

	17-24 Years		25 Years and over	
Institution	Male	Female	Male	Female
A	19	15	20	14
B	47	15	8	17
C	25	19	12	12
Total	91	49	40	43

Note. Nine students did not report their age and seven did not report their sex.

As the survey sample included 84% of the total number of students enrolled in programming classes at the three Wellington institutions at the time this study was conducted it is considered that the sample is reasonably representative of students studying programming in these three Wellington tertiary institutions.

Interview Sub-Sample

The intention was to interview a purposive sub-sample of 36 students from the three institutions. It was hoped to have equal numbers of students from the sex and origin subgroups. At the time of administering the CUCEI, students were asked to indicate on the Consent Form (see Appendix 3A) their willingness to be interviewed and, if so, to include their contact details. This invitation rendered very few interview candidates and so at the conclusion of the teaching of each observation session, students were asked if they would be willing to spend approximately 30 minutes being interviewed at a mutually convenient time and place. It was explained again that the main point of interest was their perceptions of the programming learning environment. This personal, in-the-field approach proved successful and as the researcher approached those who had indicated their willingness to participate in the interviews, students were asked the length of time they had been in New Zealand (for the new arrivals category), their contact details, and age and told that they would be contacted later to arrange a mutually suitable interview time and date.

The next stage was to allocate the students to the sex and origin subgroups. Table 3.3 shows that a total of 15 new arrival students (8 male, 7 female) and 13 New Zealanders (6 male, 7 female) were interviewed. It was not possible to interview the same numbers of students from each institution because of two factors. First, despite telephoning and emailing reminders of meeting times, there were students who either forgot or did not attend interviews for various reasons. Second, some institutions had fewer numbers of students in the new arrivals subgroup. For these reasons, 28 of the expected 36 students were interviewed. The sample is believed to be broadly representative of the student subgroups attending each institution as there was diversity of ages and ethnicity and students' self-perceptions of their success with the study of programming.

Table 3.3

Student Interview Structure

Category	Institution	Male	Female
New arrivals	A	3[a]	1
	B	3	4[a]
	C	2	2
Total number of new arrivals		8	7
New Zealanders	A	3	3
	B	2	1
	C	1	3
Total number of New Zealanders		6	7

[a]Two interview sessions were held to accommodate the students who forgot to attend the first interview session.

A total of six lecturers from the three institutions taught programming. Five of the six lecturers took part in this study, participating in the survey and interviews as well as granting permission for observation of their classes. All but one lecturer were cooperative and helpful in allowing access to students and themselves. At Institution A, the lecturers were a male and a female, who were both very experienced programming teachers. The male lecturer at Institution B was also an experienced programming teacher. An ex-physics teacher, with several years of programming teaching experience, taught Institution C's programming classes. The younger female lecturer at Institution C had recent programming experience through working in the computing industry.

Two interviews were with the two lecturers from two different institutions (A and C) and one interview was with the lecturer from Institution B who did most of the first year programming teaching. The two lecturers from Institution A were interviewed in the lecturers' shared office. The lecturers from Institution C were also interviewed together in their office. The lecturer from Institution B forgot to attend the first scheduled meeting and subsequently was interviewed at the researcher's home a week later. There was a second lecturer at Institution B, teaching at the satellite campus, who found it difficult to commit to interview times or visits to her classes taught at the institution's satellite campus. She also stated she was very stressed. After several attempts at formalising dates and times it became obvious she was uncomfortable in participating in the study and the satellite campus was not included in the research. This meant that potentially 23 students were excluded from that institution's data and contributed to the 16% of enrolled students at the three institutions who did not participate in this study. Her colleague explained that four staff members had recently resigned, resulting in a higher workload for the remaining staff members and staff morale was low because of persistent rumours that the institution was in financial difficulty. Five months later the Associate Minister of Education announced the dis-establishment of Institution C due to financial difficulties.

Instrumentation

This section describes the instruments used, gives reasons for their selection and details the properties of each type.

Questionnaire: The CUCEI

The questionnaire enabled a quantitative measurement of the learning environment and provided a highly-structured and efficient data collection technique for this study. Each participant responded to the same set of statements that provided information about their perceptions of the classroom environment. Demographic information was obtained by participants responding to several questions presented in a box at the top of the questionnaires (see Appendices 2A, 2B, 2C and 2D for student and instructor's versions of the CUCEI).

CUCEI Scales

Nair and Fisher's (2000a) newly-modified CUCEI was used for this study. The CUCEI has 7 scales with a total of 49 items. As discussed in chapter 2, the scales are Personalisation, Innovation, Student Cohesiveness, Task Orientation, Individualisation, Cooperation and Equity. Chapter 2 reported Nair and Fisher's (2000a) modifications to the original version of the CUCEI. The two researchers reworded all items in the five scales from the original CUCEI to the personal approach and replaced the Involvement and Satisfaction scales with the Cooperation and Equity scales, adopted from the What is Happening in This Class (WIHIC) questionnaire (Fraser et al., 1996). Response alternatives have a five-point scale of Almost Never, Seldom, Sometimes, Often, Almost Always. Each CUCEI Scale has seven items that are worded in a personal fashion. For example, the Actual Version has one statement for the Equity scale of, "I am treated the same as other students in this class"; for the Personalisation Scale, "The instructor goes out of his/her way to help me". For the Preferred Versions the statements read, respectively, "I would be treated the same as other students in this class" and "The instructor would go out of his/her way to help me".

The researchers also made changes to the way items were ordered in the questionnaire. In the original CUCEI the items appeared in a cyclical manner. In the modified version all items are grouped in their appropriate scale with all seven items belonging to the same scale appearing in one block, thus making it easier for hand-scoring purposes.

Validation and Reliability of the Modified and Personalised CUCEI

The modified and personal form of the CUCEI has been reported to be a valid and reliable instrument (Nair & Fisher, 2000a). The instrument was used to measure student and instructor perceptions of their tertiary classroom learning environment. The sample consisted of a total of 504 students studying a variety of science subjects and 24 instructors. Two hundred and five participants were from Canadian institutions and 299 students from Australian institutions (Nair & Fisher, 2000a). Information about each scale's internal consistency (Cronbach's alpha reliability) and discriminant validity (mean correlation of a scale with the other six scales) suggests that each CUCEI scale displays satisfactory internal consistency for a scale composed of only seven items. The Cronbach Alpha Coefficients are reported in Table 3.4 for two units of analysis for each of the seven scales in the CUCEI for the Actual and Preferred Versions. Alpha coefficients using the individual student as the unit of analysis ranged from 0.73 to 0.93 and 0.76 to 0.94 for the Actual and Preferred versions, respectively. With class means as the unit of analysis, all alpha reliability values were higher, ranging from 0.84 to 0.97 for the Actual Version and 0.87 to 0.98 for the Preferred. Alpha coefficients are reported for both the Student and the Instructor Versions of the CUCEI with higher coefficients being generally evident for students.

The discriminant validity is described as the extent to which a scale measures an unique dimension not covered by the other scales in the instrument. Table 3.4 indicates that the mean correlations of the scales in the CUCEI ranged from 0.15 to 0.38 for the Actual Version and from 0.25 to 0.47 for the Preferred Version, suggesting that the scales measure distinct although somewhat overlapping aspects of classroom environment (Nair & Fisher, 2000a).

A one-way ANOVA with class membership as the main effect, and using the individual as the unit of analysis, was used to investigate the differentiation between perceptions in different classes (Nair & Fisher, 2000a). The eta^2 values are statistically significant ($p < .05$) indicating that the scales differentiate between classrooms.

Table 3.4

Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation with Other Scales) and the Ability to Differentiate between Classrooms (ANOVA) for Two Units of Analysis for the CUCEI Scales (from Nair & Fisher 2000a, p. 421)

		Internal Consistency				Mean Correlation with Other Scales				
CUCEI	Unit of	Student		Instructor		Student		Instructor		ANOVA
Scales	Analysis	A[a]	P[b]	A	P	A	P	A	P	Eta^2
Personal-	I[c]	0.87	0.84	0.79	0.72	0.34	0.45	0.30	0.44	0.23**
isation	C[d]	0.95	0.87			0.30	0.30	`		
Student	I	0.82	0.83	0.77	0.75	0.20	0.47	0.28	0.28	0.28**
Cohesion	C	0.96	0.88			0.38	0.43			
Task	I	0.77	0.79	0.64	0.74	0.27	0.44	0.33	0.21	0.27**
Orientation	C	0.92	0.92			0.33	0.44			
Cooperatio	I	0.92	0.93	0.84	0.87	0.25	0.45	0.29	0.40	0.11*
n	C	0.96	0.94			0.29	0.38			
Individual-	I	0.82	0.80	0.85	0.90	0.15	0.25	0.35	0.41	0.22**
isation	C	0.93	0.94			0.34	0.35			
Equity	I	0.93	0.94	0.90	0.91	0.30	0.42	0.18	0.19	0.09*
	C	0.97	0.98			0.38	0.45			
Innovation	I	0.73	0.76	0.72	0.93	0.22	0.43	0.18	0.42	0.13**
	C	0.84	0.93			0.35	0.39			

Note. The sample consisted of 504 students in 26 classes and 24 instructors.

[a]Actual

[b]Preferred

[c]Individual

[d]Class

** $p < 0.001$ * $p < 0.01$.

CUCEI Description

The CUCEI comprises three pages (for both the Actual and the Preferred Versions) with the first page identifying the name of the questionnaire and directions for responding to the statements (see Appendices 2A and 2B for the student versions and Appendices 2C and 2D for the instructor versions). The second page of the student version backs the first and starts with demographic questions relating to qualification, gender, age and New Zealand or new arrival status. For the instructors' forms, the second page begins with questions asking the lecturer's name, qualification they are teaching programming for, sex and age. The first scales (each with seven items) appear below these questions and the remaining scales are on page 3. A reminder instruction and response headings appear immediately above the first statements on both pages 2 and 3. The response format for each item in each scale ranges from Almost Never (scored one) to Almost Always (scored five). The numbers appear under these alternatives and students and lecturers circle their choice. The form ends with an expression of thanks. The questionnaire was copied onto different coloured paper to identify institutions as well as distinguishing the Actual from the Preferred forms.

Participant, Content and Context Observation

A strength of observation which Patton (1990, p. 204) notes is that the researcher is able "to move beyond the selective perceptions of others". By becoming involved in a physical sense, the researcher is more able to reflect from a position of informed understanding of the environment within which all participants are teaching and learning. Criticism of observation may be made on the grounds of "selective perception" (Patton, 1990) reflecting biases and perceptions and interpretations of the observer, thereby justifying casting doubt on observation as a valid and reliable method of inquiry. In addition, errors of observation are virtually inevitable, especially in observations of human behaviour. It is acknowledged that the observer cannot see (or understand) everything going on but through participation and experience within the environment, and with a clear plan of what to focus on and the recording of field notes, observation can contribute important insights which other methods can not. Kaplan (1988) believes that despite the criticisms, "observation is inseparable from a grasp of meanings" (p. 89).

Observation of participants' interactions, both verbal and behavioural, within the programming learning context, is one of the three methods of data collection used in this study. It provides for triangulation of data, allowing a better understanding of the findings. The context of the different physical learning environments (lecture hall, classroom, and computer laboratory), the lesson content and mode of delivery were observed as well as the participation of students and lecturers. It is not possible to observe everything and therefore a "sensitizing" approach was adopted as the basic framework for observation. Through this avenue, "certain kinds of events, activities, and behaviors" (Patton, 1990, p. 216) were looked for. It was recognised that the researcher brought certain preconceptions and perceptions to the observational task and therefore did not enter the field with a complete blank slate. However, awareness of the four environmental variables (social climate, the physical setting, organisational factors and types of people present) which Moos (1979) believes affects an environmental system, helped to focus the observational process.

Interviews

Semi-structured interviews of students and lecturers were used because they provide a greater breadth than other types of data collection approaches (Fontana & Frey, 1994) and are useful for identifying possible areas for more detailed analysis. The interviews are a common way to generate qualitative data, being less formal than structured interviews (Arksey & Knight, 1999). They allow observation of nonverbal communication as well as affording the opportunity of asking complex questions. The opportunity to probe and follow-up on responses allows the exploration of ideas or themes which interviewees may bring up and which have not been directly addressed by questions. Another positive feature is that interviewees often feel that their input has been taken account of.

As a method of collecting data, the interviews contrasted with the CUCEI which was highly structured, yielding fixed responses on a narrow range of questions. Within this mixed-method study, the interviews provided a good way of exploring further the issues identified in the scales of the CUCEI.

A specific agenda was followed with the interview questions based on the scales of the CUCEI. The loosely structured interview contained key questions (see Appendix 3B Students' Interview Questionnaire and Appendix 3C Lecturers' Interview

Questionnaire) yet gave the freedom to follow up ideas, probe responses and ask for clarification or further elaboration.

Data Collection

This section focuses on how the data were collected. Ethical issues associated with ensuring confidentiality, the selection of the participants, the development of the questions to be raised in the interview, and the conduct of the interviews are discussed.

The timing of the two surveys (Actual and Preferred Versions of the CUCEI) was carefully considered. The aim was for students to assess the learning environment on the basis of experience rather than as students coming to a new environment so data collection occurred over a period of three months, in the latter half of the second semester. Mutually convenient times for the multiple visits were agreed with the lecturers.

Ethical Issues

The Human Research Ethics Committee of Curtin University of Technology granted ethical approval for this research. The proposal was also approved by Institution A's Human Ethics Committee, the Academic Director of Institution C and Institution B's Research Committee.

Confidentiality was the major ethical issue of this study and after explaining the purpose and reasons for the study in the Human Research Ethics Committee application, and to all the participants in the study, assurances were given that published results arising from this research project would not identify individuals. It was made clear to the participants that they could withdraw themselves or any information they provided at any time. The opportunity to ask questions and to receive feedback on the outcome of the research at its conclusion was also made explicit (Appendix 3D, Participant Information Sheet and Appendix 3A Consent Form).

The heads of the three information systems departments were contacted in writing, seeking permission for the research project to be conducted at their institutions and for permission to approach the programming lecturers. A summary of the proposal was included and assurances given on meeting codes of conduct both legally, ethically and morally. The institutions' ethics committees approved the project and permission was granted. The researcher contacted the lecturers involved in first year programming teaching and, after explaining the study, was granted their permission and approval to conduct the research. Interview participants were asked whether they agreed to have the interview audio-taped. All agreed to this and they were assured that the transcriptions would be done by the researcher and that pseudonyms would be used to preserve confidentiality.

The CUCEI

Administration of the survey form, the CUCEI, was done by the researcher, over a period of four weeks. Care was taken to avoid surveying at a time when students were preparing for examinations. It was decided to emulate the administration process of the Actual and Preferred CUCEI forms that Nair used in his research involving 504 students studying a variety of science subjects in Canadian and Australian institutions (Nair & Fisher, 2000b). This involved students completing the Actual Version on the first visit and at a later date (depending on agreement of a mutually convenient time) the Preferred Version was administered. The intention of this approach was to prevent response fatigue thus helping to ensure a more accurate response. In addition, the researcher was conscious of taking up valuable learning and teaching time and did not want the majority of the teaching session to be taken up with filling in the survey. This administration strategy met these objectives but an unexpected disadvantage resulted in the matching of the Actual and Preferred Versions. At all three institutions student attendance was erratic. This meant that some students were present for one of the survey sessions and absent on the other occasion (Table 3.5 shows the student responses by institution). This resulted in 58

Actual, 51 Preferred and 126 matched Actual and Preferred Versions of the CUCEI being obtained.

Table 3.5

Student Responses to the CUCEI

Institution	Actual Only	Preferred Only	Both Actual And Preferred	Total
A	16	19	39	74
B	19	22	50	91
C	23	10	37	70

Note. Four forms were unusable

Visits to a number of different venues at each institute were required as students were in different programmes (Certificate of Business Computing, Diploma in Business Computing and degrees). After agreeing on suitable dates and time and upon arrival at the institution, the lecturers introduced the researcher to the students who then briefly described her study, explained the format of the CUCEI and the importance of the students' voluntary responses. On the first visit, the Actual forms were handed out and the researcher waited for students to complete them. On several occasions students sought clarification of some of the items. The same procedure was followed for the Preferred forms on the second visit. This resulted in an excellent response rate from those present, with very few students declining to participate.

Observation

Observations of lectures, classrooms and laboratories were conducted at all three institutions for a total of 11 hours 20 minutes over a period of three months. The two tiered lecture theatres at Institutions B and C accommodated student numbers of 200 and 100 respectively. The classrooms were flat rooms with individual tables and chairs, accommodating, depending on the room, up to 25 and 30 students. Computer laboratories also varied as to the number of seats and computers; ranging from 25 to 32. The duration of each observation session was one to two hours, depending upon the type of session (lecture, classroom lecture/discussion and computer laboratory). Once permission was granted from the heads of departments of each institution, permission was sought from the lecturers involved in teaching first-year programming to observe their classes. All lecturers were very cooperative. Table 3.6 shows the observation time spent in each type of learning environment, the names of the lecturers (pseudonyms) and the institutions.

Table 3.6

Observation Schedule

Institution	Lecturer	Lecture Theatre	Classroom	Laboratory
A	Ruth			2 hours
	Barry			1 hour
B	Alex	1 hour	2 hours	20 minutes
	Rob[a]			2 hours
C	Richard	1 hour	1 hour	
	Deb			1 hour

[a]A tutor who assisted Alex in the computer laboratory

Upon arrival at the start of class, the researcher was re-introduced by the lecturer who reminded students they had probably seen her some weeks before if they had been present when the questionnaire was administered and advised students of the observation session. The social relations between the researcher as observer and the students and lecturers (as the observed) was an aspect which was approached from a position of respect; being conscious of the researcher's role and that of the hosts – the students and lecturers.

The researcher briefly described the purpose and reasons of the research. To avoid intruding unnecessarily in the class activities, the researcher sat in a location that afforded a good view of participants and the room. In the formal lectures the researcher positioned herself at the back and did not move around as this would have been disturbing to both students and lecturer. However in the laboratories there was much general movement from the students and instructors and the researcher also felt free to move within this situation.

The recording of observations was by hand. Audiotape was not used but notes were taken of observations of the interactions between student and student and between lecturer and student(s), both verbal and non-verbal. The scales of the CUCEI (Personalisation, Innovation, Student Cohesiveness, Task Orientation, Individualisation, Cooperation and Equity) served to guide the researcher's points of focus.

The researcher was particularly interested in the subgroups of gender and new arrivals and consequently their participation in the classroom milieu as well as the other students were the focus of observation. While the researcher could not initially be sure of the identity of new arrivals, their status was confirmed with the lecturers at the conclusion of the teaching. In addition, the interviews with the subgroups further helped in this identification.

The physical and social environments varied amongst institutions as well as within the same institution. Size of room, its purpose, the number of students and so on were noted, as were the ways in which participants behaved toward each other. The researcher looked for the ways in which people organised themselves into groups and subgroups, patterns of interaction, frequency of interactions, the direction of communication patterns (from lecturers to students and students to lecturers) and changes in these patterns.

Interviews

Students and lecturers involved in the programming classes were interviewed. The interviews were the last component of the data collection and by that stage the researcher was familiar to the students and lecturers, having delivered the two versions of the CUCEI and sat in on the lectures, classes and laboratory sessions while doing the observations.

Considerable time was spent via telephone and email arranging mutually convenient times and dates for the semi-structured group interviews. On the evening prior to the interviews, participants were telephoned to remind them of the meeting. Usually two or three people attended an interview but on three occasions, a student who had forgotten to show for the scheduled time contacted the researcher and a one-to-one interview resulted. Interviews were conducted on each campus at various locations (a study room in a campus library, a meeting room and empty classrooms).

Student interview questions were mostly open-ended and developed around the scales of Personalisation, Innovation, Student Cohesiveness, Task Orientation, Individualisation, Cooperation and Equity (see Appendix 3B, Students' Interview Questionnaire). An example of a question relating to the Innovation Scale is, "What do you think of the way programming is taught; for instance the mix of lecture and laboratory work?" All participants were asked the same questions, in approximately the same order. They were not necessarily identical in phrasing but were in intent. The initial lecturer interview questions related to student enrolment and completion numbers and asked for lecturers' opinions on the similarity of their programming courses to those delivered at the other two Wellington institutions. The remaining questions focused on student subgroup differences in approaches to learning programming, the teaching of programming and classroom management (see Appendix 3C, Lecturers' Interview Questionnaire).

The interview session began by ensuring the interviewees knew each other. The research aims were briefly explained and the value of the interviewees' contribution to the data expressed. Confidentiality assurances were given and ethical safeguards explained. They were asked if they objected to the interviews being audio-taped. The length of the student interviews varied between 45 to 75 minutes. Coffee or tea was offered at the researcher's own institution and at other institutes a tangible "thank you" was made in the form of chocolate bars at the conclusion of the interviews.

Three interviews were conducted with the five lecturers. These were held after survey data collection and observations had concluded. By then an easy relationship and rapport had been formed and the lecturers were happy to attend interviews. Mutually agreeable times were made during one of the many visits to each of the institutions with the lecturers' interviews lasting between 40 and 60 minutes. A box of chocolates was given to each lecturer when the interview concluded as an expression of the researcher's gratitude for their goodwill and cooperation in the study.

Altogether, a total of 19 hours was spent in interviews. Of that total, 15 hours involved students and four hours were with lecturers. The researcher transcribed the interviews within a few days (and sometimes on the same day) of the interviews, taking a total time of 35 hours.

Overview of Analysis

The three data sets were analysed separately. Data from the CUCEI were entered into the computer program SPSS and analysis completed using this program. Student and lecturer interview transcripts were entered into QSR NUD*IST, Version 4 (1997) and categories, based on the scales of the CUCEI created. A discursive analysis (Nash, 1976) was adopted that allowed students' and lecturers' responses to be presented in a "raw" form, as they were spoken, thus attempting to convey as accurate a picture of the interviewees' intentions as possible. Observation notes were transcribed and coded around physical and behavioural themes.

It was important to be able to move between the different data sets and different parts of the study in order to develop an integrated set of results. This led to the findings from the collected data being complementary and expansive, thus contributing to forming a more complete and coherent picture of the tertiary programming learning environment.

Statistical Analysis of the CUCEI

The first step in analysing the CUCEI was to examine its psychometric properties to ensure that the seven-scale structure held up on the data obtained in this study, and that the scales were valid and reliable. Following this, multivariate analysis of variance was used to analyse students’ responses to the Actual and Preferred Versions of the instrument.

Computer-Assisted Analysis of Interview Data

The interview data sets consist of typed verbatim transcripts from the 28 student and 5 lecturer interviews. The verbatim transcripts are an important aspect of the data set as they provide a full record of what the interviewee says, reducing the researcher's conscious and, more importantly, unconscious preconceptions, prejudices and biases. Through analysing a complete and full record of the dialogue and conversation of the meetings, the context is apparent, affording a better understanding of the interviewees' comments.

The challenges of analysing a large volume of semi-structured and unstructured qualitative data (interviews and observations) were partially met through the use of the computer program, QSR NUD*IST, Version 4 (1997). As with many other computer programs, QSR NUD*IST provides ease of data management, support and flexibility that would be more difficult with manual processes. Engagement in the qualitative analysis was not removed from the researcher's control but rather enhanced by the possibilities afforded through the program. The researcher was still required to analyse, code and identify themes and interpret meanings as well as produce thematic tables with descriptive text that informed and/or explained the theme.

Before commencing coding of the transcripts an organisational hierarchical index tree structure of categories, subcategories and sometimes, sub-subcategories was created. The scales of the CUCEI defined initial categories but some of the interviewees’ responses did not fit the scales and so new categories and subcategories were created. Analysing was iterative as new ideas and concepts were discovered. The hermeneutic process of adding, deleting, reorganising the themes into categories and subcategories continued until it was felt the data were "saturated" (Glaser, 1992).

Analysis began during transcription when a new idea, theme or category was identified and the <*Enter*> key used to establish *text units* (a QSR NUD*IST term for specific chunks of data). Sometimes the category related to one that had already been established and "dimensionalized" (Gahan & Hannibal, 1998). In this case, a subcategory was created. The transcripts were then imported into QSR NUD*IST, Version 4 (1997) where they were again read and electronically labelled. During this re-reading stage, new ideas sometimes occurred, and additional categories and/or subcategories were created, taking cognisance of the *meaning* attributed to each category (see Appendix 3E Student and Lecturer Interview Categories and Themes). The naming of a subcategory crystallises thinking. For instance the category *Equity* was further informed and a wider dimension of examination afforded by the subcategories of *Age Difference, Racism, Minority, Stereotypes, Male Aptitude and Maths Ability*. The *Minority* sub-category was further informed by the sub-sub-categories of *Gender* and *New Arrivals*.

After reading and re-reading the results of searches (done within QSR NUD*IST, Version 4 (1997)) tables were created for each category and responses grouped into the student subgroups of gender, new arrivals and New Zealanders. This process quantified responses for each subgroup. The responses were additionally grouped into explanatory subcategories which informed the major categories.

Apart from labelling chunks of categorised dialogue, QSR NUD*IST, Version 4 (1997) provided for the referencing of interviewee name, date and time of interview, pseudonyms, page and paragraph number, etc. This provided the ability to drill down and contextualise the quote or paragraph after searches were run. The contextualising of qualitative data is important and relevant because it allows an understanding of what is going on and a means of validating analytical claims.

Linking Data from Different Sources

The linking of the different data sets was achieved through developing an index system, made up of nodes that are containers for categories, coding and ideas about the project. The major categories were the scales of the CUCEI. Links were then created between the scale and the relevant coded sections of the interview and observation transcripts. The nodes provide storage for ideas and exploration of the transcripts. Searches combining categories or exploring their relationship to other subjects can be run, evaluated and stored.

Summary

This chapter has described the mixed-method design adopted for this study and the application of the three different data collection methods. The sample selection and description for the CUCEI has been discussed as well as the subset sample selected for interviews. The nature of the CUCEI and explanation of how data was collected precedes an overview of analysis. Chapter 4 reports the results for the CUCEI and Chapter 5 the qualitative results.

CHAPTER 4

RESULTS FOR THE CUCEI

The CUCEI was used to provide survey data on first year students' perceptions of their programming learning environment. The first section of this chapter describes results from the analysis of the questionnaire and the statistics used to decide whether the questionnaire was a reliable and suitable instrument for this study. The second section reports results from the use of the CUCEI in investigating how the student subgroups defined by gender and as new arrivals perceived their learning environment.

Item Analysis of the CUCEI

The item analyses discussed in this section were done on the entire sample that completed each version of the CUCEI, so that the samples overlap but are not identical see Table 3.5). Table 4.1 reports means and standard deviations for each item of the seven scales of the Actual Version of the CUCEI, and Table 4.2 reports similar results for the Preferred Version. As can be seen from Appendices 4A and 4B which report the item response frequency distributions for the Actual and Preferred Versions respectively, every response choice has attracted some response. There are no responses for Item 16 on the Preferred Version due to a typographical omission on the original version, which was copied for the survey. It was not until data was being entered that the omission was realised. For all other items, Appendix 4A reports a reasonable spread of scores with standard deviations mostly about 1 or greater for the five point response format. The item means range from 2.10 to 4.54 for the Actual CUCEI and 2.40 to 4.54 for the Preferred Version of the CUCEI, but even though some means are high there seem to be no ceiling or floor effects. These results indicate that items are reasonably sensitive.

Table 4.1

Item Means and Standard Deviations for Actual Version of CUCEI

Scale Name and Items	Item	Mean	*SD*	*n*
Personalisation				
The instructor considers my feelings.	A1	3.28	1.09	172
The instructor is friendly and talks to me.	A2	3.86	0.95	184
The instructor goes out of his/her way to help me.	A3	3.63	1.06	183
The instructor helps me when I am having trouble with my work.	A4	3.96	0.96	182
The instructor moves around the classroom to talk with me.	A5	3.55	1.21	182
The instructor is interested in my problems.	A6	3.58	1.03	181
The instructor is unfriendly and inconsiderate towards me.	A7*	4.54	0.90	180
Innovation				
New ideas are seldom tried out in this class.	A8*	3.10	1.10	181
My instructor uses new and different ways of teaching in this class.	A9	2.78	0.90	181
The instructor thinks up innovative activities for me to do.	A10	2.85	1.02	180
The teaching approaches used in this class are characterised by innovation and variety	A11	2.84	0.94	181
Seating in this class is arranged in the same way each week.	A12*	2.54	1.62	184
The instructor often thinks of unusual activities.	A13	2.34	1.03	180
I seem to do the same type of activities in every class.	A14*	2.96	1.14	183
Student Cohesion				
My class is made up of individuals who don't know each other well.	A15*	3.60	1.14	181
I know most students in this class by their first names.	A16	3.94	1.22	184
I make friends easily in this class.	A17	3.81	0.93	182
I don't get much of a chance to know my classmates.	A18*	3.71	1.05	183
It takes me a long time to get to know everybody by his/her name in this class.	A19*	3.41	1.17	181
I have the chance to know my classmates well.	A20	3.40	1.10	183
I am not very interested in getting to know other students in this class.	A21*	3.90	1.10	183
Task Orientation				
I know exactly what has to be done in the class.	A22	3.65	0.87	184
Getting a certain amount of work done is important in the class.	A23	4.05	0.92	183
I often get sidetracked in this class instead of sticking to the point.	A24*	3.05	1.06	181
This class is always disorganised.	A25*	3.88	1.02	183
Class assignments are clear and I know what to do.	A26	3.50	1.10	183
This class seldom starts on time.	A27*	3.24	1.25	180
Activities in this class are clearly & carefully planned.	A28	3.68	0.89	183
Cooperation				
I cooperate with other students when doing assignment work.	A29	3.92	1.01	184
I share my books and resources with other students when doing assignments.	A30	3.83	1.04	184
I work with other students on projects in this class.	A31	3.72	1.09	184
I learn from other students in this class.	A32	3.88	1.03	183
I work with other students in this class.	A33	3.83	0.99	181
I cooperate with other students on class activities.	A34	4.00	0.93	183
Students work with me to achieve class goals.	A35	3.68	1.10	182

Individualisation				
I am expected to do the same work as all the students in the class, in the same way and in the same time.	A36*	2.10	1.10	183
I am generally allowed to work at my own pace in this class.	A37	3.58	1.14	184
I have a say in how class time is spent.	A38	2.44	1.11	180
I am allowed to choose activities and how I will work.	A39	2.62	1.13	177
Teaching approaches in this class allow me to proceed at my own pace.	A40	3.23	1.10	181
I have little opportunity to pursue my particular interests in this class.	A41*	3.28	0.99	180
My instructor decides what I will do in this class.	A42*	2.45	1.15	182
Equity				
The instructor gives as much attention to my questions as to other students' questions.	A43	4.13	0.94	181
I get the same amount of help from the instructor as do other students.	A44	3.95	1.06	183
I am treated the same as other students in this class.	A45	4.28	0.94	183
I receive the same encouragement from the instructor as other students do.	A46	4.22	1.02	182
I get the same opportunity to answer questions as other students.	A47	4.28	0.83	183
My work receives as much praise as other students' work.	A48	4.06	1.02	184
I have the same amount of say in this class as other students.	A49	4.16	0.97	184

* Reverse scored items

Table 4.2

Item Means and Standard Deviations for Preferred Version of CUCEI

Scale Name and Items	Item	Mean	*SD*	*n*
Personalisation				
The instructor would consider my feelings.	P1	3.74	1.00	174
The instructor would be friendly and would talk to me.	P2	4.10	0.86	174
The instructor would go out of his/her way to help me.	P3	3.92	0.84	172
The instructor would help me when I am having trouble with my work.	P4	4.30	0.84	171
The instructor would move around the classroom to talk with me.	P5	3.75	0.97	173
The instructor would be interested in my problems.	P6	3.76	0.96	172
The instructor would be unfriendly and inconsiderate towards me.	P7*	4.54	0.95	171
Innovation				
New ideas would be seldom tried out in this class.	P8*	3.28	1.17	172
My instructor would use new and different ways of teaching in this class.	P9	3.51	0.89	173
The instructor would think up innovative activities for me to do.	P10	3.57	0.94	174
The teaching approaches used in this class would be characterised by innovation and variety.	P11	3.60	0.91	174
Seating in this class would be arranged in the same way each week.	P12*	2.87	1.35	171
The instructor would often thinks of unusual activities.	P13	3.01	1.04	171
I would do the same type of activities in every class.	P14*	2.56	1.09	173
Student Cohesion				
My class would be made up of individuals who don't know each other well.	P15*	3.75	1.10	170
I would make friends easily in this class.	P17	3.92	0.85	172
I would not get much of a chance to know my classmates.	P18*	3.71	1.10	171
It would take me a long time to get to know everybody by his/her name in this class.	P19*	3.40	1.18	170
I would have the chance to know my classmates well.	P20	3.80	0.94	174
I would not be very interested in getting to know other students in this class.	P21*	3.92	1.18	172

Task Orientation				
I would know exactly what has to be done in the class.	P22	4.09	0.99	174
Getting a certain amount of work done would be important in the class.	P23	4.06	0.88	174
I would often get sidetracked in this class instead of sticking to the point.	P24*	3.66	1.08	173
This class would be always disorganised.	P25*	4.08	1.17	173
Class assignments would be clear and I would know what to do.	P26	4.22	1.08	169
This class would seldom start on time.	P27*	3.69	1.29	172
Activities in this class would be clearly & carefully planned.	P28	4.13	0.91	166
Cooperation				
I would cooperate with other students when doing assignment work.	P29	3.90	1.00	173
I would share my books and resources with other students when doing assignments.	P30	3.88	0.92	173
I would work with other students on projects in this class.	P31	3.82	0.97	174
I would learn from other students in this class.	P32	3.98	0.85	171
I would work with other students in this class.	P33	3.90	0.92	170
I would cooperate with other students on class activities.	P34	3.91	0.94	173
Students would work with me to achieve class goals.	P35	3.88	0.98	168
Individualisation				
I would be expected to do the same work as all the students in the class, in the same way and in the same time.	P36*	2.40	1.17	174
I would generally be allowed to work at my own pace in this class.	P37	3.86	0.82	173
I would have a say in how class time is spent.	P38	3.27	0.92	168
I would be allowed to choose activities and how I would work.	P39	3.32	0.92	170
Teaching approaches in this class would allow me to proceed at my own pace.	P40	3.62	0.93	171
I would have little opportunity to pursue my particular interests in this class.	P41*	3.37	1.10	172
My instructor decides what I would do in this class.	P42*	2.65	1.09	170
Equity				
The instructor would give as much attention to my questions as to other students' questions.	P43	4.24	0.93	174
I would get the same amount of help from the instructor as do other students.	P44	4.20	0.88	174
I would be treated the same as other students in this class.	P45	4.36	0.86	172
I would receive the same encouragement from the instructor as other students do.	P46	4.35	0.85	171
I would get the same opportunity to answer questions as other students.	P47	4.24	0.87	173
My work would receive as much praise as other students' work.	P48	4.23	0.83	174
I would have the same amount of say in this class as other students.	P49	4.28	0.87	174

* Reverse scored items

Principal Component Analysis

The structure of each version of the CUCEI was examined using a principal components analysis. Because the CUCEI was designed with seven scales, seven components were selected for varimax rotation in order to determine whether the intended scales were consistent for the current data set. Table 4.3 reports the initial statistics for the first 15 components of the Actual Version of the CUCEI and Table 4.4 reports the loadings on the components of each item. To assist interpretation,

Table 4.4 reports loadings >.30, and the full matrix of loadings is reported in Appendix 4C.

Table 4.3
Eigenvalues and Percent of Variance Accounted for by the First 15 Principal Components Extracted from the Actual Version of the CUCEI

Component	Eigenvalue	% Variance	Cumulative % Variance
1	10.60	21.60	21.60
2	5.08	10.40	32.00
3	3.05	6.20	38.20
4	2.53	5.20	43.40
5	2.16	4.40	47.80
6	1.90	3.90	51.70
7	1.52	3.10	54.80
8	1.45	3.00	57.70
9	1.39	2.80	60.60
10	1.33	2.70	63.30
11	1.22	2.50	65.80
12	1.17	2.40	68.20
13	1.05	2.10	70.30
14	1.00	2.00	72.40
15	0.95	1.90	74.30

As can be seen in Table 4.3, the principal component analysis extracted one large component with eigenvalue = 10.60 accounting for 21.6% of the total variance. In fact, 14 components were extracted with eigenvalues greater than or equal to one, accounting for a total of 72.4% of the variance. The large, first component indicates that there is considerable inter-correlation among the items and, clearly, there are not seven distinct components. This is confirmed in Table 4.4, where it can be seen, for example, that a number of items load on several components, and that items from the Personalisation and Equity scales both load on the first component. Examination of the item content shows that the items in these two scales refer to interactions between the instructor and the student personally, so perhaps this is not surprising in terms of students reporting on their actual experiences (see Table 4.1 for item content). Two scales, Student Cohesion and Cooperation, show reasonable promise, each with their assigned items loading on a single component. The items for these two scales refer to relationships and student-student interactions, respectively. The informality of the small programming classes, particularly in the computer laboratories, provided opportunities for students to get to know each other and develop collegial relationships. Students were also encouraged to work collaboratively on their projects in the laboratories and the coherence of items for these scales is consistent with these reasons. Five items of the Innovation scale load on the fourth component but Item A8 loads on Component 5, A12 loads on Component 6 and A13 is a split loading-item. Item A12 refers to seating in the class being arranged in the same way each week. This is not a relevant question for students attending computer laboratory sessions as there is little opportunity to arrange seating other than that prescribed because of the cabling and connection to the personal computers. Items A8 and A13 refers to the instructor thinking up "new ideas" and "unusual activities" which are not always applicable to programming classes. At the time this survey was completed, students were working on their own programming projects with lecturers acting in an advisory role rather than presenting new material. Task Orientation and Individualisation do not form clear components and split over five components.

Table 4.4
Loadings on Seven Components of the Actual CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	A1	0.57			0.31			
	A2	0.67					0.32	
	A3	0.60					0.44	
	A4	0.67					0.42	
	A5	0.62						
	A6	0.70						
	A7	0.42						
Innovation	A8					-0.40		
	A9				0.78			
	A10				0.75			
	A11				0.79			
	A12						0.38	
	A13				0.67		0.36	
	A14				0.36			
Student Cohesion	A15			0.67				
	A16			0.58				
	A17			0.58				
	A18			0.64				
	A19			0.57				
	A20		0.35	0.60				
	A21			0.65				
Task Orientation	A22	0.51				0.40		0.41
	A23	0.47						
	A24		0.36			0.39		
	A25	0.52		0.32				
	A26	0.58						
	A27	0.29[a]						
	A28	0.57						
Cooperation	A29		0.68					0.33
	A30		0.73					
	A31		0.80					
	A32		0.78					
	A33		0.82					
	A34		0.60					
	A35		0.75					
Individualisation	A36						0.41	
	A37					0.75		
	A38				0.33	0.45		0.48
	A39				0.30	0.62		
	A40	0.36				0.70		
	A41		-0.32					-0.48
	A42						0.60	
Equity	A43	0.68						
	A44	0.69	0.33					
	A45	0.79						
	A46	0.78						
	A47	0.74						
	A48	0.76						
	A49	0.67						

[a]The highest loading for A27

Note. Only loadings ≥ 0.30 are reported (see Appendix 4C for full matrix).

These analyses were repeated for the Preferred Version of the CUCEI and the results shown in Tables 4.5 and 4.6 and the full matrix of loadings in Appendix 4D. Table 4.5 shows that the principal component analysis extracted one large component with eigenvalue = 12.18 accounting for 25.40% of the total variance. Twelve components were extracted with eigenvalues greater than one, accounting for a total of 71.20% of the variance. The large, first component indicates that, as for the Actual Version, there is considerable inter-correlation among the items and not seven clean components.

Table 4.5
Eigenvalues and Percent of Variance Accounted for by the First 15 Principal Components Extracted from the Preferred Version of the CUCEI

Component	Eigenvalue	% Variance	Cumulative % Variance
1	12.18	25.40	25.40
2	4.95	10.30	35.70
3	3.41	7.10	42.80
4	2.28	4.80	47.60
5	2.04	4.30	51.80
6	1.87	3.90	55.70
7	1.65	3.40	59.10
8	1.39	2.90	62.00
9	1.20	2.50	64.50
10	1.13	2.30	66.90
11	1.07	2.20	69.10
12	1.03	2.10	71.20
13	0.94	2.00	73.20
14	0.90	1.90	75.10
15	0.84	1.80	76.80

Table 4.6 confirms this expectation where it is reported, for example, that a number of items load on several components. Cooperation shows most promise as a coherent scale on the Preferred Version, with its items loading on one component. In both versions of the CUCEI, there are not clean results for the structure of the other scales. However, there are some consistent problems over the two versions, which suggests that by omitting some items the results may be improved to obtain some usable scales. For example, in both versions of the CUCEI, Item 7 is a weak item on the

Personalisation scale because the other six items all load heavily on the same component (Component 1 for Actual, and Component 3 for Preferred).

Six items for the Innovation scale in the Preferred Version load on Component 5 but Items P10, P11 and especially P12 are weak because they have split loadings. Student Cohesion has good results for the Actual version, but only Items P15, P18, and P19 load on one component (Component 4) in the Preferred Version. Remember Item 16 did not appear on the Preferred questionnaire, which may have contributed to this result. Further, several items from Task Orientation, notably Items P24 and P25, also load strongly on Component 4.

The Task Orientation scale has five items for the Actual Version (A22, A23, A25, A26, A28) and six items for the Preferred Versions (P22, P23, P24, P25, P26 and P28) which load >.30 together, but they also load with Equity items on both versions of the scale. Items A22, A24, A25, P23, P24, P25 and P28 have mixed loadings on other components. Again, the nature of the teaching of programming with its emphasis on problem-solving and innovative solutions, where the students are often not clear on what they need to do and work within a fairly relaxed environment, is different from other courses. Perhaps many students perceive the freedom they have in programming classes equates with an equitable environment. Item 27 is problematic as it refers to the class start time. Whilst the lecturer and laboratory assistant were present at the start time, many students were not, preferring to come and go as they wished and this was acceptable practice.

The Individualisation scale for both versions also has four strong items, 37, 38, 39 and 40 forming a component (Component 5 on the Actual Version and Component 6 on the Preferred) but the other three items are not consistent. Items 36 and 42 refer to the work instructors expect students to do within class and load on a separate component in each version. These items are inappropriate for programming classes as many students work significant hours on their assignments outside class time, often choosing to absent themselves from set class times.

Finally, the Equity scale appears to be the most coherent in that all of its items load strongly on the first component in both solutions. However, this component also has attracted items from other scales, the Personalisation scale, especially on the Actual version, and the Task Orientation scale, especially on the Preferred version. As mentioned above, the free and relatively uncontrolled classroom management of a typical programming class nearing the end of a year's study could be viewed as a personalised and equitable environment by many students, accounting for the mixed loadings.

Table 4.6
Loadings on Seven Components of the Preferred CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	P1			0.65				
	P2			0.83				
	P3			0.70			0.30	
	P4	0.39		0.63				
	P5	0.31		0.61				
	P6	0.31		0.71				
	P7				0.40			0.38
Innovation	P8					-0.87		
	P9					0.71		
	P10	0.32				0.56	0.31	
	P11		0.38			0.67		
	P12					0.40		0.40
	P13					0.57		
	P14							-0.76
Student Cohesion	P15				0.58			
	P17		0.37		0.36			
	P18				0.68			
	P19				0.69			
	P20		0.50		0.53			
	P21		0.39					
Task Orientation	P22	0.62						
	P23	0.47				0.34		
	P24	0.43			0.45			
	P25	0.46			0.55			
	P26	0.59						
	P27				0.66			
	P28	0.49				0.43		
Cooperation	P29		0.78					
	P30		0.75					
	P31		0.87					
	P32		0.85					
	P33		0.85					
	P34		0.86					
	P35		0.83					
Individualisation	P36							0.48
	P37	0.38					0.49	
	P38						0.61	
	P39						0.71	
	P40						0.63	
	P41				0.41			
	P42						0.59	0.43
Equity	P43	0.83						
	P44	0.76						
	P45	0.87						
	P46	0.88						
	P47	0.79		0.32				
	P48	0.68	0.34	0.32				
	P49	0.76						

Note. Only loadings ≥ 0.30 are reported (see Appendix 4D for full matrix).

Given these rather disappointing results, and given that the reason for using the CUCEI was to examine students' perceptions about their learning environment on a number of dimensions, it was decided to modify the CUCEI quite drastically to see whether some useful scales could be obtained. It is recognised that modifying scales based on a single data set capitalises on chance, but by using data from both the Actual and Preferred Versions which were administered at different times and to somewhat different samples, it was anticipated that this would counterbalance the chance aspect to some extent. Further, this seemed to be the most practical way of obtaining some potentially useful information from these results.

The structure of the CUCEI was modified by deleting a total of 10 items. These were Items 7, 8, 12, 14, 23, 24, 27, 36, 41, 42. It is noticeable that 9 of these 10 items are negatively-worded items, and there are only 14 negatively-worded items on the CUCEI. This suggests that the negative wording has not worked well, and students are responding to these items in a different way. The modification of the structure of the CUCEI was done by successively deleting items, based on their statistical performance in the principal component analysis and consideration of item content in the context of the intended scale. The resulting rotated component structures were examined together with the internal consistency of the reduced scales using Cronbach's Coefficient Alpha. The penultimate versions of the scale structure are reported in Tables 4.9 and 4.10. Table 4.7 gives the initial statistics for the first 10 components extracted and Table 4.9 reports the component loadings for the Actual CUCEI. Parallel tables (4.8 and 4.10) are provided for the Preferred CUCEI form. Again, full loading matrices are reported in Appendices 4E and 4F for completion.

Table 4.7
Eigenvalues and Percent of Variance Accounted for by the First 10 Principal Components Extracted from the Reduced Actual Version of the CUCEI

Component	Eigenvalue	% Variance	Cumulative % Variance
1	9.84	25.20	25.20
2	5.07	13.00	38.20
3	2.79	7.20	45.40
4	2.33	6.00	51.40
5	1.78	4.60	55.90
6	1.67	4.30	60.20
7	1.24	3.20	63.40
8	1.09	2.80	66.20
9	1.06	2.70	68.90
10	0.94	2.40	71.30

Table 4.8
Eigenvalues and Percent of Variance Accounted for by the First 10 Principal Components Extracted from the Reduced Preferred Version of the CUCEI

Component	Eigenvalue	% Variance	Cumulative % Variance
1	11.31	29.80	29.80
2	4.66	12.30	42.00
3	2.83	7.40	49.50
4	1.91	5.00	54.50
5	1.83	4.80	59.30
6	1.57	4.10	63.40
7	1.12	3.00	66.40
8	1.08	2.90	69.20
9	0.94	2.50	71.70
10	0.90	2.40	74.10

Both Tables 4.7 and 4.8 indicate that either 6 or 7 components is a reasonable number for extraction from the reduced matrix. A scree test indicates that seven factors account for most of the common variance and, in each version of the scale, around two-thirds of the variance is accounted for. Accordingly 7 components were extracted and rotated for each version.

Tables 4.9 and 4.10 report the rotated component loadings for the reduced Actual and Preferred Versions of the CUCEI. The scales are much more coherent now that some items have been omitted, but they are still not perfectly clean. In particular, there are a number of items with small (<.40) loadings on a second component, for example, Items A4 and A5 in the Actual Version and P5 and P6 of the Preferred Version of the Personalisation scale. Although the remaining six items of this scale now form a separate component (Component 3 in both solutions), these items with split loadings clearly have some variance in common with the Equity scale, which is the mainstay of Component 1.

The main problem in these solutions relates to the Task Orientation Scale. It does not form its own clean factor because the items correlate highly with the Equity items. Not surprisingly, other analyses show that as a four-item scale, it has low internal consistency (.71 and .64 for the Actual and Preferred Versions, respectively) and correlates 0.54 and 0.67 with the Actual and Preferred versions of the Equity scale. Examination of the item content for Task Orientation (see Table 4.1) shows some items to be inappropriate for programming classes. For instance, most of the items infer a controlled, teacher-led class where the students are set specific topics and tasks for completion. The timing of this survey was towards the end of the first year of study and students were working on large projects, which involved no formal teaching but rather, assistance with specific problem-solving. The classes were not teacher-led in the traditional, obvious manner.

Table 4.9

Loadings on Seven Components of the Reduced Actual CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	A1	0.30		0.64		0.30		
	A2			0.72				
	A3			0.82				
	A4			0.81				
	A5	0.32		0.67				
	A6	0.38		0.68				
Innovation	A9					0.76		
	A10					0.76		
	A11			0.30		0.74		
	A13					0.76		
Student Cohesion	A15				0.73			
	A16		0.31		0.57			
	A17				0.56			
	A18				0.65			
	A19				0.61			
	A20		0.39		0.60			
	A21				0.66			
Task Orientation	A22						0.32	0.67
	A25	0.44						
	A26	0.45						0.54
	A28	0.47						0.36
Cooperation	A29		0.78					0.32
	A30		0.77					
	A31		0.82					
	A32		0.78					
	A33		0.84					
	A34		0.74					0.31
	A35		0.79					
Individualisation	A37						0.78	
	A38					0.34	0.48	0.41
	A39					0.31	0.72	
	A40						0.74	
Equity	A43	0.56		0.39				
	A44	0.66		0.36				
	A45	0.83						
	A46	0.81						
	A47	0.85						
	A48	0.68						
	A49	0.74						

Note. Only loadings > 0.30 are reported (see Appendix 4E for full matrix).

Table 4.10

Loadings on Seven Components of the Reduced Preferred CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	P1			0.65				
	P2			0.84				
	P3			0.70				
	P4	0.39		0.62				
	P5	0.34		0.59				-0.35
	P6			0.71				
Innovation	P9				0.78			
	P10				0.71			
	P11		0.32		0.76			
	P13				0.65			
Student Cohesion	P15						0.63	
	P17		0.38			0.46		
	P18					0.69		
	P19					0.72		
	P20		0.49			0.55		
	P21		0.41					
Task Orientation	P22	0.52					0.32	
	P25	0.47				0.51		
	P26	0.59				0.30		
	P28	0.44			0.35			0.36
Cooperation	P29		0.77					
	P30		0.74					
	P31		0.88					
	P32		0.85					
	P33		0.85					
	P34		0.85					
	P35		0.82					
Individualisation	P37						0.64	
	P38						0.65	
	P39						0.79	
	P40						0.77	
Equity	P43	0.83						
	P44	0.78						
	P45	0.88						
	P46	0.86						
	P47	0.81						
	P48	0.70	0.32					
	P49	0.78						

Note. Only loadings > 0.30 are reported (see Appendix 4F for full matrix).

At this stage, it was decided to abandon the Task Orientation Scale and examine a 6-component solution. The new results appear in Tables 4.13 and 4.14. The full loading matrices are reported in Appendices 4G and 4H for completion. It can be seen that the 6-component solutions account for 74.23% and 76.57% of the variance for the Actual and Preferred versions (see Tables 4.11 and 4.12, respectively) and the rotated component solutions are much cleaner (see Tables 4.13 and 4.14). For both the Actual and Preferred Versions, each scale is the basis of a different component, and most items that load on more than one component have trivial loadings on the second component.

Table 4.11
Eigenvalues and Percent of Variance Accounted for by the First 10 Principal Components Extracted from the Six Component Solution of the Actual Version of the CUCEI

Component	Eigenvalue	% Variance	Cumulative % Variance
1	8.90	25.43	25.43
2	4.91	14.03	39.46
3	2.77	7.92	47.38
4	2.21	6.30	53.68
5	1.63	4.65	58.32
6	1.60	4.58	62.90
7	1.11	3.18	66.08
8	1.03	2.95	69.03
9	0.93	2.67	71.69
10	0.89	2.54	74.23

Table 4.12
Eigenvalues and Percent of Variance Accounted for by the First 10 Principal Components Extracted from the Six Component Solution of the Preferred Version of the CUCEI

Component	Eigenvalue	% Variance	Cumulative % Variance
1	10.38	30.52	30.52
2	4.28	12.57	43.09
3	2.70	7.93	51.02
4	1.86	5.47	56.49
5	1.65	4.84	61.33
6	1.49	4.37	65.71
7	1.08	3.18	68.89
8	1.01	2.96	71.84
9	0.88	2.58	74.42
10	0.73	2.14	76.57

Table 4.13

Loadings on Six Components of the Actual CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6
Personalisation	A1			0.68			
	A2			0.74			
	A3			0.81			
	A4			0.82			
	A5		0.32	0.65			
	A6		0.40	0.69			
Innovation	A9					0.76	
	A10					0.77	
	A11			0.31		0.75	
	A13					0.75	
Student Cohesion	A15				0.73		
	A16	0.30			0.60		
	A17				0.56		
	A18				0.62		
	A19				0.61		
	A20	0.38			0.62		
	A21				0.67		
Cooperation	A29	0.79					
	A30	0.78					
	A31	0.82					
	A32	0.78					
	A33	0.84					
	A34	0.75					
	A35	0.79					
Individualisation	A37						0.80
	A38					0.30	0.59
	A39					0.31	0.69
	A40						0.77
Equity	A43		0.57	0.39			
	A44		0.66	0.33			
	A45		0.84				
	A46		0.81				
	A47		0.86				
	A48		0.69				
	A49		0.75				

Note. Only loadings > 0.30 are reported (see Appendix 4G for full matrix).

Table 4.14

Loadings on Six Components of the Preferred CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6
Personalisation	P1			0.67			
	P2			0.82			
	P3			0.73			
	P4		0.33	0.66			
	P5		0.33	0.60			
	P6			0.71			
Innovation	P9				0.79		
	P10				0.73		
	P11				0.78		
	P13				0.64		
Student Cohesion	P15						0.72
	P17	0.34					0.42
	P18						0.74
	P19						0.69
	P20	0.46					0.52
	P21	0.41					
Cooperation	P29	0.78					
	P30	0.77					
	P31	0.87					
	P32	0.84					
	P33	0.85					
	P34	0.84					
	P35	0.81					
Individualisation	P37		0.31			0.62	
	P36					0.68	
	P39					0.80	
	P40					0.76	
Equity	P43		0.83				
	P44		0.79				
	P45		0.87				
	P46		0.85				
	P47		0.82				
	P48		0.72				
	P49		0.77				

Note. Only loadings > 0.30 are reported (see Appendix 4H for full matrix).

Internal Consistency of New Scales of CUCEI

Tables 4.15 and 4.16 report the results of the analyses to determine the internal consistencies of the new scales. The final column of these tables report the Cronbach Alpha Coefficient values for the six different scales of the CUCEI for both the Actual and Preferred reduced versions. The Cronbach Alpha Coefficients measure the internal consistency of each of the six scales in the CUCEI and indicate the extent to which items in the same scale measure the same dimension. Coincidentally, for both the Actual version and the Preferred Version of the CUCEI, alpha values range from .70 to .93. These figures exceed the threshold of 0.60 set by (Nunnally, 1978) as being acceptable for research purposes. Tables 4.15 and 4.16 also report the mean item score and standard deviation for each scale in the two versions of the reduced CUCEI.

Table 4.15

Internal Consistency Results, Means and Standard Deviations for the Scales of the Reduced Actual Version of the CUCEI

Scale	Item	Corrected Item-total Correlation	Alpha if Item Deleted	Scale Statistics		
				Mean	*SD*	Alpha
Personalisation	1	0.65	0.87			
n = 169	2	0.70	0.86			
	3	0.77	0.85			
	4	0.74	0.85			
	5	0.59	0.88			
	6	0.74	0.85	3.65	0.83	0.88
Innovation	9	0.66	0.77			
n = 179	10	0.67	0.77			
	11	0.71	0.75			
	13	0.56	0.82	2.68	0.79	0.82
Student Cohesion	15	0.58	0.73			
n = 179	16	0.56	0.73			
	17	0.51	0.74			
	18	0.45	0.75			
	19	0.42	0.76			
	20	0.58	0.73			
	21	0.37	0.77	3.68	0.72	0.77
Cooperation	29	0.78	0.92			
n = 184	30	0.74	0.92			
	31	0.81	0.91			
	32	0.77	0.92			
	33	0.82	0.91			
	34	0.71	0.92			
	35	0.76	0.92	3.83	0.85	0.93
Individualisation	37	0.47	0.65			
n = 177	38	0.47	0.66			
	39	0.49	0.64			
	40	0.54	0.61	2.96	0.81	0.70
Equity	43	0.65	0.89			
n = 181	44	0.66	0.89			
	45	0.80	0.88			
	46	0.78	0.88			
	47	0.77	0.88			
	48	0.65	0.89			
	49	0.68	0.89	4.15	0.77	0.90

Table 4.16

Internal Consistency Results, Means and Standard Deviations for the Scales of the Reduced Preferred Version of the CUCEI

Scale	Item	Corrected Item-total Correlation	Alpha if Item Deleted	Scale Statistics		
				Mean	*SD*	Alpha
Personalisation	1	0.59	0.86			
n = 172	2	0.74	0.83			
	3	0.69	0.84			
	4	0.70	0.84			
	5	0.61	0.85			
	6	0.67	0.84	3.93	0.72	0.87
Innovation	9	0.63	0.73			
n = 174	10	0.66	0.72			
	11	0.68	0.71			
	13	0.48	0.81	3.42	0.75	0.80
Student Cohesion	15	0.40	0.67			
n = 169	17	0.41	0.67			
	18	0.56	0.62			
	19	0.42	0.67			
	20	0.47	0.65			
	21	0.37	0.69	3.75	0.67	0.70
Cooperation	29	0.70	0.93			
n = 166	30	0.67	0.93			
	31	0.83	0.91			
	32	0.84	0.91			
	33	0.83	0.91			
	34	0.80	0.92			
	35	0.76	0.92	3.91	0.78	0.93
Individualisation	37	0.43	0.71			
n = 167	38	0.52	0.67			
	39	0.55	0.64			
	40	0.57	0.63	3.53	0.67	0.73
Equity	43	0.71	0.92			
n = 173	44	0.74	0.92			
	45	0.81	0.91			
	46	0.79	0.91			
	47	0.80	0.91			
	48	0.76	0.91			
	49	0.74	0.92	4.26	0.73	0.93

Discriminant Validity

Discriminant validity describes the extent to which a scale measures a dimension not covered by the other scales in an instrument. Tables 4.17 and 4.18 report the inter-correlations among the six scales, together with the mean correlation of each scale with the five other scales as an indication of the discriminant validity of the Actual and Preferred Versions of the CUCEI. The correlations between scales for the Actual Version range from -.03 to .62 and for the Preferred Version, .04 to .59. The mean correlation values for the Actual Version range from .18 to .34 and for the Preferred .25 to .42, suggesting that most of the CUCEI scales have adequate discriminant validity for use in its Actual and Preferred forms. However the correlation coefficients between the Actual scales of Personalisation and Equity, Student Cohesion and Cooperation are higher than the others, indicating these scales are not as independent. For the Preferred form, the scales showing higher correlations are Personalisation with Innovation, Cohesion with Cooperation, and Personalisation with Equity. Generally, the reduced version of the CUCEI appears to measure aspects of the learning environment which overlap to some extent.

Table 4.17

Correlation Coefficients for Actual Version of the CUCEI

Scale	Personal-isation	Innovation	Student Cohesion	Cooperation	Individual-isation	Mean Correlation
Personalisation						0.34
Innovation	0.36					0.26
Student Cohesion	0.11	0.18				0.18
Cooperation	0.21	0.15	0.46			0.22
Individualisation	0.39	0.36	-0.03	0.07		0.21
Equity	0.62	0.23	0.16	0.23	0.27	0.30

Table 4.18

Correlation Coefficients for Preferred Version of the CUCEI

Scale	Personal-isation	Innovation	Student Cohesion	Cooperation	Individual-isation	Mean Correlation
Personalisation						0.42
Innovation	0.46					0.27
Student Cohesion	0.30	0.15				0.26
Cooperation	0.39	0.40	0.46			0.36
Individualisation	0.36	0.37	0.04	0.17		0.25
Equity	0.59	0.35	0.36	0.36	0.33	0.40

The next section reports on findings resulting from the application of the CUCEI to examine students' perceptions of their learning environment.

Overview

This section examines the results obtained through applying the Actual and Preferred Versions of the CUCEI in order to meet the study's objectives to:

1. investigate students' perceptions of their programming learning environment
2. investigate the perceptions of student subgroups defined as new arrivals and by gender
3. investigate lecturers' perceptions of their programming learning environment.

Data for the Actual and Preferred Versions of the CUCEI were obtained separately over a period of six weeks, as explained in chapter 3. This resulted in different, but overlapping samples for each version and students' responses will be examined separately. The mean scores on the sample for each version are used to provide an overview of the results, and this is followed by an analysis of the results for the sex and origin subgroups. Because students responding to each version of the CUCEI completed all of the scales, the scale mean scores are not independent and, as shown by the inter-scale correlations reported in Tables 4.17 and 4.18, some scales, particularly Personalisation and Equity, are correlated. In order to take account of this inter-dependence, the data are examined using a repeated measures multivariate analysis of variance (MANOVA) with sex and origin as between subject factors. Although the numbers of new arrival students are small in each sex group, they are about equal and MANOVA is reasonably robust to deviations of this extent. In addition, Bartlett-Box tests for homogeneity of variance and multivariate tests for homogeneity of dispersion matrices (Box's-M) indicated these assumptions were not violated.

Students' Perceptions Overall of Their Programming Learning Environment

Actual Version of the CUCEI

Table 4.19 provides mean item scores for six scales of the reduced Actual Version of the CUCEI based on the total sample completing the instrument. The values of the means range from 2.68 to 4.15 out of a possible maximum mean score of 5.0. The mean score for the Equity scale is very high, at 4.15 and Personalisation, Student Cohesion and Cooperation are also quite positive, being above the midpoint of 3.0, representing an average of "Sometimes" for the items of the scale. In contrast, Innovation and Individualisation means are below the mid-point, suggesting students perceive a low level of innovative activities and only some scope for self-direction of activities in the classroom.

Table 4.19

Means and Standard Deviations for Actual Version of the CUCEI for the Total Student Sample

Scale	*n*	Mean	*SD*
Personalisation	187	3.65	0.83
Innovation	179	2.68	0.79
Student Cohesion	188	3.68	0.72
Cooperation	187	3.83	0.85
Individualisation	177	2.96	0.81
Equity	187	4.15	0.77

Preferred Version of the CUCEI

Table 4.20 reports mean item scores for six scales of the reduced Preferred Version of the CUCEI, based on the total sample completing the instrument. The mean scores are all above the mid-point of 3.0 and, as for the Actual Version of the scale, the Preferred Equity mean is the highest. The standard deviations for all scales are smaller for the Preferred Version of the CUCEI, indicating that students are more homogeneous in their perceptions. Although the means for the Preferred scales are higher than those for the Actual scales, these results are on different samples and results for the two versions are not compared.

Table 4.20

Means and Standard Deviations for Preferred Version of the CUCEI for the Total Student Sample

Scale	*n*	Mean	*SD*
Personalisation	176	3.93	0.72
Innovation	174	3.42	0.75
Student Cohesion	175	3.75	0.67
Cooperation	175	3.91	0.78
Individualisation	167	3.53	0.67
Equity	177	4.26	0.73

Students' Perceptions of Their Programming Learning Environment According to Their Sex and Origin

Actual Version of the CUCEI

Table 4.21 provides scale item means for six scales of the Actual Version of the CUCEI for the four subgroups based on sex and origin. The item means range from 2.60 to 4.37 and they are graphed to show a profile of the item means in Figure 4.1. It can be seen that the results for the four groups are very similar. As noted earlier, means are generally highest for Equity, and noticeably lowest for Innovation and Individualisation.

Table 4.21

Mean Item Scores Standard Deviations for Sex and Origin Subgroups for the Actual Version of the CUCEI

	Male		Female	
	NZ	NA	NZ	NA
Scale	*n*= 79	*n* = 15	*n* = 59	*n* = 13
Personalisation	3.60 (0.81)	3.34 (0.69)	3.77 (0.92)	3.51 (0.84)
Innovation	2.60 (0.78)	2.75 (0.42)	2.70 (0.85)	2.69 (0.86)
Student Cohesion	3.70 0.71)	3.53 (0.48)	3.85 (0.80)	3.36 (0.61)
Cooperation	3.93 0.78)	3.47 (0.74)	3.93 (0.84)	3.67 (0.82)
Individualisation	2.95 (0.71)	3.05 (0.80)	2.93 (0.86)	3.10 (1.23)
Equity	4.18 (0.63)	3.66 (0.79)	4.18 (0.91)	4.37 (0.50)

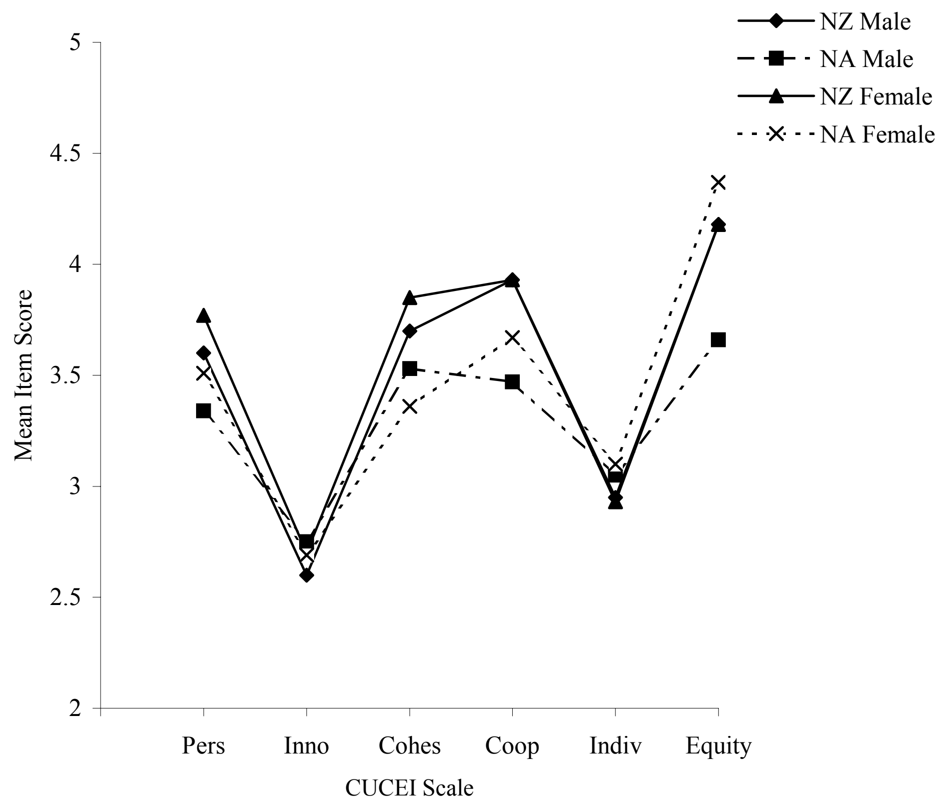

Figure 4.1. Means for sex and origin subgroups for Actual Version of the CUCEI

The results of the MANOVA to determine whether there were statistically significant differences associated with students' sex or origin are reported in Table 4.22. *F*-values are based on Wilks' Lambda, and the effect sizes are calculated from this.

Table 4.22

Multivariate Analysis of Variance Results for Sex and Origin for the Actual Version of the CUCEI

Effect	*F*	*p*	Effect Size (Wilks')
Sex x Origin	1.92	.081	.068
Sex	1.00	.426	.037
Origin	1.96	.074	.070

Note: F-tests have (6, 157) degrees of freedom

The results show that none of the effects are statistically significant at $p<.05$. The interaction and origin effects have small effect sizes, accounting for around 7% of the variance in the scores, but as these effects are not statistically significant, they will not be examined further.

Preferred Version of the CUCEI

Table 4.23 provides scale item means for six scales of the Preferred Version of the CUCEI for the four subgroups based on sex and origin. The item means range from 3.31 to 4.51 and they are graphed to show a profile of the item means in Figure 4.2. As for the Actual Version, it can be seen that the results for the four groups are very similar. The means are generally highest for Equity, and noticeably lowest for Innovation and Individualisation.

Table 4.23

Mean Item Scores and Standard Deviations for Sex and Origin Subgroups for the Preferred Version of the CUCEI

	Male		Female	
	NZ	NA	NZ	NA
Scale	*n* = 73	*n* = 18	*n* = 49	*n* = 16
Personalisation	3.87 (0.68)	3.89 (0.73)	4.11 (0.63)	3.93 (0.84)
Innovation	3.37 (0.79)	3.31 (0.63)	3.58 (0.65)	3.41 (0.88)
Student Cohesion	3.77 (0.63)	3.64 (0.63)	3.98 (0.73)	3.67 (0.65)
Cooperation	3.84 (0.80)	4.02 (0.75)	4.04 (0.79)	3.79 (0.76)
Individualisation	3.50 (0.57)	3.60 (0.67)	3.52 (0.74)	3.67 (0.80)
Equity	4.23 (0.69)	4.13 (0.79)	4.51 (0.67)	4.27 (0.78)

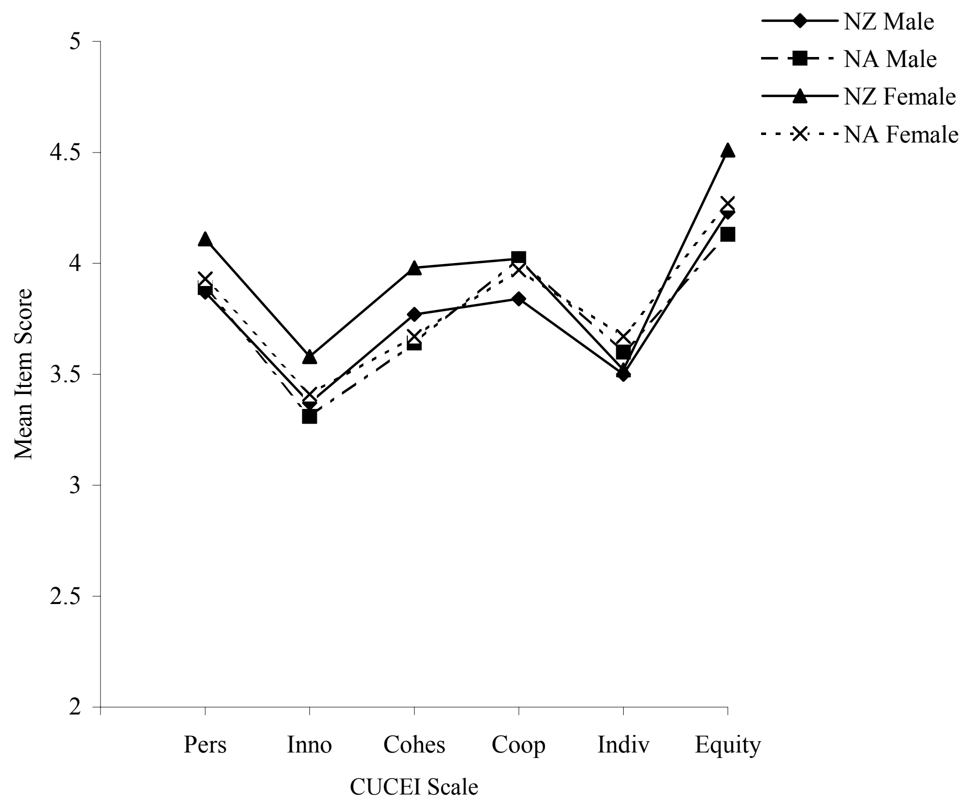

Figure 4.2. Means for sex and origin subgroups for Preferred Version of the CUCEI

The results of the MANOVA to determine whether there were statistically significant differences associated with students' sex or origin are reported in Table 4.24. *F*-values are based on Wilks' Lambda, and the effect sizes are calculated from this.

Table 4.24

Multivariate Analysis of Variance Results for Sex and Origin for the Preferred Version of the CUCEI

Effect	*F*	*p*	Effect Size (Wilks')
Sex x Origin	0.41	0.871	.016
Sex	0.79	0.576	.031
Origin	1.12	0.352	.044

Note: F-tests have (6, 157) degrees of freedom

The results show that none of the effects are statistically significant, with very small effect sizes ranging from 1.6% to 4.4% of the variance in the scores. As they are not statistically significant, the effects will not be examined further.

Comparisons Between Students' Perceptions of Their Actual and Preferred Programming Learning Environment

In making comparisons between the Actual and Preferred Versions of the CUCEI, analysis must be based on the sample of students who completed both versions of the instrument. The analysis proceeded in two steps using repeated measures MANOVA to take account of the correlated scales. The dependent variables were the difference scores, Preferred mean – Actual mean, for the scales. First, comparisons were made between the Actual and Preferred scale means by testing whether the overall difference was zero. Second, the possibility that students' sex or origin were associated with differences between means on the Actual and Preferred Versions was examined. Subsequently, comparisons between the results for the Actual and Preferred Versions of the CUCEI were made using the univariate tests where statistically significant differences were found.

The overall pattern of differences is shown in Table 4.25, which reports the scale item means, standard deviations, and difference scores for the Actual and Preferred Versions of the CUCEI. The values of the means of the scales in the Actual Version of the CUCEI range from 2.69 to 4.20 and from 3.52 to 4.36 for the Preferred Version. In the Actual Version all of the means (with the exception of Innovation and Individualisation) are greater than 3.5 out of a possible maximum mean score of 5. The actual and preferred means for the paired data, when compared with the total data for the total student sample (Tables 4.19 and 4.20) are very similar, which is not surprising given the large overlap between the samples. However, the similarity of the means for the total sample and the paired sample also suggests that the paired results are generally representative of the total sample.

Table 4.25

Means, Standard Deviations and Difference Scores for Actual and Preferred Versions of the CUCEI

Scale	Actual		Preferred		Difference
	Mean	*SD*	Mean	*SD*	Preferred-Actual
Personalisation	3.67	0.80	3.99	0.65	0.32
Innovation	2.69	0.84	3.52	0.72	0.83
Student Cohesion	3.67	0.75	3.91	0.69	0.24
Cooperation	3.84	0.84	4.02	0.70	0.18
Individualisation	2.95	0.81	3.57	0.62	0.62
Equity	4.20	0.76	4.36	0.71	0.16

Note. $n = 108$

The results of the MANOVA carried out on the difference scores between the six scales of the CUCEI are reported in Table 4.26. This table also reports the tests for the effects of the sex and origin between-subject factors.

Table 4.26

Multivariate Analysis of Variance Results for the Preferred-Actual Version Mean Difference Scores for the Scales of the CUCEI

Effect	*df*	*F*	*p*	Effect Size (Wilks')
Constant	6, 102	11.71	<.001	.408
Sex x Origin	6, 98	0.92	.484	.053
Sex	6, 98	0.71	.641	.042
Origin	6, 98	1.33	.252	.075

Table 4.26 shows that test of the null hypothesis for the constant, that is, that the mean difference score is zero, is rejected. The effect size of 0.41 is large indicating that overall, there are meaningful differences between at least some of the means on

the Actual and Preferred Versions. Results for the separate analyses for the effect of sex and origin, the between-subjects factors are also reported in Table 4.26. Clearly the overall effects of these factors are not statistically significant, and neither is there a statistically significant interaction. Consequently, there is no need to consider sex and origin differences further, a finding which is consistent with the results obtained from analysis of the Actual and Preferred Versions separately. Thus the univariate tests for the difference between the means on the Preferred and Actual Versions of the scales are considered without regard to sex or origin. The univariate results are reported in Table 4.27.

Table 4.27

Univariate Results for Multivariate Analysis of Variance on the Preferred-Actual Versions of the CUCEI

Scale	*SS*	Error *SS*	*F*	Eta-square
Personalisation	10.79	72.53	15.91***	.129
Innovation	74.58	130.98	60.93***	.363
Student Cohesion	6.54	73.73	9.50**	.082
Cooperation	3.42	73.15	5.00*	.045
Individualisation	41.56	108.94	40.83***	.276
Equity	2.59	67.06	4.13*	.037

$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Table 4.27 indicates that the difference between the means of the Preferred Version of the CUCEI are statistically significantly higher than the means of the Actual Version on every scale at the .05 level. This can be seen in Figure 4.3 which graphs the Actual and Preferred profiles. The effect sizes, as shown by eta-square, vary from quite small for Equity (less than 4% of the variance is accounted for by the difference between scores on the Actual and Preferred Scales), to over 36% for Innovation. The pattern of effect sizes are reflected in Figure 4.3.

From Figure 4.3 it can be seen that students preferred a more positive learning environment than that which they perceived they were experiencing. Personalisation, Innovation and Individualisation scales have the largest effect sizes, indicating that students would like a more personalised environment with greater innovation and more individualisation in their classes. The smallest effect sizes are recorded for Equity, Cooperation and Student Cohesion, suggesting that students are more satisfied with the classroom environment with respect to these scales.

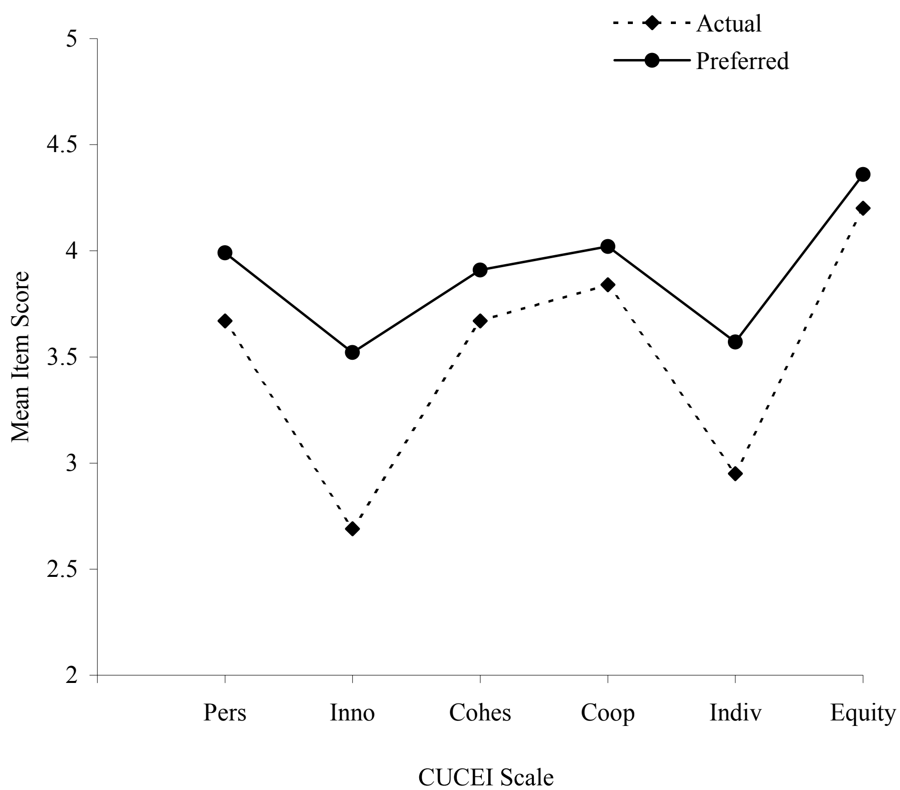

Figure 4.3. Scale mean profile for Actual and Preferred Versions of the CUCEI for paired student data

Results from the comparison of the students' Actual and Preferred learning environments show that students view their environments differently but sex and origin do not seem to have significant effects (although the number of new arrivals is small).

Lecturers' Results for the CUCEI

Five lecturers completed both versions of the CUCEI, responding to the item statements from their personal perceptions of what they thought their class to be like. The sample size is too small for statistical tests beyond the means and standard deviations reported in Table 4.28. The means for the Actual Version range from 2.79 (Innovation) to 4.02 (Equity) and for the Preferred Version, 2.33 (Student Cohesion) to 4.40 (Equity). The differences between the actual and preferred means for lecturers are small, as can be seen in Figure 4.6. Interestingly, perceptions of the actual environment for Student Cohesion exceed that for the lecturers' preferred environment. Perhaps lecturers perceive students' high cohesiveness as resulting in too social an atmosphere and may prefer more individual work. For all other scales, lecturers prefer a more positive environment than the one that they perceive is actually experienced by students.

Table 4.28

Means and Standard Deviations for the Actual and Preferred Versions of the CUCEI for the Lecturers

Scale	Mean		Difference[a]	*SD*	
	Actual	Preferred		Actual	Preferred
Personalisation	3.88	3.95	0.07	0.27	0.34
Innovation	2.79	3.32	0.53	0.53	0.61
Student Cohesion	3.77	2.33	-1.44	0.63	0.35
Cooperation	3.73	3.85	0.12	0.65	0.53
Individualisation	3.00	3.58	0.58	0.88	0.88
Equity	4.02	4.40	0.38	0.78	0.79

[a] Preferred-Actual

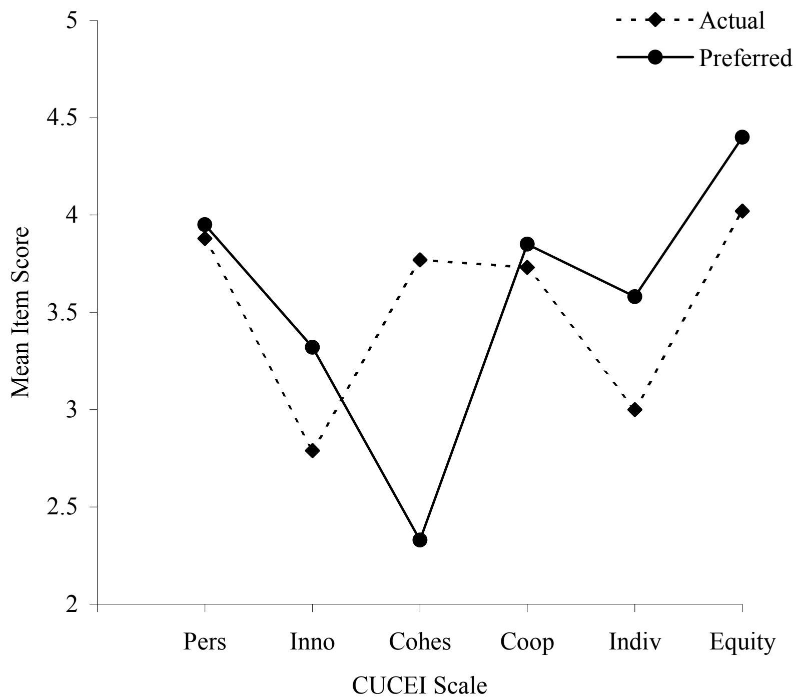

Figure 4.4. Scale mean profile for Actual and Preferred Versions of the CUCEI for lecturer data.

Summary

This chapter began by reporting the overall results for the Actual and Preferred Scales of the CUCEI, followed by analysis of the scales by the overall student group and then by the subgroups of sex and origin. A number of items were omitted from the scales due to their poor performance in the principal components analysis. Multivariate analysis of variance revealed statistically significant differences between the Actual and Preferred Versions, with students preferring a more innovative and individualised environment. The possibility that students' sex or origin were associated with differences between Actual and Preferred Versions of the CUCEI was examined. There were no statistically significant differences between male and female students or between New Zealand and new arrival students. The five lecturers preferred a more positive environment on all the scales except for Student Cohesion. The next chapter explores students' perceptions in more detail, reporting results of the observation and interview data.

CHAPTER FIVE

ANALYSIS AND RESULTS OF INTERVIEWS

This chapter reports the observations and interview data gathered from the three tertiary institutions participating in this study. The first section describes the physical environment of each institution and the teaching methods based on the observational data, followed by the results of the student interviews. Student results are presented under the categories of the CUCEI's scales. Themes that inform the categories are discussed with representative quotes from the interviews. Discussion of the lecturers' interviews follows, presented under major categories that are broader, but inform the CUCEI's scales. The chapter concludes with a synthesis of the findings from student and lecturer interviews.

The Teaching Environment

The features of the three institutions that participated in the study were outlined in chapter 3. As mentioned, Institution A is in the city and had the most ethnically diverse population. Institution B (now disestablished) was a large polytechnic sited on campus grounds with lawns and gardens. It had a rural aspect, being some five kilometres from the nearest city and approximately 25 kilometres from Institution A. Institution C is the smallest of the three and is sited on the outskirts of another city, some 20 kilometres from Institution A. These factors contributed to the difference in ambience of the three institutions.

During visits to the institutions for data collection, the nature of the facilities could be observed. The computing laboratories of all three institutions were well-resourced with up-to-date hardware and ergonomic environments. There was one student to one computer, thus restricting class size and facilitating a more personalised atmosphere in the laboratory than was possible in a lecture. A very informal, relaxed atmosphere prevailed in many of the computer laboratory sessions, particularly at Institution A. Students arrived and departed as they wished. The year of study was nearing an end when data were collected and most students were working on projects that could engage them for three to six weeks, depending on the institution and the nature of the projects. At Institution C, a new mid-year intake of students for one class was participating in more structured laboratory sessions where new concepts were introduced by the lecturer with the use of overhead transparencies. These students were some of those included in the study.

Lectures were also delivered at two institutions. At Institution B, and for some classes at Institution C, large tiered halls were used to deliver weekly lectures during the year's program. At Institution A, a change from earlier years was made to the number and timing of lectures. As a result of student feedback collected in the previous year, it was decided to reduce lecture time and increase laboratory time. Lectures were delivered, therefore, for the first eight weeks of the semester only. Essential concepts were covered in these lectures and followed up by specific laboratory exercises where a lecturer and/or a tutor were available for help.

Seminar-type sessions were also held in classrooms with students in different programmes at all the institutions. At the time of data collection, the majority of the teaching at Institutions A and C involved small groups of about 20 students, sometimes taking place in classrooms and sometimes within the computer laboratories. At Institution A, formal lectures had finished and students worked on their assignments in the laboratories with the lecturers being available for help and discussion. A high degree of personal interaction was observed between lecturer and students, and between students. This was not unexpected as most of the students had been studying together since February and knew each other well by the time data were collected for this study in the months of September to November. The interviews were carried out with a total of 28 students during the months of November and December.

Approach to Interview Analysis

The data from the interviews comprised 16 transcripts totalling 53 single-spaced, A4 pages. There was a basic structure to the interviews because, although the interview questions were mostly open-ended, as described in chapter 3, they were developed around the scales of the CUCEI (see Appendix 3A, Students' Interview Questionnaire). Analysis of the transcripts was aided by the use of the computer program NUD*IST and coding of categories (see Appendix 3E, Student and Lecturer Interview Categories and Themes) was initially defined by the scales of the CUCEI relating to aspects of the learning environment. However, as explained in chapter 3, some of the interviewees responded on a much wider scale that reflected their expectations and awareness of their own learning processes; consequently many issues were not covered by the items of the CUCEI's scales. Some students were self-reflective whilst others provided helpful suggestions on how improvements could be made to the teaching of programming. Eventually, a wider coding scheme was developed for the analysis.

On initial analysis, a major theme found to run through all of the interviews was equity. This theme encompassed a much broader spectrum of issues than did the seven items of the CUCEI's Equity Scale. In addition, when examining student responses to the interview questions which were intended to seek opinions relating to the other six scales of the CUCEI (Personalisation, Innovation, Student Cohesion, Task Orientation, Cooperation and Individualisation), the comments were often found to be concerned with equity issues. For example, the equity focus around the Personalisation theme is illustrated by the following comment on how approachable and accessible the lecturer was.

> The tutor was so good because when you raised your hand he always acknowledged us and always divided some time and always make sure to go to everyone and so he always covered the class (Subako, NA,F,A,37)[1]

---

[1] The bracketed data indicate the student's name (a pseudonym), subgroup (NA, new arrival; NZ, New Zealander), sex, institution and age in years

This student not only reflected positively on a personalisation aspect of the tutor's actions but commented on how the tutor ensured fairness in managing a class of individuals so that everyone had an opportunity for one-to-one contact. This comment clearly belonged to both the personalisation and the equity categories. Many of the interviewees expressed equity concerns to varying degrees and it became evident that in order to represent the students' responses as fairly as possible, equity had to become the major organising theme.

Analysis of the interview results, therefore, is from an equity standpoint but takes into account the structure of the scales of the CUCEI. The analysis began with identifying comments that related to each of the seven CUCEI scales. The comments for each scale were typed into table format, read, and then separated into those concerned with equity issues and those that referred to the scale alone. The next step was to segregate the positive comments from the critical and negative comments. This was done so that an indication of representativeness of opinion for each subgroup could be gauged and to identify what students' perceived as supportive about the learning environment and what they found hindered their learning. This also enabled a validity check to ensure the researcher was not unduly influenced by any one interviewee's opinion to the extent of believing this opinion represented the subgroup's view of the issue. Sometimes the comments were a mix of both positive and critical, such as a criticism of a certain practice or event followed by a suggestion of how things could be improved. In this case, the comments were cross-referenced to both the positive and critical categories and during analysis the original transcript was re-read to refresh contextual understanding.

The open-ended, loosely-structured style of interview and the divergent responses to the generalised questions had to be taken into account when considering how best to present the results. It was decided that an appropriate way of providing an insight into how the students perceived their environment was to adopt a discursive analysis (Nash, 1976). This involved the reasoned categorisation of themes and presentation of students' responses in verbatim form. This approach provided a way of reflecting students' responses in a "raw" form, as they were spoken, thus attempting to provide a true picture of the interviewees' intentions.

The next section reports the interview results presented under the categories of the CUCEI's scales. Students' responses to each category are then presented as themes with representative quotes (see Appendix 5A Student and Lecturer Interview Categories and Themes). The scale of Task Orientation has not been included due to its poor performance in the sense that students' responses tended to reflect other scale concepts. This is perhaps not surprising because, as discussed in chapter 4, the Task Orientation Scale was abandoned because it did not form its own dimension in the principal component analysis and the items correlated highly with the Equity items. The comments students made in response to questions about this scale were easily included in the themes under the other scales. This enabled the presentation of interview results to be consistent with the reporting of the survey results.

Student Interview Results

Personalisation

The Personalisation Scale in the CUCEI referred to the instructor considering the student's feelings, being friendly, helpful and having an interest in the student's problems. Students were asked in the interviews: "How do you find programming, what's good, what's bad about it?" and many of the responses referred to this dimension. Four themes were found that explained or informed the Personalisation Scale. They relate to the lecturer being approachable, helpful and responsive; able to explain; readily accessible; and, friendly, not arrogant.

In the following section, each of these themes are described and illustrated with representative comments.

1. Approachable, Helpful and Responsive

Reasons the students gave for finding their lecturers approachable and helpful centred on the type of environment in which they learned. As discussed earlier in this chapter, there was a very relaxed, casual ambience in most of the classrooms, providing an atmosphere conducive to a high degree of personalisation. The interactive nature of this environment contributed to the personalised aspect for many students.

> He was always approachable, very helpful. (Nola, NZ,F,B,21)

> If we've needed help we can ask and Brad's [lecturer] pretty good about that. (Clare, NZ,F,A,31)

> I chatted to the lecturer about the next part … Tutors happy to assist when they were free. (Matt, NZ,M,C,38)

New arrival students contrasted the New Zealand learning environment with their home country's environments. For instance, Zhou (NA,F,A,41), a teacher of adults in a mechanical workers college in China, and Subako, from Japan, (NA,F,A,37) noted that their New Zealand classrooms had more interaction than in their home countries and, they said, this resulted in a friendlier and more relaxed relationship between students and teacher. A New Zealand student also reflected on the impact that a participative environment had on the classroom.

> Interactive discussion turned the class from not being responsive to being quite responsive. (Matt, NZ,M,C,38)

The responsiveness identified by Matt extended to written feedback on assignments. For some new arrival students, the time the lecturers took to ensure students understood the concepts was favourably commented upon. Both verbal and written feedback was recognised by Ming as helping him in his programming.

> I find Rachel [lecturer] is very good teacher and help me a lot. When you got back your assignment you find lots of marks and write down lots of things; even you didn't talk to her so improved my skills. (Ming, NA,M,A,23)

2 Able to Explain

The lecturer's ability to explain problems or difficulties so that the student understood was cited by several students as reasons for their high rating of a lecturer. Conversely, students were dissatisfied with lecturers who were unable to meet their expectations of what the teacher should do for them. For example, Viri and Peter appreciated their Teacher's ability to explain clearly and precisely, thus meeting the specific and immediate concerns that the student had at that time.

> What's good about her if you tell her you understand but you don't know what's the reason I take that option so she can explain; most of
>
> the teachers don't do that; they just do it; don't really explain why I'm doing this thing. (Viri, NA,M,C,24)

> The teachers here are good; good at explaining it; they're fairly open; if you're having trouble you can go and ask for help. (Peter, NZ,M,A,22)

In contrast, Harry objected to the tutor taking over his keyboard and fixing the problem without explaining so that Harry understood what was happening.

> Some tutors just sit there and do nothing or else if you ask they just do the program for you; they take over the keyboard; they solve it straight away but you don't know how to do it. He should teach us how to fix it; not do it for me. (Harry, NZ,M,B,18)

Other students found their lecturers verbose and expressed intolerance of what they felt was time-wasting.

> I do go to him for small things but he's not going to help me; he's just going to talk to me for an hour and he's going to waste my time. (Evan, NZ,M,A,24)

> The lecturers do like to talk; it's 5 minutes problem-solving, 15 minutes talking; that sort of thing. (Peter, NZ,M,A,22)

Another problem Patsy and Drew found with their lecturer was his inability to explain things at the class level, when he could do so much better at the personal level.

> I think he found it very hard to convey what he knows to our level … I found it really hard to learn from Richard [lecturer]. He's a really really nice guy; he didn't put us down. Because he is a programmer, he couldn't get it across. (Patsy, NZ,F,C,39)

> The time Ana and I have been to him [Richard], just the two of us, he has been absolutely brilliant; got his ideas across, uses different processes; try thinking of it like this; try doing it like that. He doesn't do that with a class; he just stands there and burbles at the front … he doesn't actually explain it … (Drew, NZ,F,C,37)

3. Accessibility

Students generally equated helpful, friendly and approachable lecturers with ease of access to them.

> We had accessible tutors and good lab tutor. (Nola, NZ,F,B,21) The tutor was so good because when you raised your hand he always acknowledge us and always divide some time and always make sure to go to everyone and so he always covered all the class. (Subako,NA,F,A,37)

However, for a few students, particularly at Institution C, one male lecturer, responsible for the majority of the programming teaching, was reported as standing "at the back" of the room. The choice of position made by this teacher was interpreted by students as being unapproachable and unfriendly and therefore he was perceived as not readily accessible to them.

> He stood at the back of the classroom. (Patsy, NZ,F,C,39)

> Sometime the teacher is not very friendly; I'm doing the program but I couldn't do it; he stand at the back but he didn't help me; he talk to some Kiwi [New Zealander]. (Kev, NA,M,C,19)

For another student, after-class access was difficult.

> They were always so hard to find; I suspect it was the timing - when I was available he wasn't. (Carmen, NZ,F,B,35)

Innovation

Items of the CUCEI's Innovation Scale refer to the extent to which the instructor plans new, unusual activities, teaching techniques and assignments. At the time of the survey students were working on large programming assignments where very little formal teaching was being done. This did not give much opportunity for lecturers to try out new and different ways of teaching. There were many reflective responses to the interview questions of "Are you generally satisfied with the work and assignments you have to do?", "What do you think of the way programming is taught?" and "How would you like to see programming taught?" Students commented on what they had experienced over the previous months in their learning and these centred around the following themes: lectures, practical laboratory sessions, assessments and teaching resources. Discussion of these themes is illustrated with selected student comments.

1 Lectures

Students had mixed views about the programming lectures. Many described them as "OK", "useful", and "quite successful". Reasons for the favourable comments referred to lectures that were focused on the laboratory work and assessments students were currently working on. Students appreciated specific and timely help, seeing a structure and purpose for the lecture that they found useful. The careful pacing and sequencing of lecture topics was important also.

> If we were given more amount of new ideas at the time I couldn't cope with it (Subako, NA,F,A,37).

However, other students felt that the lectures lacked relevance to the laboratory work, they often covered syntax which could have been given in handouts, provided little opportunity for interaction, and were "impersonal". Two students described the lectures as "boring" (Mani, NA,F,A,20) and "absolutely pointless" (Pauline, NZ,F,C,39). Zhou found the lectures unsatisfactory, opting to rely on her own efforts.

> I don't think lecture helps very much; reading more books helps very much (Zhou, NA,F,A,41).

2 Practical Laboratory Sessions

Practical laboratory work was very popular with students and was often compared with the lectures as being more valuable and worthwhile. Students enjoyed the independence and autonomy of their time in the laboratories. They had set projects with the goal of producing programs which worked and, within structured guidelines, were left to achieve this. Reasons given for the popularity of the laboratories were a feeling of satisfaction and a sense of achievement, and being provided with an opportunity to practice and implement what was taught in the lectures.

> Being able to do something practical; achieve set goals for example in each class; actually learn something; add two numbers and have
>
> output on the screen and you feel as though you've actually achieved something (Matt, NZ,M,C,38)

Harry noted the value of experience, saying

> The more you practice, the more errors you got, the more you understand (Harry, NZ,M,B,18).

Rita was critical of lectures that did not relate to the practical work.

> Better to finish one section in the lecture then do the lab; sometimes we went to the lab and hadn't finished one particular topic in the lecture so we couldn't try out what we had learned because we still hadn't finished it. (Rita, NA,F,B,41)

Other students requested "lots of practice in problem-solving" and "more examples" to help them in their practical laboratory sessions.

3. Assessments

Students believed that assessments should be interesting and useful, and relate to the "real world", thereby "increasing our interest" (Ling, NA,F,B,28). Two new arrival women compared their learning with their home country (China and Japan) and said that the assessments are bigger and more creative. Subako (NA,F,A,37) said that in Japan everyone is expected to have the same answer. Ling and Subako agreed that the work and assignments were "a good amount" and "no problems".

Peter appreciated the preparatory exercises which related to the assignment.

> That's the good thing about programming; we had the assessments and before that were exercises which were marked as though they were assignments so they didn't have the same pressure and you got experience. (Peter, NZ,M,A,22)

However, some students were critical of the size of the assessments given the time allotted to complete them.

> And the size of the assessments were just bloody ridiculous; design a factorial calculator … that sounded a bit interesting but that was ONE assessment and we had three weeks or something for it and we had to do it and check it and test it. (Patsy, NZ,F,C,39)

4. Resources and Teaching Approaches

There were no complaints about the hardware and software resources used in the programming classes. As discussed earlier in this chapter, teaching approaches included some lectures in a large lecture hall, more intimate lecture/discussion seminars in classrooms as well as the practical laboratories and students' comments on these approaches have already been discussed in a previous session. However other responses to the question "How would you like to see programming taught?" referred to criticism of the prescribed texts, and teaching resources and approaches which focused on computer functions rather than concepts and problem-solving techniques. Rita distinguished between performing actions and understanding.

> The text was step-by step which wasn't any good because you didn't have to think and there was no understanding; the steps should be guidance and some examples. (Rita, NA,F,B,41)

Khalid expressed similar concerns and was angry that the activities were not carefully planned and a “monkey-see, monkey-do” approach was taken.

> There's no programming in putting a button on - any child can do it … when we get out of here and into work we wouldn't know how to do it … what the hell! It's like teaching babies … they didn't teach me; they give me a handout book. If I put it aside I will not be able to do it again; so it's a general feeling amongst the mature students. (Khalid, NA,M,B,34)

This student criticised the lack of multimedia aids, suggesting

> The institute should subsidise or something and burn student copies and everyone have a copy; see it’s live rather than a book which is dead now. (Khalid, NA,M,B,34)

Student Cohesion and Cooperation

Student Cohesion is concerned with relationships and friendliness amongst students and many of the interview questions elicited responses using words such as "friendly" "helping", "support", which indicated cooperative and collaborative practices which would not have occurred had there not been cohesiveness. When categorising themes from the interviews, therefore, it was difficult to isolate a comment and assign to just one of the two CUCEI scales of Student Cohesion or Cooperation. It was obvious that collaboration could not have been effective if the students were unfriendly and competitive to the extent of not sharing their knowledge. For this reason, discussion of the interview responses refers to comments relating to both scales of Student Cohesion and Cooperation.

The interviews indicated that there was a high level of student cohesion and cooperation in all the classes for the majority of students. Most commented favourably on these aspects, saying that they liked the group work and the “internal tuition” that went on. However one successful student (Khalid, NA,M,B,34) resented giving so much help to “students who are struggling” because he was worried of the consequences of the work looking “suspiciously similar”. The new arrival subgroup faced additional issues relating to adjustment to a new country with language and lack of family and financial support being major themes identified in this section.

1. Language

Expressing oneself in a foreign language was identified as a problem by several of the new arrival students. For Viri, studying in English did become easier but initially he viewed his competency in English as a problem, contributing to his shyness and inhibiting his participation in class.

> Main problem here is the language. Other thing is if you can speak good English then you can express yourself if you have problems. What's hard here is I was shy to ask in front of the class; now it's easy but I know what I face when I first started here. (Viri, NA,M,C,24)

Language was identified as a barrier to collaborative work with New Zealanders who were reported as being reluctant to work with new arrival students, especially in group assessments.

> We had study group with all foreigners, no Kiwis [New Zealanders]. (Reni, NA,F,B,35)

> Sometimes when doing a group job I feel not comfortable. Native people don't like to do the job with us - Interpersonal Skills group project - because our language is not good. (Zhou, NA,F,A,41)

This response was followed with a probing question: "Is this because you're Chinese?" Zhou replied "No" and when asked directly if she had experienced any racism was emphatic that she had not. These comments relate to assessments but when there was nothing at stake, most students reported enjoying the “friendly people” and being treated as everyone else. However not all new arrival students were happy

> Always just face to face with computer and you talk to someone and they say ok, you can just do yourself. Not really student help. (Wayne, NA,M,C,19)

> In first term I feel no good; in final I come more confident (Ken, NA,M,C,19)

Ken and Wayne, two Chinese students, found their first semester very difficult in coping with the English language as well as the different food, and culture shock. They were asked if anybody at Institution C had talked about adjusting to a new culture and replied “No”. Wayne identified the computing language as an additional barrier to the English language

> Computer language problem; not only English problem (Wayne, NA,M,C,19)

The computing environment, together with a feeling of being on one’s own resulted in Wayne and his friend Ken feeling isolated and alienated.

2. Lack of family and financial support

Some of the new arrival students found that being away from family support and financial help was difficult when they first arrived in New Zealand. Viri worked significant part-time hours and found this stressful when combined with his full-time study.

> In India first thing is you have family and good support; no financial problems. The system - you know how it works; you know the language; and understanding the system. (Viri, NA,M,C,24)

3. Maturity

Maturity appeared to affect cooperation and cohesiveness in that the older students were able to organise themselves into study groups which helped their studies whereas the younger students were perceived by the mature students as not being able to do this so easily. This was confirmed by one young woman who said

> For me it was a bit of a one-man battle whereas some of the older students in our class, they do tend to have a little problem-solving session and see what they come up with; come back and see what they all came up with before jumping straight into computing. (Nola, NZF,B,21)

Nola was asked if she would like to do that and she replied

> Yes, I think I would have but it's a little bit awkward with a lot of younger brighter students who have done programming before; you feel a little bit awkward in asking. They [the older students] are easier to talk to; I don't know; less competition I think.

Nola, despite being an A-grade student, was not confident, perceiving other students as “brighter” than her and finding it easier to talk to the mature students.

Individualisation

The Individualisation Scale in the CUCEI refers to the extent to which students are allowed to make decisions and are treated differently according to ability, interests, and rate of working. There was a majority of positive responses to the questions, "How do you find programming; what's good, what's bad about it?, "How do you like to solve programming problems?" and "Do you think most students get a fair go with their learning?" This is not surprising because, as mentioned earlier in this chapter, the programming laboratories, in particular, were very casual environments where students arrived and left as they wished, there were usually no set teaching sessions, no conformity to a particular programming answer was expected, and the lecturer worked with individuals as they requested. The two themes that illustrate how students considered the environment was individualised are freedom and responsiveness.

1. Freedom

Students were expected to work on lengthy assignments in class was well as additional hours out of set class times. The freedom and onus was given over to the students and Clare’s comment illustrates how this was perceived.

> There isn't any unreasonable control over things we do; in fact there haven't been a lot of restrictions placed on us at all; it's pretty good. (Clare, NZ,F,A,31)

In contrast, Evan recognised that he works better in a more controlled, structured environment, which provides interim milestones or achievement goals in order for him to complete work on time.

> We know what we have to do and by when but between those times there is no …, you're basically given free rein; you're on your own. I don't like that; I need a push sometimes … he just leaves it up to us until it's time to hand it in. (Evan, NZ,M,A,24)

Freedom of programming style and results (within reason) were encouraged by some lecturers and appreciated by students.

> Dee's a good teacher; she is better than others. Like, you can use your own ideas (Viri, NA,M,C,24).

Two very successful programming students who would have liked to extend their learning beyond set class material felt somewhat restricted and restrained.

> I found the text was going into OO [object oriented] programming and they're not teaching it at first year level so bulk of book was, 'yes, you're allowed to look at it, but you're not to do it that way!' (Carmen, NZ,F,B,35)

Matt also regretted conforming to a prescribed amount of teaching with no provision made for extension work but acknowledged the help provided when tutors were free.

> Disadvantage was it didn't cater for accelerated learning; the tutors were happy to assist with more advanced stuff when they were free. (Matt, NZ,M,C,38)

*2. **Individual Responsiveness***

The way lecturers and laboratory assistants responded and helped was important to students. Patsy's appreciation was related not only to the teacher's responsiveness but to her ability to respond at the individual level, thereby meeting Patsy's needs at that time.

> The lab assistant, she's really good but she goes to too high a level and I say I don't understand, come back down here to where I am and she says ok, fine and she does; she was really good but you have to say, hey, back up. (Patsy, NZ,F,C,39)

Equity

Items of the CUCEI's Equity Scale refer to the extent to which the teacher treats students equally. Most students were happy, commenting "yes, we could ask questions" (Ravi, NA,F,C,19) and "they give a chance to everyone to say" (Viri, NA,M,C,24). However this aspect of equity proved to be too narrow and restrictive a concept to cover the equity issues that students raised in their interviews. As mentioned earlier in this chapter, the interviews revealed equity themes that ran through comments that addressed the other scales, thereby covering a broad spectrum of issues. This section, therefore, begins by discussing students' comments regarding their treatment by the teacher then continues with other equity issues raised by the students and which are not covered by the items of the CUCEI's Equity Scale. These issues were organised into the themes of favouritism, teachers' assumptions of prior knowledge, institutional support and enrolment policy, racism, being a minority and student attitudes.

1. Students are treated equally by the teacher

As discussed above, students appreciated the teacher who maintained an environment where students felt able to ask questions and have their say. They also liked a teacher who was well-organised and who made explicit, in an open and obvious manner, the expectations for work to be covered within a particular time frame. For example, Peter was happy with the way his lecturer proceeded.

> The lecturer would put at the beginning of the week on the board what was going to be covered. (Peter, NZ,MA,22)

However, other students raised the following themes which showed that not all students experienced an equitable learning environment.

2. Favouritism

Three students reported incidents relating to teachers favouring certain students over others and to the teacher's ability to manage a class of students fairly. Teachers who permitted themselves to be captured for lengthy periods by articulate students, thereby neglecting other students who were waiting for help, contributed to Reba's sense of unfairness.

> Really individuals were the favoured; the ones who had the gift of the gab … some of us out here are really working hard for everything we get and I'm not taking anything away from those ones but things went wrong for them and suddenly they got that extra help. (Reba, NZ,F,B,32)

Mature students were noted as receiving preferential treatment from this lecturer, being considered to have the ability to capture and monopolise the lecturer's time. Clare (a mature student) thought she got a "fair go" but pointed out

> The mature students are more likely to grab the tutor when he walks in the door so I think the young ones miss out quite a bit in our class.

> The mature ones would have a list of what they wanted and they'd be waiting and grab the lecturer. (Clare, NZ,F,B,31)

Students who got on with the teacher were also viewed as being especially favoured by the teacher. Ian commented that a lot of time was devoted by the lecturer to helping a student in this category.

> There are a few students that had a good relationship with the teacher and they go to them because the teacher is ready to spend two hours really, really helping them; sitting next to them, typing in the code; I saw it. (Ian, NZ,M,A,22)

When a teacher fairly allocated time across the whole class this was appreciated: "he always make sure to go to everyone and so he always covered all the class" (Subako, NA,F,A,37).

3. *Teachers' Assumptions of prior knowledge*

Three mature women from Institution C who were doing the introductory Certificate in Business Computing course had enrolled believing (correctly) that no prior knowledge in computing was required. They were very upset when they had difficulties in the course and said the lecturer was assuming they knew and understood basic concepts that they believed the younger male students, in particular, would be familiar with because of their interest in computers but which they didn't know. They felt disadvantaged and believed the work was difficult because their lecturer was not teaching the basic principles.

> I think they have the wrong impression that people taking CBC [Certificate in Business Computing] know the basics of programming; we don't. (Agnes, NZ,F,C,32)

> A high percentage coming into these programs are young kids; they have a lot of basic ideas which we have no idea about. He needs to teach the actual [basic] concepts before he teaches the big stuff. (Drew, NZ,F,C,37)

4. *Institutional Support and Enrolment Policy*

Equity issues did not centre entirely on the students. Issues that students commented on were the institutional support available to lecturers and the open-entry student enrolment policy for some of the programmes. Three women from Institute C who were interviewed together, believed their lecturer should have had more support in the way of teacher training and time allowance for preparing new course materials when a new programming language was introduced. They reported that the lecturer had very little time in which to learn and prepare the new language before commencing teaching in the second semester.

There was criticism of the low enrolment criteria for the certificate program. Khalid believed that some of the students accepted into the certificate program were ill-prepared, found studying difficult, and these factors contributed to the poor success rate.

> Management will not accept only good students; they take anyone so it's money; one third drop out, one third fail and one third pass. (Khalid, NA,M,B,34)

5. Racism

New arrival students were asked if people in their learning environment treated them differently because they were from another country. This was sometimes followed by a blunter probe of: "Have you experienced any racism?" Most of the new arrival sub group students reported perceiving no racist comments or behaviour and it appears that the attitude these students bring to their living and studying in a foreign country helps with their adjustment. For example, Rita (NA,F,B,41) reported that she had experienced "certain instances, certain looks; minor, but it didn't affect my learning". Ming was interested to learn about the new country he had come to and made an effort to be friendly and approach his New Zealand classmates.

> It was easy because I also want to understand what makes their culture and sometime I find some chance to talk with them but if I don't then noone would talk. (Ming, NA,M,A,23)

Min, a father of four children and an ex-mathematics teacher from Sri Lanka, said he was pleasantly surprised at how accepting the younger New Zealand students were of students his age.

> In my country, if I go and study with the younger, they will laugh and say what's this old man but here, I didn't feel anything about this. (Min, NA,M,B,42)

6. Being a Minority

The new arrival and female students formed minority subgroups. The females were asked if their minority status had affected them in any way. Some said they had noticed and wondered, “why less ladies here?” (Ravi, NA,F,C,19), but they thought this had not impacted on their learning. There was a consensus that it “doesn’t matter” with Reni saying

> I don’t think it depends on gender. It’s whether you like it and grab the information. (Reni, NA,F,B,35)

Subako (NA,F,A,37) was “very comfortable” and Zhou (NA,F,A,41) said her minority status didn’t affect her “at all”. Two females cited maturity and experience as reasons for being happy with their minority status. Mani (NA,F,A,20) felt that because many were “mature students … it didn’t affect me that much” whereas Reni (NA,F,B,35), a student from India, felt her experience helped as her background included doing a Masters in Agriculture in Russia where the majority of students were male and she was “used to it”.

7. ***Student Attitude***

A classroom environment that suits all students all of the time is, unfortunately, not a reality. Each individual brings to the classroom his or her different expectations, motivation, learning styles and ways of working. Four students commented on the different dependent and independent attitudes of students. Harry identified the varied motivations of students and the value of taking responsibility for one’s own learning.

> Depends on yourself actually. Some students pretty slack; they often want somebody else to do it for them. If I solve it I get more experience; they don’t know anything. (Harry, NZ,M,B,18)

Matt (NZ,M,C,38) thought learning was “a case of self-help” and Brad (NZ,M,C,21) said help was available for “those who ask”.

Peter recognised the difficulty of catering to all types.

> Some people like their independence, some don't. You can't really have it both ways and the way it is works for me. (Peter, NZ,M,A,22)

Results from the student interviews indicated general satisfaction with many aspects of the learning environment as well as some areas which students felt hindered their learning. However, students are but one of the stakeholders in a learning environment and in order to gain a fuller understanding of what was happening within this milieu, lecturers contributed their perceptions via interviews. The approach to analysis of lecturers' interviews commences the next section of this chapter.

Approach to Analysis of Lecturers' Interviews

There were three interviews with the five lecturers, as discussed in chapter 3. The data from the interviews resulted in three transcripts totalling 10 single-spaced, A-4 pages. The approach to interviewing the lecturers was similar to that adopted for the student interviews with many of the semi-structured questions being open-ended. The first five questions established enrolment numbers for the total programming student population as well as for the subgroups (providing information for sample size and description in chapter 3), lecturers' opinions about the hardware and software and confirmation that students of each institution would receive the same sort of first-year programming basics (see Appendix 3B Lecturers' Interview Questionnaire). The remaining questions were loosely structured around the scales of the CUCEI and analysis of the transcripts was aided by the use of the computer program, NUD*IST. As with the student interviews, a discursive analysis (Nash, 1976) was adopted, resulting in the reasoned categorisation of categories and themes to represent the lecturers' responses in as true a fashion as possible.

The next section reports the interview results presented under the categories and themes (Appendix 3E Student and Lecturer Interview Categories and Themes). These relate to dimensions of the CUCEI's scales but lecturer's comments are discussed under the central categories, rather than each scale of the CUCEI. This approach was taken because the questions and responses often focused on characteristics and features of participants' attitudes and aspects of the learning environment that were not directly related to the CUCEI's scales but viewed as possibly influential in the programming learning environment. It was considered important not to inhibit nor restrict responses to questions which suited only the categories of the CUCEI's Scales, but to allow lecturers the freedom to express what they saw as relevant and pertinent.

Lecturer Interview Results

Reflections on Teaching Programming

Lecturers were asked “How would you like to see programming taught?” Two themes were identified and these related to the lecturers reflecting on the physical teaching environment and the importance of establishing a physical distance from the personal computers. In the following section, each of these themes is described and illustrated with representative comments.

1. The Physical Teaching Environment

Comments relating to the physical teaching environment reflected on the lecture theatres, the configuration of seating and tables in laboratories and classrooms and the size of student numbers in any one class. All five lecturers commented that the hardware and software were up-to-date and had adequate specifications for teaching the programming languages. They also commented on the different venues where they taught. As discussed earlier in this chapter, programming was taught in classrooms, computer laboratories as well as lecture theatres. There was agreement that lectures had limited value in the teaching of programming and there was a preference for small classes because lecturers could

> keep in touch with students and spend time with each individual. (Ruth, Institution A).

Alex believed that a personalised environment was difficult to achieve in a lecture theatre and echoed Ruth’s preference for smaller classes. He contrasted his teaching in a 20-student class with that of the 80-student lecture.

> When there are only 20 students in the class you can actually gauge if they understand what’s going on; you can see it on their faces. If you have 80 students in the lecture theatre you just talk about something and that’s it and if they don’t follow it there’s no way that you can actually see if they are following you or not. (Alex, Institution B)

Alex believed it was particularly important for him to be able to monitor whether his students “clicked” [understood] and “to get people to actually see something, understand something”.

2. Establishing a Physical Distance from the Personal Computers

The computer laboratories provided students with the opportunity for practice and to implement the concepts introduced in the lectures but Barry believed that even within this environment where there were smaller student numbers, it was "important to get away from the machines". One way of checking on understanding and to create a more personalised environment was to equip the laboratories with tables for group work.

> I like the rooms where we have table space in the middle and students can get away from being in front of their PCs which are on the outside. They can come together like a group. (Ruth, Institution A)

At all the institutions there were one or two laboratories that were configured with personal computers as well as separate tables and there was agreement amongst the lecturers that this was a more desirable layout than laboratories that had personal computers only. Barry pointed out that "a lot of students can't see the whiteboard because there's computers in the way" and this lack of visibility together with little opportunity for students to have a break from interfacing with the computer, meant that in the lecturer's view the physical environment was not ideal.

Class Management

Lecturers were asked "What sort of control/direction do you exercise in managing a class, lecture or laboratory?" Themes identified from the responses are the need for a structured environment with freedom and having a sensitive, reflective awareness in teaching approaches.

1. A Structured Environment with Freedom

The lecturers agreed that when students began their programming course, it was necessary to "take them through the course" (Alex, Institution B) by teaching initial concepts and that this was best done through lectures or formal teaching in the classroom. This changed as students neared the end of their first year of study.

> At the end they will be working on assignments entirely and a greater proportion of them working independently with no formal teaching. (Barry, Institution A)

Students were quickly expected to produce small programs of their own and group work was encouraged: “it’s good if they help each other” (Richard, Institution C). However, there was recognition that independent work was necessary in order “to force algorithmic thinking” (Alex, Institution B). The experience of creating a program on one’s own was emphasised.

> It’s very important, especially in programming; you’ve got to sit and do and make it happen yourself; alone; at the machine. No good doing it in a group. (Richard, Institution C)

Independent application and practice was also viewed as a necessity.

> In the end they have to do it themselves; you’ve got to put the hours in at the machine … sometimes they think they can go away and read a book and they’ll get it but it’s just not right. (Richard, Institution C)

2. A Sensitive, Reflective Awareness

Lecturers’ comments indicated that they were sensitive to and reflective about their teaching situations, being aware of personalisation and equity issues. These issues were informed by a concern for ensuring fairness of access and responsiveness to students and the need for variety in order to maintain student interest. Alex (Institution B) when describing the need to force algorithmic thinking said

> They tend to get left by themselves and request help when they want it. But one tends to move round the lab and try and go from person to person.

Deb (Institution C) realised that she “couldn’t be too boring” so tried to keep theory to 20 minutes and practical laboratory exercises to 40 minutes. Deb was also conscious of making herself accessible and helpful to students in the laboratories so had a tutorial assistant “Who I can call when I’m stuck and she can call me if she’s stuck”.

Deb described a strategy that indicated she tried to include all her students.

> I try not to force myself on people who don’t want you to look at their code; I try and divide the room into quarters and check I’ve been to that quarter, that next quarter of the room and at the end of the session I’ve done everyone. (Deb, Institution C)

Richard (who was interviewed with Deb) agreed that he tried to do the same but also said “I’m not so sure that I’m good at turning it into reality”.

Attitudes and Application

Lecturers were asked if they noticed any difference in the way males learned programming compared with females. Responses centred on the bi-polar theme of caution and recklessness, and four other themes of perseverance, aptitude and motivation, group work and self-efficacy.

1. Caution and Recklessness

Lecturers contrasted the different attitudes that males and females brought to their programming learning. Three lecturers commented on the more cautious, dependent attitude of some of the female students compared with that of the male students. The cautious approach that many females adopted was evidenced by their inclination to more often seek help, sit up the front and ask questions.

> The female students will tend to come to my office for help; the males tend not to (Alex, Institution B)

> Females sit up the front, listen carefully, ask questions; the boys are hiding down the back, doing their own thing (Deb, Institution C)

A reason for the females being more cautious was offered by Deb (Institution C) who said that, “women get more upset about it when it [the program] doesn’t work”. It appeared that they were less-prepared to risk-take or take the chance of adopting a programming strategy on their own, but rather, sought confirmation that the direction they were taking was suitable. Deb also noted that although their approach to programming was different to the males, “they get the same kick out of it that anyone else does; like it’s hugely satisfying”.

Alex offered another reason for the females’ cautious approach, saying he believed that “the women have better judgment whether they’re out of their depth or not” and prefer to seek affirmation and help before proceeding with their different sections of their programming. Richard (Institution C) agreed with this comparison when he commented on the approach many males took.

> There’s a greater reluctance from males to seek help; from both the teacher or peers. I think males are more likely to go away and deal quietly with it themselves whereas females are more likely to seek help from whoever.

The unstructured, more reckless, try-it-out-and-see-what-happens approach taken by males to their programming was noted by all the lecturers.

> Guys are more likely to jump around and try different ideas; maybe wasting a lot of time in the process but ready to chance it. (Richard, Institution C)

> The boys just get in there and crash around. (Deb, Institution C)

The uninhibited group behaviour of some males was illustrated by Barry's (Institution A) comment.

> [Some] groups of young males; they behave like hoons. They want to rip into it, into the code. Never mind the documentation, never mind designing anything. Typically a smallish number of people.

The probe, "Have you ever struck a group of young females exhibiting that sort of behaviour?" brought the response:

> All sorts of individuals will behave like that but I think young males as a group; always a number of young males. (Barry, Institution A)

2. Perseverance

The perseverance of the female students was noticed by Alex (Institution B) who believed that

> females slog it out more I suspect; more perseverance. Given an average to weak student, the female would tend to succeed and the male probably wouldn't.

The preference for some females to persevere with a strictly structured approach towards their programming was not always considered to be efficacious.

> Women seem to follow rather logical steps and if they're going the wrong way they just keep on going the wrong way; maybe women have a greater reliability on a process. (Richard, Institution C)

Richard commented that women tended to remain on the "wrong track for much longer" when coping with bugs (programming coding errors) and contrasted this with the males who adopted a more cavalier attitude and perhaps accidentally found a quicker solution!

3. Aptitude and Motivation

The interviews ended with the question “Is there anything else you’d like to say?” Alex (Institution B) believed that some students have a natural aptitude in programming and “actually enjoy it” compared with others who were “banging their heads against a brick wall”. However, Alex thought there was a middle ground where people work very hard and get through programming but doubted if they would be “any use out in the big bad world as programmers … the others are always going to be so much further ahead and enjoying it.”

Deb (Institution C) recognised the difficulties with language and culture that new arrival students faced when studying in a foreign land and believed that “the ones who are really motivated and bright will make it … but the average, foreign students won’t”. She commented on the different attitude some of the students in the new arrival category bring to their learning.

> They have an attitude that the tutor knows everything and …in the tutor evaluations they wouldn’t dare tell you how to teach better. They won’t ask questions, they never come into our office and ask anything.

Motivation and ability level of the new arrival students was also a theme commented on by Alex.

> Two things have struck me about them [new arrivals]. They’re either very good students or very weak and fail dismally. I think the reason for that is it seems to depend on why they are here. I suspect the residents do better than those who have been sent here to study. I suspect many of the students who were sent by their parents can’t get into local institutions; I can’t document it but I think they were weak students to start with. (Alex, Institution B)

4. Group Work

The tendency for females to “work in groups” was noted by Deb (Institution C) but was quickly followed by the qualifier, “but then I’ve seen guys working together as well”. Deb felt that females gained a sense of support from group work because initially, “the girls are a bit more timid”. She thought the timid attitude of the females applied particularly to the “older women” concerning their initial experiences with the personal computer. Richard (Institution C) who had received complaints about his teaching from three older women disagreed.

> I don't know about that; some older women have the timidity of a battleship actually.

5. Self-efficacy

Lecturers were asked if they thought females had a harder time learning programming than males. There was consensus that females were as successful as males with Ruth and Barry agreeing, "Our very top students are female" (Ruth, Institution A) and Alex (Institution B) answering unequivocally, "No", disagreeing with the suggestion that females had more difficulties with learning programming than males. Richard (Institution C) commented on females' sense of self-efficacy or self-belief in their own ability and judgment.

> Girls often start from a bad place; they think it's too hard. I'd say it's a misconception that they can't do it.

Mathematics and Programming

Lecturers responded with different opinions to the question "Do you have to be good at maths to program?" Barry and Ruth (Institution A) agreed that ability in maths was not necessary in order to program.

> Maths has got nothing to do with it; irrelevant. (Barry, Institution A)

Three lecturers believed that ability in maths did "help".

> I'm not convinced it's a rule [ability in maths] but it helps; I've never met anyone who's very good at maths and hasn't been able to program. (Alex, Institution B)

> Certain parts, like algebra; people that grasp maths, grasp programming more quickly. (Deb, Institution C)

All the lecturers were in agreement that to be a successful programmer, "you have to be able to think" (Barry, Institution A) and to "visualise things, algorithms, abstractly" (Alex, Institution B).

Institutional Policy and Enrolment

Three lecturers from Institutions B and C commented on the “wide ability level” (Richard, Institution C) of their students and the difficulties they found in teaching to students whose qualifications ranged from very little to others with university entrance qualifications and, in some cases, to a few students with under-graduate and post-graduate degrees. Institutions B and C offered the Certificate in Business Computing and had an open entry policy. Deb (Institution C) was shocked when she discovered that,

> They didn’t know about the greater than and less than symbols. I expected them to know basic maths, find keys on keyboard. I didn’t know that they didn’t know. I probably should have but it’s a tertiary institution!

She then wondered whether the teaching resource (the workbook) made the meaning of these symbols clear and concluded that the writer of the workbook would make the same assumption that she had. Richard (Institution C) reflected that “it would be quite hard to go through the school system without learning that; an achievement really!” Alex (Institution B) reported similar concerns with his students.

Deb (Institution C) said that some students, particularly those of the mid-year intake, were of “poorer ability and application, attended fairly irregularly and were not motivated”. There was agreement that the open entry enrolment policy permitted enrolment of students who did not have the basic skills and this contributed to the high drop-out and failure rates.

Synthesis

Equity was an underlying theme throughout both the student and the lecturer interviews and covered a much broader range of issues than the items of the CUCEI’s Equity Scale. The high degree of personalisation possible within the programming classes was conducive to an equitable environment for most of the students, as evidenced by student and lecturer comments and the favourable students’ perceptions shown for the Personalisation and Equity Scales of the CUCEI.

The analysis of the student interviews indicates that the majority of the students from all subgroups was generally satisfied with the programming learning environment. However, some students had concerns with certain aspects and made suggestions for improvements. During the interviews some students reported dissatisfaction with the lectures, preferring the hands-on sessions in the computer laboratories where concepts presented in the lectures could be implemented and practised. Inappropriate teaching resources were criticised, such as texts and handouts which taught how to do a computer function, rather than teach concepts, and lack of multimedia aids.

The students also raised classroom management issues. These included the positive and negative impact of mature students on the younger students. The older students were reported to be more articulate and focused, and were criticised by some younger students as being better able to capture and monopolise the lecturer's time, thereby reducing the time available to the younger students. However, a young female student found it easier to discuss programming problems with the older students because she sensed "less competition". The lack of extension work was cause for dissatisfaction for some of the more able students as was the too-free environment with few checks or milestones that made it difficult for a student who identified himself as needing "a push sometimes". Two lecturers stressed that it was important for students to work and practise programming independently. They recognised the value and place of group work but felt individual application was essential. Lecturers who were perceived as favouring particular students by spending more time and providing more help than others were viewed negatively. Three women complained about a lecturer who assumed prior knowledge when no pre-requisites were stated for an introductory certificate programme.

There was surprising homogeneity amongst the groups with no one theme dominating for any particular subgroup. Some of the new arrival subgroup students did have different concerns that related to their living and studying in a different country. The main issue for these students was the adjustment they had to face, particularly problems with language and initial loneliness. Racism was not reported as evident except for one student who said she had experienced minor incidents that did not affect her learning. The minority status of the females and the new arrivals did not appear to affect the students, possibly due to the positive and independent learning attitude of many of them.

The lecturers and students interviewed were generally satisfied with the physical resources (hardware and software) available to them, although two lecturers expressed a preference for computer laboratories to have tables separate from the personal computers in order to establish a physical distance from the computers and to better facilitate group work on concepts.

Lecturers identified differences between males and females in their attitudes and application. Males were perceived as more cavalier and more willing to 'give it a go' than females who adopted a cautious approach, seeking affirmation that their strategies were correct. Females were perceived as persevering to a greater degree than males and also being more inclined to prefer group work. Some male students believed that females were suited to programming because of their ability to multi-task, which they considered was a good attribute for programming. The lecturers and most students were agreed that females were as successful at programming as males but one lecturer commented that "girls … think it's too hard". One male student identified lack of confidence as an issue for females rather than a lack of natural aptitude. Ability in maths was not considered essential in order to program but was thought to be helpful as students with a maths background were more likely to "be able to think" abstractly.

Institutional policies were commented on by both lecturers and students, particularly the low entrance qualifications required to enter the certificate programme. In this context, comments centred on New Zealand and new arrival students not understanding basic maths symbols and many of these students failing the programme and/or dropping out early. Institutional policy that did not allow lecturers adequate time to learn and prepare teaching resources for new programming languages was also criticised.

Overall, the student and lecturer interviews produced complementary information. Equity was a theme linking comments in both sets of interview data. The next chapter summarises the purpose of, approaches taken, and findings in this study. It concludes with an examination of implications for practice and further research.

CHAPTER 6

SUMMARY
CONCLUSIONS AND IMPLICATIONS

The general purpose of this study was to investigate tertiary computing students' perceptions of their learning environment and in particular, the perceptions of male and female students and the student subgroup defined as new arrivals. This chapter begins by presenting an overview of the specific objectives of the study, the research design and the findings. The limitations of the study are identified in the next section and the thesis concludes with a discussion of the implications for practice and further research.

Overview of Study

The objectives of this study were to:

1. investigate students' perceptions of their programming learning environment,
2. investigate how the student subgroups defined by gender and as new arrivals differ in their perceptions of their programming learning environment,
3. investigate lecturers' perceptions of their programming classroom learning environment,
4. make recommendations, where appropriate, to assist lecturers to make the learning environment more inclusive for all participants, and
5. examine the use of the College and University Classroom Environment Inventory (CUCEI) as an instrument to explore perceptions of the tertiary learning environment.

The study employed a mixed-method design, collecting data from first year programming students and lecturers at three tertiary institutions in Wellington over the months of October to December 2000. At that time of year students were nearing the end of their year's study and were familiar with the institutional and learning environment. Triangulation of data collection was achieved through administering the Actual and Preferred Versions of the CUCEI to 239 students (135 male and 97 female, with seven students not reporting sex) and 5 lecturers, conducting semi-structured interviews with 28 students and 5 lecturers, and field observations of the different learning environments while teaching was taking place.

Analysis of the CUCEI

Data from the CUCEI were analysed using SPSS in two stages. The first analysis was to check whether the questionnaire was a reliable and suitable instrument for this study. In the second stage, results from the CUCEI were examined for the total student population and then, for the student subgroups defined by gender and by origin.

The item analysis of the two versions of the CUCEI indicated that the items of the seven scales were reasonably sensitive and every response choice on the questionnaires attracted some response. However, when the structure of each version of the CUCEI was examined using principal components analyses, the results were disappointing. Items of most scales split over components, although in both versions, the Equity Scale was coherent with all of its items loading strongly on one component. Clearly, the existing scale structure of the CUCEI was unsatisfactory for the purposes of this study and if it were to be used, some modification of the questionnaire was necessary. A number of items were deleted, based on their statistical performance in the principal component analysis and consideration of item content in the context of the intended scale. Further, the Task Orientation Scale was not coherent and it was decided to abandon the scale altogether. These decisions resulted in a reduced, six-scale revised CUCEI which yielded a satisfactory solution to a principal components analysis (see Tables 4.13 and 4.14 for the Actual and Preferred versions, respectively). The internal consistency of the final scales, using

Cronbach's Alpha Coefficient, were found to be acceptable for both the Actual and Preferred Versions (see Tables 4.15 and 4.16 respectively). Inter-correlations among the scales showed that there was some overlap, but the six revised scales were considered satisfactory for the next analysis.

The Actual and Preferred Versions of the CUCEI were administered on separate occasions and were completed by different but overlapping samples of students. Consequently the analysis of the scale results first considered the results on the Actual and Preferred Versions separately. Differences between students' perceptions of their Actual and Preferred environments were examined on the smaller sample of students who completed both instruments.

Analysis of the Interviews

The interviews for both students and lecturers were structured around the scales of the CUCEI as a way of ensuring coverage of the salient features of the learning environment. Although students commented on much broader issues than those covered by the scale items, the scales provided a reasonable framework to report the results. The interviews of the lecturers also raised wider topics than those covered by the scales of the CUCEI with many of the comments being of a reflective nature.

Findings and Conclusions

Objective 1: Students' Perceptions of Their Programming Learning Environment

Findings from the CUCEI

Overall results of students' perceptions for the Actual scales of the CUCEI indicated that they viewed their actual environment with some satisfaction with the mean item scores for Equity, Personalisation, Student Cohesion and Cooperation Scales being above the mid-point of 3.0. However, Innovation and Individualisation were perceived less positively, being scored below the mid-point. For all scales of the

Preferred Version of the CUCEI the mean scores were above the mid-point indicating that students preferred an environment that was strong on the CUCEI's scales. As these results were on different samples the Actual and Preferred Versions were not compared.

Results of analysis using repeated measures MANOVA showed statistically significant differences between the scales of the CUCEI. The Equity and Cooperation Scales had the smallest Preferred-Actual differences (0.16 and 0.18 respectively) with the Innovation and Individualisation Scales having the largest (0.83 and 0.62 respectively). In the subsequent univariate tests for the difference between the means on the Preferred and Actual Versions of the scales statistically significant differences were found for all the scales at the .05 level. The effect sizes varied from quite small for Equity (4%) to moderate-to-large for Innovation (36%). Thus, for the Equity Scale, students' actual and preferred perceptions were similar, but indicated a small preference for more instructor attention, help, praise and encouragement. The Innovation Scale showed the greatest difference between students' Actual and Preferred preferences of their learning environment. Students indicated a preference for new, innovative and different approaches to teaching to that which they perceived in their Actual environment. The effect size of 28% for the Individual Scale indicates that students would prefer an environment more tailored to their individual interests and working styles. The 12% effect size for Personalisation shows that students would prefer instructors to be more friendly, helpful, accessible and considerate. The Cooperation and Student Cohesion Scales'effect sizes of 5% and 8% respectively are small, meaning that although students' perceptions of their Actual and Preferred environments are similar, there is a small preference for greater cooperation and student cohesion.

Findings from the Interviews

The main themes that students commented on concerned whether their lecturers were friendly, approachable and readily accessible and if they could give clear explanations without being verbose. Many comments related to lectures and practical laboratory sessions. Students were ambivalent as to the value of many of the lectures but all students perceived the practical laboratory sessions as being valuable and worthwhile. Issues relating to the assessments included lack of relevance to the "real world" and the time allotted to complete assessments was viewed by some students as unrealistic. A theme relating to resources included favourable comments about the hardware and software used in the programming classes but the way the resources were used was criticised. Students expressed concerns about the "monkey-see, monkey-do" approach that did not allow for their own creativity and promotion of conceptual understanding. There was also criticism of the lack of multi-media aids.

Responses to questions in the Student Cohesion and Cooperation categories mostly indicated that there was a high level of student cohesion and cooperation for the majority of students but some students had concerns that related to too much group work which could be seen as cheating. Maturity was a theme which students identified as being both positive and negative. One younger student felt more confident discussing programming with older students whereas a mature female student thought mature students had a greater ability than the younger students to monopolise the lecturer's time.

Students were generally positive about the freedom and responsiveness of their learning environment. However one student preferred a more controlled, structured environment and three students wanted more extension work, thus indicating that the Individualisation dimension of the learning environment was not perceived as ideal by all students.

Students commented that their lecturers were responsive, helpful and encouraging (as indicated by items of the Equity Scale) but they raised a broader spectrum of issues than that covered by the Equity Scale of the questionnaire. Themes from the interviews included favouritism, lecturers' assumptions of prior knowledge and not teaching the basic concepts, institutional support for poor teachers and enrolment policy, racism, being members of a minority and student attitudes. Students commented that individual attitudes influenced their approaches to learning and identified dependent and independent learners as having different expectations.

Linking the CUCEI and Interview Findings

The interviews reinforced some of the findings of the CUCEI and initiated the emergence of fresh perspectives not evident from the results of the CUCEI. Students commented favourably on aspects of Equity, Cohesion and Cooperation (as covered by the CUCEI), thus complementing the small Preferred-Actual differences for these scales. Students perceived the largest differences between their Preferred and Actual environments for the Innovation and Individualisation Scales of the CUCEI and the interviews complemented these findings. Many of the comments related to the teaching of programming and students made suggestions that they considered would improve their programming learning environment. These related to improved delivery and content of lectures, better sequencing and connection with the practical laboratory work, use of multi-media resources and extension work. The lecturers also suggested ways to improve their teaching. They were critical of the lecture mode of teaching programming, thus matching the concerns of some of the students.

Objective 2: Student Subgroup Perceptions of their Programming Learning Environment

Findings from the CUCEI

The perceptions of the student subgroups defined by gender and as new arrivals were investigated in this study. Overall, the MANOVA found no statistically significant differences between the subgroups based on students' sex and origin. The perceptions of male and female students have been found to move closer together as they participate in higher education (Fraser, 1989; Johnson & Johnson, 1991) and the results of this study confirm this trend. Although the CUCEI did not appear to be sufficiently sensitive to identify differences between the subgroups, the interviews did suggest there were some alternative perceptions.

Findings from the Interviews

New arrivals. The interviews indicated that while some new arrival students perceived their learning environment favourably, especially when compared with that of their home country, some of the younger new arrival students expressed concerns with the English language and identified their lack of language proficiency as a barrier to collaborative work with New Zealanders. Some students identified language as being a major concern for them in the early months of their time in New Zealand and found this became less of an issue as time went on. Personal issues were identified as a concern for some new arrival students. They found the lack of financial and family support through being away from home presented difficulties for them, citing the need to work in part-time jobs, often late in the evenings. One student said this impacted negatively on his studies.

A new arrival male student was critical of institutional policy where students with little or no qualifications were accepted into the certificate programme. He noted the high failure and drop-out rate.

The majority of new arrival students reported no racist attitudes or actions. Many of the more mature new arrival and female students perceived their minority status as not affecting them adversely. The maturity of the new arrival students, and for some, their experience of living in a foreign country prior to coming to New Zealand, had prepared them for some of the potential adverse consequences of culture shock. A study of Japanese students in the United States found that older students were more likely than younger students to desire contact with their American peers (Trice & Elliott, 1993), and possibly the New Zealand mature new arrival students adopted this attitude which helped facilitate an easier transition and adaptation to a new culture.

Gender. Generally, the female students did not perceive their minority status as affecting them adversely. However three women from the same institution were dissatisfied with their lecturer teaching to assumed knowledge and felt he was directing his teaching to the younger male students who formed the majority of their class. They were also critical of his inability to explain concepts in a way which they could understand in the class environment. These comments relate to the provision of an equitable environment for all and these women did not experience this.

Maturity. Although mature students were not the focus of this study, there were several comments on the ability of some mature students to receive more individual lecturer help and attention (compared with the younger students) because of their confidence and assertiveness. They were also viewed as being better able to organise themselves into effective and collaborative study groups.

Linking the CUCEI and Interview Findings

Figure 4.1 shows that new arrival male and female students perceived the CUCEI's Cooperation and Cohesion Scales of their environment less positively than the New Zealanders and the new arrival males had the lowest score for the Equity Scale. Although these differences were not statistically significant, the interview comments made by three new arrival males of their early experiences in adjusting to a new education system and methods of teaching suggested that they experienced some difficulties. The similar scores for the New Zealand males and new arrival and New Zealand females for the CUCEI's Equity Scale were supported by comments made by the female students on their minority status which they felt did not, generally, affect them adversely. For the Personalisation, Innovation and Individualisation Scales the subgroups' scores were very similar and many of the comments made in the interviews corroborate the homogeneity of these perceptions. The interviews provided a greater understanding than did the results from the CUCEI (which found little difference between the subgroups) and provided new insights into the reasons for the new arrival males and some of the female students' experiences and difficulties in their programming classes.

Objective 3: Lecturers' Perceptions of their Programming Learning Environment

Findings from the CUCEI

Lecturers completed the Actual and Preferred Versions of the CUCEI and the results indicated that lecturers perceived the Personalisation and Cooperation Scales of their actual environment as being very similar to their preferred environment. Perceptions for the Cohesion Scale showed the greatest difference between the Actual and Preferred Versions with lecturers preferring students to be less cohesive. Lecturers preferred greater Innovation, Individualisation and Equity than they perceived was in their actual environment.

Findings from the Interviews

The five lecturers who participated in the semi-structured interviews responded to questions that established enrolment numbers, the specifications of the hardware and software used within their institutions and the programming languages and concepts that they taught in the first year of study. The lecturers offered opinions on how they would like to see programming taught. They reflected on the physical teaching environment and the importance of establishing a physical distance from the personal computers. Two lecturers believed that laboratories that had worktables separate from the computers and where group discussion could be held was a more desirable topology than laboratories with personal computers only. There was agreement that lectures were useful when introducing new programming concepts but lecturers believed that the lecture environment created difficulties in establishing a personalised environment where student learning could be gauged. They considered independent and group student work was necessary and said that this was best achieved in class seminar-type situations and within the computer laboratories. The lecturers commented on personalisation and equity issues, describing incidents where they were aware of the need to try to meet the needs of their students.

Lecturers were in agreement that females adopted a more cautious and careful approach to programming than males. They said many males were reluctant to seek help and were more likely to "jump around and try different ideas". Females were noted as having greater perseverance than males although one lecturer believed this was not always an efficacious attribute, believing that females may persevere in the wrong direction. It is notable that these gender differences perceived by lecturers did not appear in student interviews.

Linking the CUCEI and Interview Findings

The CUCEI Innovation Scale results showed lecturers preferred greater Innovation and this was corroborated and expanded by comments made in the interviews relating to the physical teaching environment. The lecturers agreed with the students that the teaching of programming via lecture mode had limited value and they expressed a preference for small classes. The provision of a separate worktable area from the personal computers was also considered important.

The results for the Cohesion Scale of the CUCEI indicated that lecturers preferred students to be less familiar with each other in the classroom. In the interviews, lecturers agreed that group work was a positive approach to learning programming but commented on the importance of independent application and practice. Perhaps lecturers considered that a less cohesive environment might facilitate more independence in student work habits.

Lecturer interview comments relating to the Equity Scale were, as for those made by the students, concerned with a greater range of issues than that covered by the CUCEI. The lecturers showed concern when they reflected on their teaching practices and these comments expanded the Personalisation and Equity Scale findings of the CUCEI.

Objective 4: Recommendations for a More Inclusive Learning Environment

The results of the CUCEI show that there were no major subgroup differences in the students' perceptions of their learning environment, but the interviews revealed issues with which students were dissatisfied. In some instances, they made suggestions for improvement. The ability of some mature students to receive extra help and attention from lecturers and to organise study groups was compared with some of the younger students who were not as successful with these activities. The lecturers' interviews identified gender differences in how students approached the learning of programming as well as discussion relating to the physical aspects of teaching delivery. The following recommendations, therefore, are drawn mainly from the interview findings and focus on increasing achievement for individual students, based on their individual needs, rather than making recommendations for male and female and for New Zealand and new arrival students separately, which is more likely to accentuate rather than ameliorate any difference. The recommendations are contained within two areas: institutional policy and teaching practice. In the following section the word "teacher" is used instead of "lecturer" as it is a more generic term implying a broader range of attributes and characteristics than "lecturer" which may imply only one who "lectures".

Improve Institutional Policy

Good teaching practices and the provision of a positive learning environment are made possible by institutional policies as well as individual teachers' attitudes and abilities. These policies may be formal or informal and contribute to the culture and ethos of an institution. Examples of policies that contribute to the culture and effectiveness of an institution include the allocation of teaching staff to courses, provision of student-support/bridging courses and relationships between teachers and senior staff. Issues which could be addressed by positive institutional policies are: use "good" teachers for first-year students, provide professional development for "second-best" teachers, allocate a time-allowance for teachers of programming who need to learn a new programming language, provide greater institutional support to address language and cultural-adjustment problems for new arrival students, and provide bridging mathematics courses for students enrolling in programmes which have no formal entry requirement.

Use "good" teachers for first-year students. The students of this study perceived "the good teacher" as one who exhibits an ethic of care (Noddings, 1984) citing personal attributes of friendliness (not arrogance), helpfulness, accessibility both in and out of class and the ability to explain without excessive verbosity. Excellent teachers can positively affect learning and have been shown to improve the retention and enrolment rate of women enrolled in Carnegie Mellon University's undergraduate computer science programme (Margolis & Fisher, 2002). It is paradoxical that "good" teachers who have demonstrated their ability in the classroom are often promoted and rewarded with opportunities of teaching third-year and post-graduate students and are given an increased administrative workload.

First year students, more than second- and third-year students who have experienced the new environment and require less structure and direction, need excellent teachers who demonstrate the personal attributes which students of this study recognised as important to their learning. The first year experience has been identified as critical to both the short-term academic goal of student retention and the longer term goal of establishing positive orientations to learning (Bruck et al., 2001). By using the best teachers for first-year programming classes, student retention and positive attitudes to learning are more likely to be achieved.

Provide professional development for "second-best" teachers. Some students of this study were critical of aspects of their lecturer's teaching and considered he would benefit from teacher-training sessions. Professional development opportunities have been found to impact on teachers who in turn impact on student learning (Horsburgh, 1999). Therefore, lecturers who are not “good” teachers could be offered professional development opportunities as a way of improving their performance.

Allocate a time-allowance for teachers of programming who need to up-skill to a new programming language. The necessity for upgrading teaching knowledge and skills is a frequent requirement for teachers of programming. As new programming languages are introduced teachers need time to learn the programme and prepare teaching materials for their students.

Provide institutional support to address English language and cultural-adjustment problems for new arrival students. Some new arrival students considered their English language skills and cultural adjustment problems inhibited their learning, especially in the initial months of study in New Zealand. These areas have been confirmed as issues of concern from other studies (Beaver & Tuck, 1998; Burns, 1991; Mullins et al., 1995). Burns (1991) made recommendations that would mitigate some of the problems new arrival students face on arriving in a new country of study. They include pastoral care provision through requiring new arrivals to attend a longer familiarisation period than is usual, using older, experienced students of the same ethnic group in a buddy/mentor scheme to assist new students settle in and the identification of at least one member of staff in each department who is known as the contact person for new arrival students in the provision of support, advice, and monitoring progress. English language courses that focus on computing terms as well as colloquial English usage would negate some of the negative initial experiences on which some new arrival students have commented. Implementation of these recommendations would facilitate a “gradual infusion into the culture and local community” (Burns, 1991, p. 75) before study starts, thus preparing the new arrival students for their study.

Provide bridging mathematics courses for those students who need them, thus ensuring a basic standard of competency before enrolment is accepted for programming courses. The high failure and drop-out rates of students in programming was commented on and attributed to poor mathematical skills.

Institutions could offer a pre-entry bridging mathematics course before accepting students into the programming courses, thus better equipping students for their computing study.

Improve Teaching Practice

The following suggestions, based on the findings from students and lecturers, may be useful for programming teachers who wish to improve their teaching practice.

*Provide an equitable environment through an awareness of, and catering to, diverse student needs***.** Some female students believed their "ways of knowing" (Belenky, Clinch, Goldberger, & Tarule, 1986) and interests were not catered to by their teacher. They contrasted his teaching in the classroom where "he found it very hard to convey what he knows to our level" with a private tutorial with two of the women where he "got his ideas across, used different processes" and was "absolutely brilliant". Computing is recognised as a male-dominated domain (Bernstein, 1999; Grundy, 1996; Morritt, 1997; Ryba & Selby, 1995; Young, 2000) with teaching often orientated to male interests. Some female students complained that their teacher was teaching to assumed knowledge that they believed the young males in their classes had and which they did not. A teacher who is aware of the diverse student backgrounds and is willing to incorporate different teaching approaches will create a more inclusive learning environment

There are both positive and negative effects of mature students in the learning environment. An awareness of the positive benefits which maturity brings to the classroom (such as the older students' ability to organise themselves into study groups and mentor younger, shyer students) can increase the cohesive and cooperative dimensions of the environment. However it was found mature students also had a greater ability to monopolise the lecturer's time. A lecturer who is aware of these attributes of some mature students can utilise them to make the classroom a more effective learning environment.

The cooperative and cohesive learning environment was a positive feature for many students, with one lecturer believing that females "gained a sense of support from group work" because initially they were "a bit more timid". Teaching practices should continue with group work that could help foster positive self-efficacy for all students. However, the fostering of students' independent work habits was also found to be important and lecturers need to consider ways of incorporating both group work and independent work. One suggestion was the establishment of a separate space, identified as an area for students to group together for discussion and also as a space for independent work where individuals can sit to design and analyse their programs within the same room but away from the personal computers and the distractions that the computer may offer.

Raise programming students' awareness of the computing culture. There is much in the literature indicating specific attributes of the computing culture and how these can adversely impact on students, particularly novices, females and minority subgroups. Lecturers could, through discussion at student orientation functions, web page information linked to the web sites advertising computing programmes, or in the initial programming classes, inform students of the existence of the computing culture, the attributes and impact of this culture. Moos (1979b) believes that knowledge about the social environment of a setting is relevant to prospective members of that environment. Informed students will be better prepared for entry into the new setting and culture, easing the adaptation process. Moos (1979b) says that the reduction of discrepant perspectives and expectations has been shown to enhance successful adaptation in the new environment and this seems likely to be the case in the computing milieu.

Provide a flexible but structured approach to assessment. Students found the rather casual learning environment very acceptable, but many students preferred more structure in assessment, such as milestone dates for the completion of components of a major assignment. If lecturers see value in a large assessment, then break down assignments into smaller chunks where feedback can be given before the student proceeds to the next section. Another area that could be improved is the setting of programming assignments that are more realistic to the "real world" and can be completed within a reasonable time frame. The Carnegie Mellon University researchers found that women were more interested in the *uses* of computing, contextualizing their interest in computers in fields such as medicine, space, or the arts (Margolis et al., 2001). Students are more likely to be motivated in programming classes when they see the applicability of assessments in work situations.

An awareness of favouritism and equity of learning. To avoid favouring particular student(s), developing an awareness of the amount of time lecturers spend with individuals will ensure there is equity of opportunity for interaction with the lecturer. Another measure to provide an equitable learning environment is to check students' extant knowledge before introducing new concepts. This will avoid lecturers making assumptions of prior knowledge when teaching introductory programming classes with no explicit pre-requisite requirements.

Relate structured and purposeful lectures to the practical laboratory work. Students indicated that they found lectures to be more relevant and worthwhile when key concepts were introduced and then implemented in the following practical laboratory sessions. Learning through doing and making one's own mistakes is valuable and a greater proportion of programming teaching time should be laboratory-oriented rather than lecture-oriented.

Use resources innovatively and appropriately. Students suggested improvements could be made by using multi-media resources and accessing web-based programs, thus providing them with additional sources of reference and programming examples. Handouts were also suggested as ways of providing extension as well as remedial work. Students indicated that they appreciated textbooks and teaching that promoted problem-solving, creativity and the promotion of conceptual understanding. They found the "step-by-step" teaching texts unsatisfactory "because you didn't have to think". Teachers who carefully select a broad and appropriate range of teaching materials will more likely meet the needs of students who have a diverse range of abilities and learning styles. Both lecturers and students preferred the highly-personalised environment facilitated by teaching in the smaller seminar-type classrooms and where this is administratively possible, teaching to smaller groups should be implemented.

The recommendations for a more inclusive learning environment were based on the findings from student and lecturer data. Institutional policies provide the framework within which lecturers work and if both administrators and teachers examine their current practices and identify areas for change it will be possible to provide a more equitable programming learning environment.

Objective 5: Examine the Use of the CUCEI as an Instrument to Explore Perceptions of the Tertiary Learning Environment

Unfortunately, the statistical performance of the CUCEI was poor. Scale item and principal component analyses showed initial unsatisfactory and disappointing results. It was only after quite drastic modification of the CUCEI that the questionnaire had acceptable reliability and discriminant validity for this research. There were high inter-correlations between some of the Actual scales and some of the Preferred scales indicating that these scales were not as independent as might have been hoped.

One reason for the poor performance of the CUCEI is likely to be the apparent inappropriateness of some of the item statements. The CUCEI was chosen because it was reported as having been used successfully in tertiary environments. However, different disciplines or sub-disciplines have different cultures thus influencing the environment and it is suggested that some items of the CUCEI may not be suited to the computer programming environment. For instance, many of the Task Orientation items were inappropriate for the programming classes where conventional class "control", teaching delivery and time-keeping conventions were not applicable. The lecturer was an advisor and facilitator, who adopted an egalitarian attitude towards students. It is recommended that careful examination of item content and how it relates to the discipline to which it is being applied be made prior to administering the CUCEI.

The CUCEI has 49 items for the Actual Version and 49 for the Preferred Version. Some students made adverse comments about the perceived repetitiveness of the seven items of each scale and some found difficulty in distinguishing the Actual Version items from the Preferred Version items. Students regard their time as valuable and therefore items need to be perceived by students as important and relevant if they are to answer in a thoughtful and careful manner. Students also resented the length of time needed to complete the instrument. It may be possible to construct a shorter scale, using only the items with best properties. Testing of the new revised form would be required. A revised, shorter CUCEI may find greater acceptance by students, making them more inclined to respond to the statements in a truthful and considered manner.

The five-point response format of “Almost Never” to “Almost Always” was not always appropriate for the item statements. For example, for the Innovation Scale, Item 10 states: “The instructor thinks up innovative activities for me to do”. If a student selected the “Almost Always” option, does this suggest a positive response? It is unlikely that students are “Almost Always” wanting to do different and innovative activities as there is value in routine and repetition. In addition, there are limited activities that students can do in programming classes when the goal is to learn design and syntax in order to write working programs.

There are 14 negatively-worded statements in the 49 items of the CUCEI which are reverse scored. Some students were confused as to the meaning of the statements when they tried to select a response choice. It is suggested that items be reviewed to check that the response format is appropriate and the negatively-worded statements be changed to match the tone of the other items.

The importance of checking the CUCEI’s psychometric properties before using the scales as published has been demonstrated in this study. Despite the difficulties, however, results from the application of the CUCEI did provide a framework for interview questions and the interpretive analysis of the social climate of the programming learning environment. The study would have been very limited if only the CUCEI had been used. The interviews were an essential data source that enabled the issues that students thought were important to be exposed. Without the interviews the dominance and breadth of equity issues would have remained hidden as these were not reflected in the CUCEI’s results.

Limitations of the Study

This study provided first-year programming students' perceptions of their learning environment but there were several limitations in terms of the nature of the samples and their representativeness. First, data were collected from students enrolled in first-year information systems programming courses at two polytechnics and one ex-polytechnic (now a university) within one region of New Zealand. Generalisation of the results to computer science students enrolled at a long-established university, albeit within the same region, may be limited because of the different institutional contexts and learning environments. Further, the results here refer only to classes in computer programming, not to other aspects of computer science or information systems.

Although the qualitative data provided valuable insights to the students' perceptions of their learning environment, the numbers within each subgroup were small and therefore the comments may not be widely representative of the larger general subgroup population. A broader representation was attempted through the survey but due to erratic student attendance this reduced the final sample that did both the Actual and Preferred Versions of the CUCEI. As previously mentioned, the CUCEI provided rather limited findings, detecting no statistically significant differences between subgroups.

The number of lecturers who participated in this study was small. Most of the programming was taught by one lecturer at Institution B, one at Institution C and two at Institution A. The qualitative data indicate their perceptions but the sample is too small to be assured of generalisability to other lecturers.

The mixed-method design involved three sources of data that revealed different aspects and perceptions. The CUCEI provided a framework and a broad overview of how the programming students experienced their learning environment. The questionnaire provided data for statistical assessment of the probability with which the sample's pattern of responses to the CUCEI statements would be reproduced in similar proportions if a survey was conducted of the whole population. However as discussed in an earlier section, results from the CUCEI were not sufficient, by themselves, to address the research objectives adequately. The qualitative data therefore formed an important component of this study. The interview data identified themes not covered by the Scales of the CUCEI and observation data provided the contextual understanding. The use of the qualitative data enabled the students' voices to be heard and when blended and integrated with data from the CUCEI provided a more comprehensive understanding of the programming learning environment.

Implications for Further Research

This research examined programming students' perceptions of their learning environment using a survey instrument, interview and observational data. The findings suggest that while the CUCEI provided a framework to measure important dimensions of the learning environment, the interviews provided a much broader view of how students perceived their environment. A number of suggestions follow for future research in this area.

First, similar research should use a mixed-method design with a qualitative component that allows participants freedom to express what they see as important and provide meaningful, insightful data. Of course some studies may have research questions that require large-scale surveys, but as this study shows, researchers need to be aware that questionnaires can provide information relating only to the items on the instrument.

Second, conduct comparative studies of programming students' perceptions of their computing learning environment as they are experienced within different institutional contexts (for example computer science and information systems). This research could identify institutional characteristics and practices that students perceive as conducive to their learning and that are found to be influential in attracting and retaining female students.

Third, it is important to conduct additional studies of students' perceptions attending institutions where changes in teaching practices have been made to improve the learning environment. A study which addressed recruitment and retention of women in an introductory computer science course for intending majors of one New Zealand institution found the relationship between recruitment practices and the impact on participation and retention rates for women was uncertain (Gale et al., 1997). An American study of the participation of women at Carnegie Mellon University found that over five years of specific efforts aimed at bringing more women into its undergraduate computer science program, the percentage of women in the entering class had increased five-fold (Blum, 2001). The different results from the two studies highlight the need for further investigation of what works and whether first-year students' perceptions differ because of national differences that impact on the learning environment.

Fourth, further research is needed to investigate the positive and negative consequences of the impact on the learning environment of the large numbers of new arrival students who are enrolling in computing programmes. While research has identified issues that new arrival students face when learning in a new country there have been no studies that explicitly examine the impact of these students on the learning environment of the host institutions, or the effect on domestic students (Ward, 2001). As the internationalisation of education continues to be promoted within New Zealand there is an increasing need for research in this area. For example, the effectiveness of current and new institutional support programmes for new arrival students should be evaluated so that an optimum learning experience can be provided that meets the needs of this student subgroup.

Finally, given the experience and lessons learned from using the CUCEI with programming tertiary students, researchers interested in investigating computing students' perceptions of their learning environments are advised to consider a number of factors before committing to the use of this instrument, or another "off-the-shelf" questionnaire. The literature supports the contention that the strength of the computing culture differs according to the context within which computing is taught (McLennan et al., 1999; Sproull et al., 1986) and that different disciplines and sub-disciplines have specific attributes. For example, chemistry is distinct from physics, biochemistry is distinct from chemistry and therefore the nature of the learning environment is different (Byrne, 1993). Byrne (1993) argues that diagnosis of the low female participation and access to science should be focused on specific disciplines and it is suggested that this distinction needs to be made for the assessment of perceptions of students studying computing. The computer culture is well documented as existing in computer science departments (Bernstein, 1999; Grundy, 1996; Margolis & Fisher, 2002; Sproull et al., 1987) but does not appear to be as strong or as alienating in information systems departments (McLennan et al., 1999). Moos (1979) contends that all social environments have common dimensions which can be measured but the subtleties and idiosyncrasies which distinguish the computer science computing culture from that existing within an information systems milieu needs a specifically designed instrument. For researchers interested in using a survey instrument that matches the environment under study, the CUCEI, in its current form, would appear to be unsatisfactory. The nature of survey response formats constrains students' responses. For a broader understanding of what students think, qualitative methods such as focus groups and open-ended interviews are more effective tools.

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Appendix 2A

College and University Classroom Environment Inventory (CUCEI)

Personalised Form

Student Actual Version

Directions

This questionnaire contains statements about practices which could take place in this class. You will be asked how often each practice takes place. There are no **'right' or 'wrong'** answers. Your opinion is what is wanted. Think about how well each statement describes what this class is like for you.

Draw a circle around

1	if the practice takes place	**Almost Never**
2	if the practice takes place	**Seldom**
3	if the practice takes place	**Sometimes**
4	if the practice takes place	**Often**
5	if the practice takes place	**Almost Always**

Be sure to give an answer for all questions. If you change your mind about an answer just cross it out and circle another.

Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Statistical Information

Please circle or enter the appropriate response.

Class: CBC DipBC Degree Sex: Male Female

Age: …………………..

In what country have you spent most of your life? …………………………

How long have you lived in New Zealand? …………………………………

	Remember that you are describing your **actual** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
1	The instructor considers my feelings.	1	2	3	4	5
2	The instructor is friendly and talks to me.	1	2	3	4	5
3	The instructor goes out of his/her way to help me.	1	2	3	4	5
4	The instructor helps me when I am having trouble with my work.	1	2	3	4	5
5	The instructor moves around the classroom to talk with me.	1	2	3	4	5
6	The instructor is interested in my problems.	1	2	3	4	5
7	The instructor is unfriendly and inconsiderate towards me.	1	2	3	4	5
8	New ideas are seldom tried out in this class.	1	2	3	4	5
9	My instructor uses new and different ways of teaching in this class.	1	2	3	4	5
10	The instructor thinks up innovative activities for me to do.	1	2	3	4	5
11	The teaching approaches used in this class are characterized by innovation and variety.	1	2	3	4	5
12	Seating in this class is arranged in the same way each week.	1	2	3	4	5
13	The instructor often thinks of unusual activities.	1	2	3	4	5
14	I seem to do the same type of activities in every class.	1	2	3	4	5
15	My class is made up of individuals who don't know each other well.	1	2	3	4	5
16	I know most students in this class by their first names.	1	2	3	4	5
17	I make friends easily in this class.	1	2	3	4	5
18	I don't get much of a chance to know my classmates.	1	2	3	4	5
19	It takes me a long time to get to know everybody by his/her first name in this class.	1	2	3	4	5
20	I have the chance to know my classmates well.	1	2	3	4	5
21	I am not very interested in getting to know other students in this class.	1	2	3	4	5

	*Remember that you are describing your **actual** classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
22	I know exactly what had to be done in the class	1	2	3	4	5
23	Getting a certain amount of work done is important in the class	1	2	3	4	5
24	I often get sidetracked in this class instead of sticking to the point.	1	2	3	4	5
25	This class is always disorganised.	1	2	3	4	5
26	Class assignments are clear and I know what to do.	1	2	3	4	5
27	This class seldom starts on time.	1	2	3	4	5
28	Activities in this class are clearly & carefully planned.	1	2	3	4	5
29	I cooperate with other students when doing assignment work.	1	2	3	4	5
30	I share my books and resources with other students when doing assignments.	1	2	3	4	5
31	I work with other students on projects in this class.	1	2	3	4	5
32	I learn from other students in this class.	1	2	3	4	5
33	I work with other students in this class.	1	2	3	4	5
34	I cooperate with other students on class activities.	1	2	3	4	5
35	Students work with me to achieve class goals.	1	2	3	4	5
36	I am expected to do the same work as all the students in the class, in the same way and in the same time.	1	2	3	4	5
37	I am generally allowed to work at my own pace in this class.	1	2	3	4	5
38	I have a say in how class time is spent.	1	2	3	4	5
39	I am allowed to choose activities and how I will work.	1	2	3	4	5
40	Teaching approaches in this class allow me to proceed at my own pace.	1	2	3	4	5
41	I have little opportunity to pursue my particular interests in this class.	1	2	3	4	5
42	My instructor decides what I will do in this class.	1	2	3	4	5
43	The instructor gives as much attention to my questions as to other students questions.	1	2	3	4	5
44	I get the same amount of help from the instructor as do other students.	1	2	3	4	5
45	I am treated the same as other students in this class.	1	2	3	4	5
46	I receive the same encouragement from the instructor as other students do.	1	2	3	4	5
47	I get the same opportunity to answer questions as other students.	1	2	3	4	5
48	My work receives as much praise as other students work.	1	2	3	4	5
49	I have the same amount of say in this class as other students.	1	2	3	4	5

Thank you for your time and cooperation

Appendix 2B

College and University Classroom Environment Inventory (CUCEI)

Personalised Form

Student Preferred Version

Directions

This questionnaire contains statements about practices which could take place in this class. You will be asked how well each statement describes what you would *like* or *prefer* your class to be like. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

Think about how well each statement describes what you would prefer this class to be like.

Draw a circle around

1	if you would prefer the practice to take place	**Almost Never**
2	if you would prefer the practice to take place	**Seldom**
3	if you would prefer the practice to take place	**Sometimes**
4	if you would prefer the practice to take place	**Often**
5	if you would prefer the practice to take place	**Almost Always**

Be sure to give an answer for all questions. If you change your mind about an answer just cross it out and circle another.

Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Statistical Information

Please circle or enter the appropriate response.

Class: CBC DipBC. Degree Sex: Male Female

Age: ………….

In what country have you spent most of your life? …………………………...

How long have you lived in New Zealand? …………………………………..

	Remember that you are describing your **ideal** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
1	The instructor would consider my feelings.	1	2	3	4	5
2	The instructor would be friendly and would talk to me.	1	2	3	4	5
3	The instructor would go out of his/her way to help me.	1	2	3	4	5
4	The instructor would help me when I am having trouble with my work	1	2	3	4	5
5	The instructor would move around the classroom to talk with me.	1	2	3	4	5
6	The instructor would be interested in my problems.	1	2	3	4	5
7	The instructor would be unfriendly and inconsiderate towards me.	1	2	3	4	5
8	New ideas would be seldom tried out in the class	1	2	3	4	5
9	My instructor would use new and different ways of teaching in the class.	1	2	3	4	5
10	The instructor would think up innovative activities for me to do.	1	2	3	4	5
11	The teaching approaches used in the class would be characterized by innovation and variety.	1	2	3	4	5
12	Seating in the class would be arranged in the same way each week.	1	2	3	4	5
13	The instructor would often think of unusual activities	1	2	3	4	5
14	1 would do the same type of activities in every class.	1	2	3	4	5
15	My class would be made up of individuals who did not know each other well.	1	2	3	4	5
17	I would make friends easily in the class.	1	2	3	4	5
18	I would not get much of a chance to know my classmates.	1	2	3	4	5
19	I would take a long time to get to know everyone in my class by his/her first name in the class.	1	2	3	4	5
20	I would have the chance to know my classmates well.	1	2	3	4	5
21	I would not be very interested in getting to know other students in the class.	1	2	3	4	5

	Remember that you are describing your **ideal** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
22	I would know exactly what had to be done in the class.	1	2	3	4	5
23	Getting a certain amount of work done would be important in the class.	1	2	3	4	5
24	I would often get sidetracked in the class instead of sticking to the point	1	2	3	4	5
25	The class would be always disorganized.	1	2	3	4	5
26	Class assignments would be clear and I would know what to do.	1	2	3	4	5
27	The class would seldom start on time	1	2	3	4	5
28	Activities in the class would be clearly & carefully planned.	1	2	3	4	5
29	I would cooperate with other students in my class when doing assignment work.	1	2	3	4	5
30	I would share my books and resources with other students when doing assignments	1	2	3	4	5
31	I would work with other students on projects in the class.	1	2	3	4	5
32	I would learn from other students in the class.	1	2	3	4	5
33	I would work with other students in the class	1	2	3	4	5
34	I would cooperate with other students in my class on class activities	1	2	3	4	5
35	Students would work with me to achieve class goals	1	2	3	4	5
36	I would be expected to do the same work as all the students in the class, in the same way and in the same time.	1	2	3	4	5
37	I would generally be allowed to work at my own pace in the class.	1	2	3	4	5
38	I would have a say in how class time is spent.	1	2	3	4	5
39	I would be allowed to choose activities and how I would work.	1	2	3	4	5
40	Teaching approaches in this class would allow me to proceed at my own place	1	2	3	4	5
41	I would have little opportunity to pursue my particular interests in the class	1	2	3	4	5
42	My instructor decides what I would do in this class.	1	2	3	4	5
43	The instructor would give as much attention to my questions as to other students' questions.	1	2	3	4	5
44	I would get the same amount of help from the instructor as do other students.	1	2	3	4	5
45	I would be treated the same as other students in the class	1	2	3	4	5
46	I would receive the same encouragement from the instructor as other students do.	1	2	3	4	5
47	I would get the same opportunity to answer questions as other students do.	1	2	3	4	5
48	My work would receive as much praise as other students work.	1	2	3	4	5
49	I would have the same amount of say in the class as other students.	1	2	3	4	5

Thank you for your time and cooperation

Appendix 2C

College and University Classroom Environment Inventory (CUCEI)

Personalised Form

Instructor Actual Version

Directions

This questionnaire contains statements about practices which take place in this class. You will be asked how well each statement describes what you think your class to be like. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

Draw a circle around

1	if the practice takes place	**Almost Never**
2	if the practice takes place	**Seldom**
3	if the practice takes place	**Sometimes**
4	if the practice takes place	**Often**
5	if the practice takes place	**Almost Always**

Be sure to give an answer for all questions. If you change your mind about an answer just cross it out and circle another.

Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Statistical Information

Lecturer's Name: ……………………… Class: Degree DipBC CBC

Sex: Male Female Age: ……………

	Remember that you are describing your **actual** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
1	I consider my students feelings.	1	2	3	4	5
2	I am friendly towards my students and talk to them.	1	2	3	4	5
3	I go out of my way to help my students.	1	2	3	4	5
4	I help my students when they have trouble with their work.	1	2	3	4	5
5	I seldom move around the classroom to talk with my students.	1	2	3	4	5
6	I am interested in my students problem.	1	2	3	4	5
7	I am unfriendly and inconsiderate towards my students.	1	2	3	4	5
8	I seldom try out new ideas in this class.	1	2	3	4	5
9	I seldom use new and different ways of teaching in this class.	1	2	3	4	5
10	I think up innovative activities for students to do.	1	2	3	4	5
11	The teaching approaches I use in this class are characterized by innovation and variety.	1	2	3	4	5
12	Seating in this class is arranged in the same way each week.	1	2	3	4	5
13	I often think of unusual activities in this class	1	2	3	4	5
14	I seem to have the same type of activities in every class.	1	2	3	4	5
15	My class is made up of individuals who don't know each other well.	1	2	3	4	5
16	Students in my class know one another by their first names.	1	2	3	4	5
17	Students make friends easily in my class.	1	2	3	4	5
18	Students in my class don't get much of a chance to know their classmates.	1	2	3	4	5
19	Students in my class take a long time to get to know everybody by his/her first name in this class.	1	2	3	4	5
20	Students in my class have the chance to know their classmates well.	1	2	3	4	5
21	Students in my class are not very interested in getting to know all their classmates.	1	2	3	4	5
22	Students in my class know exactly what has to be done in this class.	1	2	3	4	5
23	Students find getting a certain amount of work done is important in this class.	1	2	3	4	5
24	Students often get sidetracked in this class instead of sticking to the point.	1	2	3	4	5
25	My class is always disorganised.	1	2	3	4	5
26	My class assignments are clear and my students know what to do.	1	2	3	4	5
27	My class seldom starts on time.	1	2	3	4	5
28	I plan the activities in this class, clearly & carefully.	1	2	3	4	5

Please Turn Over

	Remember that you are describing your **actual** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
29	Students in my class cooperate with each other when doing assignment work.	1	2	3	4	5
30	Students in this class share their books and resources with other students when doing assignments.	1	2	3	4	5
31	Students work with other students on projects in this class.	1	2	3	4	5
32	Students in my class learn from each other in this class.	1	2	3	4	5
33	Each student works with other students in this class.	1	2	3	4	5
34	Students in this class cooperate on class activities.	1	2	3	4	5
35	Students work with each other to achieve class goals.	1	2	3	4	5
36	I expect all my students in the class to do the same work, in the same way and in the same time.	1	2	3	4	5
37	I generally allow my students to work at their own pace in this class.	1	2	3	4	5
38	Students in this class have a say in how class time is spent.	1	2	3	4	5
39	I allow my students to choose activities and how they will work.	1	2	3	4	5
40	The teaching approaches I use in this class allow my students to proceed at their own pace.	1	2	3	4	5
41	Students in my class have little opportunity to pursue their particular interests in this class.	1	2	3	4	5
42	I decide what will be done in this class.	1	2	3	4	5
43	I give equal attention to all the students questions.	1	2	3	4	5
44	I give the same amount of help to all my students.	1	2	3	4	5
45	I treat all students in this class the same.	1	2	3	4	5
46	I give the same encouragement to all my students.	1	2	3	4	5
47	All my students get the same opportunity to answer questions.	1	2	3	4	5
48	I give equal praise to all my students when required.	1	2	3	4	5
49	All my students have the same amount of say in this class.	1	2	3	4	5

Thank you for your time and cooperation

Appendix 2D

College and University Classroom Environment Inventory (CUCEI)

Personalised Form

Instructor Preferred Version

Directions

This questionnaire contains statements about practices which could take place in this class. You will be asked how well each statement describes what you would *like* or *prefer* your class to be like. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Think about how well each statement describes what you would prefer this class to be like.

Draw a circle around

1	if you would prefer the practice to take place	**Almost Never**
2	if you would prefer the practice to take place	**Seldom**
3	if you would prefer the practice to take place	**Sometimes**
4	if you would prefer the practice to take place	**Often**
5	if you would prefer the practice to take place	**Almost Always**

Be sure to give an answer for all questions. If you change your mind about an answer just cross it out and circle another.

Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Statistical Information

Lecturer's Name: ………………………………………

Class: Degree DipBC CBC

Sex: Male Female *Age*: ……………..

	Remember that you are describing your **ideal** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
1	I would consider my students' feelings	1	2	3	4	5
2	I would be friendly towards my students and talk to them	1	2	3	4	5
3	I would go out of my way to help my students	1	2	3	4	5
4	I would help my students when they have trouble with their work	1	2	3	4	5
5	I would move around the classroom to talk with my students	1	2	3	4	5
6	I would be interested in my students problems	1	2	3	4	5
7	I would be unfriendly and inconsiderate towards my students.	1	2	3	4	5
8	I would seldom try out new ideas in the class	1	2	3	4	5
9	I would seldom use new and different ways of teaching in the class.	1	2	3	4	5
10	I would think up innovative activities for students to do.	1	2	3	4	5
11	The teaching approaches I would use in the class would be	1	2	3	4	5
	characterised by innovation and variety.	1	2	3	4	5
12	Seating in this class would be arranged in the same way each week.	1	2	3	4	5
13	I would often think of unusual activities in this class	1	2	3	4	5
14	I would have the same type of activities in every class.	1	2	3	4	5
15	My class is made up of individuals who would not know each other well	1	2	3	4	5
16	Students in my class would know one another by their first names	1	2	3	4	5
17	Students would make friends easily in my class	1	2	3	4	5
18	Students in my class would not get much of a chance to know their classmates	1	2	3	4	5
19	Students in my class would take a long time to get to know everybody by his/her first name	1	2	3	4	5
20	Students in my class would have the chance to know their classmates well	1	2	3	4	5
21	Students in my class would not be very interested in getting to know all their classmates.	1	2	3	4	5

Please Turn Over

	Remember that you are describing your **ideal** *classroom*	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
22	Students in my class would know exactly what has to be done in this class	1	2	3	4	5
23	Students would find getting a certain amount of work done is important in this class.	1	2	3	4	5
24	Students would often get sidetracked in this class instead of sticking to the point.	1	2	3	4	5
25	My class would always be disorganised.		2	3	4	5
26	My class assignments would be clear and my students would know what to do.	1	2	3	4	5
27	My class would seldom start on time	1	2	3	4	5
28	I would plan the activities in the class, clearly & carefully	1	2	3	4	5
29	Students in my class would cooperate with each other when doing assignment work.	1	2	3	4	5
30	Students in my class would share books and resources with other students when doing assignments.	1	2	3	4	5
31	Students would work with other students on projects in this class.	1	2	3	4	5
32	Students in my class would learn from each other.	1	2	3	4	5
33	Each student would work with other students in the class	1	2	3	4	5
34	Students in the class would cooperate on class activities	1	2	3	4	5
35	Students would work with each other to achieve class goals	1	2	3	4	5
36	I would expect all my students in the class to do the same work, in the same way and in the same time.	1	2	3	4	5
37	I would generally allow my students to work at their own pace in this class	1	2	3	4	5
38	Students in this class would have a say in how class time is spent.	1	2	3	4	5
39	I would allow my students to choose activities and how they will work	1	2	3	4	5
40	The teaching approaches I use in this class would allow my students to proceed at their own pace.	1	2	3	4	5
41	Students in my class would have little opportunity to pursue their particular interests in this class.	1	2	3	4	5
42	I would decide what will be done in this class.	1	2	3	4	5
43	I would give equal attention to all the students questions	1	2	3	4	5
44	I would give the same amount of help to all my students.	1	2	3	4	5
45	I would treat all students in this class the same.	1	2	3	4	5
46	I would give the same encouragement to all my students	1	2	3	4	5
47	All my students would get the same opportunity to answer questions.	1	2	3	4	5
48	I would give equal praise to all my students when required.	1	2	3	4	5
49	All my students would have the same amount of say in the class	1	2	3	4	5

Thank you for your time and cooperation

Appendix 3A

Consent Form

CONSENT TO PARTICIPATE IN A RESEARCH PROJECT
CONFIDENTIAL

Title of Research Project:	First-Year Programming Students' Perceptions of their Tertiary Learning Environment
Name of Researcher:	Barbara Crump Doctoral Student Science Mathematics and Technology Education Centre Curtin University Perth, Australia

PARTICIPANT:
I have read the covering letter and understand it. I have the opportunity to ask questions. I understand that at my request I will receive feedback on the outcome of the research at its conclusion. I understand that the questionnaire will be retained for five years (as required by university regulations) and will be held securely throughout the research period.

I understand that the published results of this research project will not identify me personally and that any data I may provide towards this project will be dealt with in the strictest confidence.

I understand that I may withdraw myself or any information I have provided from this project before data collection is completed, without having to give reasons and without penalty of any sort.

I consent to take part in this research project having received details of the research, what my participation will involve and an explanation of how the published results will be used.

Signed: …………………………………………..

Name of Participant: …………………………………………..

RESEARCHER:
The participant has received details of the research, what their participation will involve and an explanation of how the published results will be used. I have provided a contact telephone number should the participant require further information.

Signed: ……………………………………….

Appendix 3B

Students' Interview Questionnaire

1 How do you find programming? Shall we start with what's good about it?
(Issues to prompt on: creativity; what's satisfying/interesting; teacher-student relationships; student-student relationships)

2 What's bad about it?
Workload; inflexibility?

3 How do you like to solve programming problems?
C*ollaboratively vs on your own; just going for it/trying it vs carefully planning a strategy?*

4 Do you think this is the way **most students** like to work in programming?

5 Are you generally satisfied with the work and assignments you have to do?
Innovation/Task Orientation

6 Do you think most students get a fair go with their learning?
Equity

7 Some people think **men** have an easier time learning programming. What do you think?

8 Some people think **women** have an easier time learning programming. What do you think?
Minority status affecting you?

9 What do you think of the way programming is taught; for instance the mix of lecture and laboratory work?
(innovation - "new ideas seldom tried out in class"; "… new & different ways of teaching .."; …"unusual activities"

10 How would you like to see it taught?

11 Some people think you have to be good at maths to programme. How do you feel about this?

12 Is there anything else?

13 ***FOR WOMEN***: How do you feel about being the minority gender in your classroom?

INTERNATIONAL STUDENTS

As above and

14 As people who haven't been in NZ for very long, do you see any differences in the teaching here?
(rote learning - surface/deep learning).

15 Some international students tell me NZ classrooms are much noisier than their home country classrooms. What do you think?

Does this affect how you work? How you learn?

16 I know many of you are the only ones from your country in the classroom. How do you feel about that?
(minority status/critical mass; personalisation, cohesiveness and cooperation)

17 Have people treated you differently because you're from another country? (how?)
(*racism*)

18 Is there anything else?

Appendix 3C

Lecturers' Interview Questionnaire

1. What was the initial enrolment number for all first-year programming students in your institution?

2. How many students will complete this year?

3. What are the numbers of international students/new arrivals and the numbers of male and female students?

4. Would students of this institution get the same sort of first-year programming basics as at other Wellington institutions?

5. Do you notice any differences between males and females in their approach to learning programming?

6. Some people say that girls have a harder time learning programming. What do you think?

7. How has the increasing numbers of foreign students (new arrivals) attending your classes affected your teaching?

8. What sort of control/direction do you exercise in managing a class, lecture or laboratory?

9. I know you probably have restraints on how you deliver your programming teaching. How would you like to see programming taught?

10. Is there anything else you'd like to say?

Appendix 3D

Participant Information Sheet

Curtin University of Technology
Perth, Australia

Science and Mathematics Education Centre
National Key Centre for School Science and Mathematics

Dear Participant

I am currently conducting research in the Wellington region for my doctorate on first-year programming students. The purpose of this research project is to gain an in-depth understanding of students' perceptions of their tertiary learning environment. This will be done through analysing a questionnaire, interviewing students and lecturers as well as observation of classes.

The key objectives are to:

- contribute to the broader theoretical literature of classroom environments,
- investigate how student subgroups defined by gender and as 'new arrivals' differ in their perceptions of their programming learning environment,
- investigate lecturers' perceptions of their programming classroom learning environment,
- make recommendations, where appropriate, to assist lecturers to make the learning environment more inclusive for all participants, and
- examine the use of the CUCEI as an instrument to explore perceptions of the tertiary learning environment.

Attached is a questionnaire asking you to describe your *actual* classroom environment as you experience it. I hope that you will be willing to participate in this study by completing the attached questionnaire.

I can assure you that your feedback will remain confidential and data from the questionnaire will be used in a purely analytical framework. Results will be used as a basis for my doctorate. The doctoral thesis is a public document and once completed, will be deposited in the University Library. Conference papers and journal articles will also be published from the research.

If you agree to participate, please sign the attached consent form and complete the questionnaire. If you would like a summary of the findings from the questionnaire or have further questions regarding the research please email me at B.J.Crump@massey.ac.nz or phone me on 04 801 2794 extension 6881 (work).

Thank you for your help,

Barbara Crump
Doctoral Student
Curtin University Perth, Australia

Appendix 3E

Student And Lecturer Interview Categories And Themes

Categories and Themes for Student Interviews

1 Personalisation
- (a) Approachable, helpful and responsive
- (b) Able to explain
- (c) Accessibility

2 Innovation
- (a) Lectures
- (b) Practical laboratory sessions
- (c) Assessments
- (d) Resources and teaching approaches

3 Student Cohesion and Cooperation
- (a) Language
- (b) Lack of family and financial support
- (c) Maturity

4 Individualisation
- (a) Freedom
- (b) Individual responsiveness

5 Equity
- (a) Students are treated equally by the teacher
- (b) Favouritism
- (c) Teachers' assumptions of prior knowledge
- (d) Institutional support and enrolment policy
- (e) Racism
- (f) Being a minority
- (g) Student attitude

Categories and Themes for Lecturer Interviews

1 Reflections on Teaching Programming
- (a) The physical teaching environment
- (b) Establishing a physical distance from the personal computers

2 Class Management
- (a) A structured environment with freedom
- (b) A sensitive, reflective awareness

3 Attitudes and Application

- (a) Caution and recklessness
- (b) Perseverance
- (c) Aptitude and motivation
- (d) Group work
- (e) Self-efficacy

4 Maths and Programming

5 Institutional Policy and Enrolment

Appendix 4A

Percentage Responses to Scale Items for the Actual Version of the CUCEI

Scale and Items		*n*	% Responses 1[a]	2[b]	3[c]	4[d]	5[e]	Mean	*SD*
Personalisation									
A1	The instructor considers my feelings.	172	7.6	12.8	37.2	29.1	13.4	3.28	1.09
A2	The instructor is friendly and talks to me.	184	2.2	5.4	23.4	41.8	27.2	3.86	0.95
A3	The instructor goes out of his/her way to help me.	183	4.4	8.7	29.0	35.5	22.4	3.63	1.06
A4	The instructor helps me when I am having trouble with my work.	182	1.6	4.9	23.1	36.8	33.5	3.96	0.96
A5	The instructor moves around the classroom to talk with me.	182	7.1	12.6	23.6	36.8	25.8	3.55	1.21
A6	The instructor is interested in my problems.	181	3.9	9.9	29.3	38.1	18.8	3.58	1.03
A7	The instructor is unfriendly and inconsiderate towards me.	180	1.1	5.6	4.4	15.6	73.3	4.54	0.90
Innovation									
A8	New ideas are seldom tried out in this class.	181	8.3	18.8	39.2	21.5	12.2	3.10	1.10
A9	My instructor uses new and different ways of teaching in this class.	181	8.3	26.5	45.9	17.1	2.2	1.78	.90
A10	The instructor thinks up innovative activities for me to do.	180	9.4	26.1	40.6	17.8	6.1	2.85	1.02
A11	The teaching approaches used in this class are characterized by innovation and variety.	181	8.3	26.5	40.3	22.7	2.2	2.84	.94
A12	Seating in this class is arranged in the same way each week.	184	40.8	19.0	7.1	11.4	21.7	2.54	1.62
A13	The instructor often thinks of unusual activities.	180	20.6	41.7	25.6	7.8	4.4	2.34	1.03
A14	I seem to do the same type of activities in every class.	183	10.9	23.5	34.4	20.8	10.4	2.96	1.14
Student Cohesion									
A15	My class is made up of individuals who don't know each other well.	181	5.0	12.2	27.1	29.8	26.0	3.60	1.14
A16	I know most students in this class by their first names.	184	5.4	10.3	14.1	25.0	45.1	3.94	1.22
A17	I make friends easily in this class.	182	.50	6.6	30.8	35.2	26.9	3.81	.93
A18	I don't get much of a chance to know my classmates.	183	2.6	13.1	24.0	35.0	26.2	3.71	1.05
A18	It takes me a long time to get to know everybody by his/her first name in this class.	183	1.6	13.1	24.0	35.0	26.2	3.71	1.05
A20	I have the chance to know my classmates well.	181	6.1	17.1	26.5	29.8	20.4	3.41	1.17
A21	I am not very interested in getting to know other students in this class.	183	4.4	16.4	32.2	28.4	18.6	3.40	1.10
Task Orientation									
A22	I know exactly what has to be done in the class	184	2.7	3.8	33.2	46.2	14.1	3.65	.87
A23	Getting a certain amount of work done is important in the class	183	1.6	4.9	14.8	44.3	34.4	4.05	.92
A24	I often get sidetracked in this class instead of sticking to the point.	181	6.1	24.3	39.2	19.3	11.0	3.05	1.06
A25	This class is always disorganised.	183	2.7	9.3	14.2	44.8	29.0	3.88	1.02
A26	Class assignments are clear and I know what to do.	183	5.5	12.6	27.3	36.1	18.6	3.50	1.10
A27	This class seldom starts on time.	180	12.8	15.6	21.1	35.6	15.0	3.24	1.25
A28	Activities in this class are clearly & carefully planned.	183	.5	9.8	27.3	45.4	16.9	3.68	.89

Cooperation									
A29	I cooperate with other students when doing assignment work.	184	3.8	3.3	22.3	38.0	32.6	3.92	1.01
A30	I share my books and resources with other students when doing assignments.	184	3.3	6.5	24.5	35.3	30.4	3.83	1.04
A31	I work with other students on projects in this class.	184	4.3	10.3	20.7	38.6	26.1	3.72	1.09
A32	I learn from other students in this class.	183	3.3	6.6	19.7	39.9	30.6	3.88	1.03
A33	I work with other students in this class.	181	2.8	6.6	22.7	40.9	27.1	3.83	.99
A34	I cooperate with other students on class activities.	183	2.7	2.7	18.6	43.7	32.2	4.00	.93
A35	Students work with me to achieve class goals.	182	6.0	6.6	25.3	37.9	24.2	3.68	1.10
Individualisation									
A36	I am expected to do the same work as all the students in the class, in the same way and in the same time.	183	37.2	31.7	18.0	10.4	2.7	2.10	1.10
A37	I am generally allowed to work at my own pace in this class.	184	5.4	12.5	25.0	33.2	23.9	3.58	1.14
A38	I have a say in how class time is spent.	180	21.7	35.0	26.1	12.1	5.0	2.44	1.11
A39	I am allowed to choose activities and how I will work.	177	18.6	29.4	28.2	19.2	4.5	2.62	1.13
A40	Teaching approaches in this class allow me to proceed at my own pace.	181	8.8	13.3	35.9	30.4	11.6	3.23	1.10
A41	I have little opportunity to pursue my particular interests in this class.	180	3.9	16.1	38.3	31.1	10.6	3.28	.99
A42	My instructor decides what I will do in this class.	182	23.6	30.8	30.8	7.1	7.7	2.45	1.15
Equity									
A43	The instructor gives as much attention to my questions as to other students questions.	181	.6	6.6	15.5	34.3	43.1	4.13	.94
A44	I get the same amount of help from the instructor as do other students.	183	.5	12.0	19.1	29.0	39.3	3.95	1.06
A45	I am treated the same as other students in this class.	183	1.6	4.4	10.4	31.1	52.5	4.2	.94
A46	I receive the same encouragement from the instructor as other students do.	182	2.2	6.0	12.1	26.9	52.7	4.22	1.02
A47	I get the same opportunity to answer questions as other students.	183	.5	2.2	14.8	33.9	48.6	4.28	.83
A48	My work receives as much praise as other students work.	184	2.7	3.3	22.8	27.7	43.5	4.06	1.02
A49	I have the same amount of say in this class as other students.	184	.5	6.0	18.5	26.6	48.4	4.16	.97

[a]Almost Never
[b] Seldom
[c]Sometimes
[d]Often
[e]Almost Always

Appendix 4B

Percentage Responses to Scale Items for the Preferred Version of the CUCEI

	Scale and Items	*n*	% Responses 1[a]	2[b]	3[c]	4[d]	5[e]	Mean	*SD*
Personalisation									
P1	The instructor would consider my feelings.	174	2.3	8.0	27.6	37.4	24.7	3.74	1.00
P2	The instructor would be friendly and would talk to me.	174	.6	2.9	20.7	37.9	37.9	4.10	.86
P3	The instructor would go out of his/her way to help me.	172	.0	4.7	25.6	42.4	27.3	3.92	.84
P4	The instructor would help me when I am having trouble with my work	171	.6	1.8	15.8	31.0	50.9	4.30	.84
P5	The instructor would move around the classroom to talk with me.	173	2.3	4.6	35.3	31.8	26.0	3.75	.97
P6	The instructor would be interested in my problems.	172	1.7	7.0	29.1	37.8	24.4	3.76	.96
P7	The instructor would be unfriendly and inconsiderate towards me.	171	2.9	2.3	7.6	12.3	74.9	4.54	.95
Innovation									
P8	New ideas would be seldom tried out in the class	172	7.0	16.3	39.0	17.4	20.3	3.28	1.17
P9	My instructor would use new and different ways of teaching in the class.	173	.6	9.2	43.9	30.6	15.6	3.51	.89
P10	The instructor would think up innovative activities for me to do.	174	1.7	8.6	38.5	33.3	17.8	3.57	.94
P11	The teaching approaches used in the class would be characterized by innovation and variety.	174	1.7	9.2	31.0	43.1	14.9	3.60	.91
P12	Seating in the class would be arranged in the same way each week.	171	21.1	18.7	28.1	16.4	15.8	2.87	1.35
P13	The instructor would often think of unusual activities	171	8.2	19.3	45.0	18.1	9.4	3.01	1.04
P14	1 would do the same type of activities in every class.	173	20.8	22.5	41.6	9.8	5.2	2.56	1.06
Student Cohesion									
P15	My class would be made up of individuals who did not know each other well.	170	305	10.0	24.7	31.2	30.6	3.75	1.10
P17	I would make friends easily in the class.	172	.6	4.1	24.4	44.8	26.2	3.92	.85
P18	I would not get much of a chance to know my classmates.	171	3.5	11.1	24.6	32.2	28.7	3.71	1.10
P19	I would take a long time to get to know everyone in my class by his/her first name in the class.	170	7.1	15.3	29.4	27.1	21.2	3.40	1.18
P20	I would have the chance to know my classmates well.	174	1.1	8.0	24.7	41.4	24.7	3.80	.94
P21	I would not be very interested in getting to know other students in the class.	172	4.7	9.9	15.7	27.9	41.9	3.92	1.18
Task Orientation									
P22	I would know exactly what had to be done in the class.	174	2.3	3.4	20.1	31.0	43.1	4.09	.99
P23	Getting a certain amount of work done would be important in the class.	174	.6	4.6	19.0	40.2	35.6	4.06	.88
P24	I would often get sidetracked in the class instead of sticking to the point	173	2.3	11.0	34.1	23.7	28.9	3.66	1.08
P25	The class would be always disorganized.	173	4.0	9.2	12.1	23.7	50.9	4.08	1.17
P26	Class assignments would be clear and I would know what to do.	169	4.1	3.0	16.0	20.1	56.8	4.22	1.08

P27	The class would seldom start on time	172	7.6	12.8	19.8	23.3	36.6	3.69	1.29
P28	Activities in the class would be clearly & carefully planned.	166	.6	3.0	22.9	30.1	43.4	4.13	.91
Cooperation									
P29	I would cooperate with other students in my class when doing assignment work.	173	3.5	4.0	22.0	39.9	30.6	3.90	1.00
P30	I would share my books and resources with other students when doing assignments	173	2.3	2.9	26.0	42.2	26.6	3.88	.92
P31	I would work with other students on projects in the class.	174	1.7	6.3	28.2	36.2	27.6	3.82	.97
P32	I would learn from other students in the class.	171	.6	2.9	24.6	42.1	29.8	3.98	.85
P33	I would work with other students in the class	170	1.8	4.7	22.9	42.9	27.6	3.90	.92
P34	I would cooperate with other students in my class on class activities	173	2.3	4.6	21.4	43.4	28.3	3.91	.94
P35	Students would work with me to achieve class goals	168	3.0	4.2	24.4	38.7	29.8	3.88	.98
Individualisation									
P36	I would be expected to do the same work as all the students in the class, in the same way and in the same time.	174	26.4	30.5	26.4	10.3	6.3	2.40	1.17
P37	I would generally be allowed to work at my own pace in the class.	173	.6	2.9	29.5	43.9	23.1	3.86	.82
P38	I would have a say in how class time is spent.	168	3.0	12.5	49.4	24.4	10.7	3.27	.92
P39	I would be allowed to choose activities and how I would work.	170	2.9	12.4	44.1	30.6	10.0	3.32	.92
P40	Teaching approaches in this class would allow me to proceed at my own place	171	1.2	9.4	33.9	37.4	18.1	3.62	.93
P41	I would have little opportunity to pursue my particular interests in the class	172	4.1	18.6	31.4	28.5	17.4	3.37	1.10
P42	My instructor decides what I would do in this class.	170	15.3	28.8	38.8	9.4	7.6	2.65	1.09
Equity									
P43	The instructor would give as much attention to my questions as to other students' questions.	174	1.1	2.9	18.4	26.4	51.1	4.24	.93
P44	I would get the same amount of help from the instructor as do other students.	174	.6	3.4	17.2	33.3	45.4	4.20	.88
P45	I would be treated the same as other students in the class	172	.6	3.5	11.0	29.1	55.8	4.36	.86
P46	I would receive the same encouragement from the instructor as other students do.	171	.6	1.8	15.8	26.3	55.6	4.35	.85
P47	I would get the same opportunity to answer questions as other students do.	173	.6	2.9	16.2	32.9	47.4	4.24	.87
P48	My work would receive as much praise as other students work.	174	.6	1.1	18.4	34.5	45.4	4.23	.83
P49	I would have the same amount of say in the class as other students.	174	.0	5.2	12.1	32.8	50.0	4.28	.87

[a]Almost Never

[b] Seldom

[c]Sometimes

[d]Often

[e]Almost Always

Appendix 4C

Loadings on Seven Components of the Actual CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	A1	0.57	0.04	0.06	0.31	0.08	0.25	0.29
	A2	0.67	-0.01	0.01	0.25	0.04	0.32	0.13
	A3	0.60	0.05	0.05	0.22	0.06	0.44	0.19
	A4	0.67	0.05	0.07	0.13	0.06	0.42	0.21
	A5	0.62	0.17	-0.14	0.22	-0.02	0.28	0.14
	A6	0.70	0.16	0.07	0.11	0.18	0.28	0.18
	A7	0.42	-0.19	0.22	-0.18	0.17	0.25	-0.13
Innovation	A8	0.12	-0.04	0.06	-0.15	-0.40	0.01	-0.07
	A9	0.15	0.07	0.05	0.78	0.14	-0.01	-0.08
	A10	0.21	-0.00	0.02	0.75	0.12	0.03	-0.04
	A11	0.22	0.11	-0.11	0.79	0.05	0.11	0.02
	A12	-0.03	-0.05	-0.04	0.08	-0.22	0.38	0.06
	A13	0.01	0.11	0.03	0.67	0.03	0.36	0.18
	A14	0.28	0.06	0.28	0.36	-0.01	0.11	-0.27
Student Cohesion	A15	0.08	0.20	0.67	0.08	-0.01	0.09	0.12
	A16	0.00	0.27	0.58	0.22	0.08	-0.16	-0.12
	A17	0.05	0.14	0.58	0.23	0.17	-0.15	-0.29
	A18	0.05	0.18	0.64	-0.05	-0.16	0.02	-0.07
	A19	-0.04	0.15	0.57	-0.15	-0.11	0.03	-0.15
	A20	0.12	0.35	0.60	0.15	0.02	-0.13	0.15
	A21	0.07	0.04	0.65	0.04	-0.11	0.10	0.15
Task Orientation	A22	0.51	-0.09	0.05	-0.10	0.40	-0.07	0.41
	A23	0.47	-0.08	0.19	0.20	0.23	-0.04	0.11
	A24	0.28	0.36	0.13	0.00	0.39	-0.16	0.04
	A25	0.52	-0.09	0.32	-0.05	0.02	-0.14	0.02
	A26	0.58	0.02	0.23	0.10	0.16	-0.24	0.24
	A27	0.29	-0.04	0.21	0.19	-0.26	0.05	0.09
	A28	0.57	0.01	0.19	0.18	0.22	-0.24	0.23
Cooperation	A29	0.14	0.68	0.27	0.04	0.03	-0.12	0.33
	A30	0.14	0.73	0.17	0.11	0.00	-0.03	0.15
	A31	0.05	0.80	0.13	0.21	-0.01	-0.00	-0.09
	A32	0.15	0.78	0.14	0.05	0.05	0.05	-0.17
	A33	0.08	0.82	0.17	-0.02	0.07	-0.08	-0.03
	A34	0.02	0.60	0.29	-0.09	0.16	-0.16	0.10
	A35	0.20	0.75	0.14	0.05	0.06	-0.12	0.08
Individualisation	A36	-0.06	-0.09	0.07	-0.09	0.12	0.41	-0.04
	A37	0.15	0.06	-0.08	-0.02	0.75	-0.01	-0.06
	A36	0.10	0.05	-0.02	0.33	0.45	0.12	0.48
	A39	0.07	0.08	-0.04	0.30	0.62	0.26	0.06
	A40	0.36	0.16	-0.07	0.01	0.70	0.12	-0.01
	A41	0.12	-0.32	0.11	0.11	0.03	0.08	-0.48
	A42	-0.17	-0.25	-0.13	-0.07	0.27	0.60	-0.14
Equity	A43	0.68	0.13	0.16	0.11	0.13	0.01	0.02
	A44	0.69	0.33	-0.03	0.14	0.03	-0.02	-0.11
	A45	0.79	0.18	-0.00	-0.03	0.05	-0.14	-0.29
	A46	0.78	0.17	-0.05	0.05	0.02	-0.12	-0.23
	A47	0.74	0.11	-0.05	-0.03	-0.08	-0.24	-0.25
	A48	0.76	0.03	-0.05	0.10	-0.04	-0.12	-0.12
	A49	0.67	0.10	0.01	0.01	-0.12	-0.29	-0.02

Appendix 4D

Loadings on Seven Components of the Preferred CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	P1	0.20	0.10	0.65	0.19	0.23	-0.04	0.15
	P2	0.20	0.01	0.83	0.03	0.15	0.05	-0.01
	P3	0.22	0.14	0.70	0.05	0.16	0.30	-0.09
	P4	0.39	0.24	0.63	0.05	0.09	0.04	0.01
	P5	0.31	0.10	0.61	-0.05	-0.03	0.24	-0.24
	P6	0.31	0.06	0.71	-0.02	0.16	0.07	0.07
	P7	0.17	0.09	0.17	0.40	0.07	-0.10	0.38
Innovation	P8	0.22	-0.05	-0.17	0.12	-0.87	0.13	0.15
	P9	0.12	0.22	0.11	0.03	0.72	0.17	0.12
	P10	0.32	0.16	0.22	-0.06	-5.64	0.31	-0.02
	P11	0.22	0.38	0.15	0.02	0.67	0.06	0.15
	P12	-0.02	-0.05	-0.07	-0.03	-0.40	0.10	0.40
	P13	0.04	0.09	0.08	-0.07	0.57	0.29	0.06
	P14	-0.22	-0.07	0.07	0.03	-0.17	0.01	-0.76
Student Cohesion	P15	0.03	0.12	-0.06	0.58	0.06	-0.03	0.18
	P17	0.21	0.37	0.21	0.36	0.13	0.02	0.15
	P18	0.20	0.14	-0.02	0.68	-0.03	-0.10	-0.13
	P19	-0.06	0.03	0.02	0.69	-0.15	-0.04	-0.03
	P20	0.04	0.50	0.21	0.53	0.12	0.13	-0.01
	P21	0.08	0.39	0.28	0.29	-0.13	-0.14	-0.21
Task Orientation	P22	0.62	-0.02	0.17	0.17	0.14	0.13	-0.02
	P23	0.47	0.18	0.09	0.11	0.34	-0.23	-0.12
	P24	0.43	-0.07	0.09	0.45	0.26	0.17	0.03
	P25	0.46	-0.12	0.11	0.55	0.13	0.09	0.01
	P26	0.59	-0.06	0.03	0.29	0.23	-0.17	0.21
	P27	0.19	-0.03	-0.04	0.66	0.12	0.12	0.01
	P28	0.49	0.03	0.21	0.24	0.43	0.00	-0.15
Cooperation	P29	0.14	0.78	0.02	-0.10	0.09	-0.00	0.05
	P30	-0.00	0.75	-0.03	0.04	0.04	0.14	-0.09
	P31	0.04	0.87	0.04	0.03	0.12	0.02	-0.14
	P32	0.10	0.85	-0.00	0.13	0.09	0.23	0.01
	P33	0.04	0.85	0.08	0.14	0.20	0.13	0.03
	P34	0.10	0.86	0.15	0.09	0.09	-0.11	0.06
	P35	0.06	0.83	0.19	0.05	0.10	-0.02	0.17
Individualisation	P36	-0.27	-0.03	0.03	0.15	-0.04	0.08	0.48
	P37	0.38	0.06	0.06	0.11	0.26	0.49	-0.21
	P36	0.22	0.12	0.21	-0.13	0.18	0.61	0.20
	P39	0.07	0.13	0.18	-0.20	0.08	0.71	0.03
	P40	0.29	0.08	0.06	0.12	0.22	0.63	-0.13
	P41	0.17	0.23	0.17	0.41	0.07	-0.16	0.21
	P42	-0.10	-0.01	-0.03	0.17	-0.18	0.59	0.43
Equity	P43	0.83	0.08	0.18	0.06	0.06	0.07	0.09
	P44	0.76	0.16	0.20	0.02	0.04	0.13	0.03
	P45	0.87	0.05	0.10	0.07	0.08	0.13	-0.01
	P46	0.88	0.04	0.13	0.16	0.06	0.13	-0.03
	P47	0.79	0.08	0.32	0.11	-0.10	-0.02	-0.01
	P48	0.68	0.34	0.32	0.05	0.01	0.07	0.03
	P49	0.76	0.19	0.21	0.08	-0.05	0.23	-0.01

Appendix 4E

Loadings on Seven Components of the Reduced Actual CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	A1	0.25	0.04	0.64	-0.00	0.30	0.00	0.21
	A2	0.30	-0.00	0.72	0.01	0.18	0.05	0.11
	A3	0.18	0.02	0.82	0.07	0.12	0.11	0.04
	A4	0.25	0.04	0.81	0.06	-0.00	0.10	0.12
	A5	0.32	0.08	0.67	-0.06	0.13	0.12	-0.07
	A6	0.38	0.15	0.68	0.07	0.06	0.20	0.17
Innovation	A9	0.10	0.08	0.20	0.07	0.76	0.10	-0.01
	A10	0.16	-0.04	0.17	0.05	0.76	0.17	-0.05
	A11	0.07	0.19	0.30	0.06	0.74	0.05	0.08
	A13	0.06	0.05	-0.06	0.09	0.76	0.03	0.04
Student Cohesion	A15	0.05	0.09	0.04	0.73	0.12	0.10	0.07
	A16	0.07	0.31	-0.12	0.57	0.21	0.02	0.08
	A17	0.08	0.25	-0.04	0.56	0.12	0.12	-0.04
	A18	0.00	0.19	0.01	0.65	-0.07	-0.12	-0.06
	A19	0.08	0.05	-0.03	0.61	-0.15	-0.07	-0.11
	A20	0.07	0.39	0.09	0.60	0.17	-0.04	0.19
	A21	-0.06	-0.03	0.18	0.66	0.07	-0.08	0.06
Task Orientation	A22	0.26	0.09	0.25	-0.08	-0.08	0.32	0.67
	A25	0.44	-0.08	0.19	0.24	0.03	0.01	0.26
	A26	0.45	0.11	0.23	0.16	0.08	0.16	0.54
	A28	0.47	-0.01	0.19	0.16	0.27	0.25	0.36
Cooperation	A29	0.01	0.78	0.09	0.19	0.06	-0.06	0.32
	A30	0.05	0.77	0.13	0.09	0.11	-0.03	0.11
	A31	0.03	0.82	0.06	0.12	0.16	0.03	-0.18
	A32	0.10	0.78	0.11	0.18	-0.01	0.14	-0.28
	A33	0.08	0.84	-0.03	0.18	-0.02	0.11	-0.11
	A34	-0.00	0.74	-0.05	0.15	-0.06	-0.06	0.31
	A35	0.17	0.79	0.03	0.10	0.05	0.02	0.06
Individualisation	A37	0.18	-0.06	-0.00	-0.03	0.03	0.78	0.09
	A38	-0.13	0.10	0.22	-0.05	0.34	0.48	0.41
	A39	-0.05	-0.02	0.19	0.00	0.31	0.72	-0.03
	A40	0.21	0.17	0.23	-0.05	0.01	0.74	0.17
Equity	A43	0.56	0.06	0.39	0.22	0.09	0.17	0.08
	A44	0.66	0.20	0.36	0.07	0.11	0.12	-0.14
	A45	0.83	0.10	0.20	0.04	0.04	0.14	-0.03
	A46	0.81	0.09	0.22	0.00	0.08	0.16	-0.02
	A47	0.85	0.01	0.12	-0.01	0.02	-0.00	0.00
	A48	0.68	0.13	0.25	-0.11	0.04	-0.02	0.26
	A49	0.74	0.04	0.14	0.02	0.10	-0.10	0.12

Appendix 4F

Loadings on Seven Components of the Reduced Preferred CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6	7
Personalisation	P1	0.24	0.13	0.65	0.11	0.10	0.06	0.24
	P2	0.19	0.01	0.84	0.16	-0.02	0.06	0.03
	P3	0.23	0.16	0.70	0.19	0.09	0.23	-0.23
	P4	0.39	0.23	0.62	0.17	0.06	0.03	-0.11
	P5	0.34	0.12	0.59	0.05	0.00	0.16	-0.35
	P6	0.29	0.05	0.71	0.12	-0.05	0.15	0.19
Innovation	P9	0.08	0.21	0.14	0.78	0.08	0.12	0.01
	P10	0.27	0.14	0.22	0.71	-0.88	0.16	0.06
	P11	0.14	0.32	0.16	0.76	0.01	0.06	0.22
	P13	0.04	0.09	0.09	0.65	0.01	0.17	-0.24
Student Cohesion	P15	0.00	0.08	-0.09	0.03	0.63	0.08	0.15
	P17	0.24	0.38	0.21	0.13	0.46	0.02	-0.18
	P18	0.19	0.14	-0.02	-0.08	0.69	-0.03	0.16
	P19	-0.00	0.05	0.04	-0.08	0.72	-0.14	-0.20
	P20	0.06	0.49	0.22	0.15	0.55	0.07	-0.09
	P21	0.13	0.41	0.29	-0.19	0.21	-0.12	0.28
Task Orientation	P22	0.52	-0.06	0.20	0.07	0.17	0.32	0.25
	P25	0.47	-0.13	0.14	0.17	0.51	0.02	0.08
	P26	0.59	-0.07	0.05	0.18	0.30	-0.02	0.24
	P28	0.44	-0.00	0.26	0.35	0.18	0.10	0.36
Cooperation	P29	0.17	0.77	0.00	0.19	-0.10	-0.06	-0.18
	P30	0.01	0.74	-0.03	0.07	0.05	0.12	-0.08
	P31	0.10	0.88	0.06	0.11	0.03	-0.03	0.00
	P32	0.12	0.85	0.02	0.10	0.16	0.19	-0.09
	P33	0.04	0.85	0.07	0.20	0.16	0.09	-0.08
	P34	0.09	0.85	0.16	0.08	0.10	-0.04	0.20
	P35	0.06	0.82	0.20	0.06	0.05	0.09	0.24
Individualisation	P37	0.29	0.04	0.04	0.17	0.10	0.64	0.21
	P38	0.13	0.08	0.20	0.20	-0.08	0.65	-0.29
	P39	0.02	0.10	0.17	0.04	-0.15	0.79	-0.15
	P40	0.23	0.05	0.05	0.14	0.07	0.77	0.15
Equity	P43	0.83	0.10	0.18	0.11	0.05	0.11	-0.04
	P44	0.78	0.17	0.19	0.09	-0.02	0.08	0.03
	P45	0.88	0.08	0.11	0.11	0.03	0.10	-0.06
	P46	0.86	0.06	0.13	0.12	0.11	0.12	-0.12
	P47	0.81	0.09	0.29	-0.08	0.05	0.06	0.12
	P48	0.70	0.32	0.29	0.08	0.01	0.08	0.04
	P49	0.78	0.19	0.21	0.02	0.08	0.20	-0.14

Appendix 4G

Loadings on Six Components of the Actual CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6
Personalisation	A1	0.05	0.23	0.68	0.00	0.28	0.06
	A2	0.01	0.29	0.74	0.01	0.18	0.07
	A3	0.03	0.19	0.81	0.07	0.11	0.12
	A4	0.05	0.26	0.82	0.07	-0.01	0.12
	A5	0.08	0.32	0.65	-0.07	0.14	0.08
	A6	0.15	0.40	0.69	0.10	0.05	0.24
Innovation	A9	0.06	0.10	0.19	0.07	0.76	0.13
	A10	-0.04	0.16	0.17	0.05	0.77	0.14
	A11	0.19	0.06	0.31	0.06	0.75	0.07
	A13	0.06	0.04	-0.03	0.09	0.75	0.06
Student Cohesion	A15	0.09	0.03	0.06	0.73	0.11	0.11
	A16	0.30	0.10	-0.12	0.60	0.22	0.06
	A17	0.26	0.09	-0.06	0.56	0.14	0.10
	A18	0.21	-0.02	0.00	0.62	-0.05	-0.17
	A19	0.06	0.08	-0.04	0.61	-0.13	-0.13
	A20	0.38	0.07	0.11	0.62	0.15	0.03
	A21	-0.03	-0.08	0.20	0.67	0.04	-0.02
Cooperation	A29	0.79	0.01	0.13	0.20	0.06	0.00
	A30	0.78	0.06	0.14	0.10	0.10	0.00
	A31	0.82	0.04	0.03	0.10	0.17	-0.01
	A32	0.78	0.11	0.06	0.15	0.01	0.05
	A33	0.84	0.09	-0.05	0.17	-0.01	0.07
	A34	0.75	0.02	-0.00	0.17	-0.09	0.04
	A35	0.79	0.18	0.04	0.10	0.06	0.01
Individualisation	A37	-0.05	0.20	-0.00	-0.02	-0.00	0.80
	A38	0.09	-0.12	0.27	-0.02	0.30	0.59
	A39	-0.03	-0.05	0.16	-0.02	0.31	0.69
	A40	0.18	0.24	0.23	-0.04	-0.01	0.77
Equity	A43	0.06	0.57	0.39	0.23	0.10	0.15
	A44	0.20	0.66	0.33	0.06	0.13	0.05
	A45	0.10	0.84	0.19	0.06	0.03	0.14
	A46	0.08	0.81	0.23	0.01	0.09	0.13
	A47	0.01	0.86	0.12	0.01	0.02	0.00
	A48	0.13	0.69	0.29	-0.07	0.05	0.02
	A49	0.03	0.75	0.18	0.07	0.08	-0.06

Appendix 4H

Loadings on Six Components of the Preferred CUCEI (Varimax Rotation)

Scale	Item	1	2	3	4	5	6
Personalisation	P1	0.11	0.21	0.67	0.13	-0.00	0.10
	P2	0.03	0.19	0.82	0.15	0.03	-0.02
	P3	0.15	0.16	0.73	0.15	0.27	0.02
	P4	0.23	0.33	0.66	0.15	0.05	0.02
	P5	0.11	0.33	0.60	0.01	0.22	-0.00
	P6	0.03	0.25	0.71	0.13	0.13	-0.01
Innovation	P9	0.17	0.08	0.14	0.79	0.14	0.10
	P10	0.12	0.28	0.22	0.73	0.17	-0.08
	P11	0.29	0.15	0.17	0.78	0.03	0.04
	P13	0.09	0.02	0.10	0.64	0.19	-0.07
Student Cohesion	P15	0.05	0.02	-0.09	0.07	0.07	0.72
	P17	0.34	0.19	0.25	0.15	0.04	0.42
	P18	0.13	0.21	-0.04	-0.05	-0.05	0.74
	P19	0.07	0.01	0.05	-0.12	-0.10	0.69
	P20	0.46	0.04	0.26	0.16	0.07	0.52
	P21	0.41	0.18	0.24	-0.15	-0.14	0.28
Cooperation	P29	0.78	0.16	0.02	0.16	-0.02	-0.07
	P30	0.77	0.02	-0.01	0.05	0.14	0.03
	P31	0.87	0.13	0.07	0.12	-0.02	0.04
	P32	0.84	0.14	0.04	0.10	0.21	0.17
	P33	0.85	0.06	0.08	0.21	0.11	0.17
	P34	0.84	0.10	0.15	0.11	-0.07	0.15
	P35	0.81	0.08	0.20	0.09	0.05	0.10
Individualisation	P37	0.03	0.31	0.04	0.19	0.62	0.13
	P36	0.04	0.12	0.21	0.20	0.68	-0.08
	P39	0.10	0.01	0.16	0.04	0.80	-0.16
	P40	0.05	0.20	0.06	0.12	0.76	0.06
Equity	P43	0.08	0.83	0.21	0.13	0.11	0.07
	P44	0.15	0.79	0.21	0.12	0.08	0.00
	P45	0.06	0.87	0.14	0.13	0.11	0.06
	P46	0.04	0.85	0.17	0.13	0.15	0.12
	P47	0.07	0.82	0.29	-0.04	0.04	0.09
	P48	0.26	0.72	0.28	0.12	0.06	0.08
	P49	0.17	0.77	0.24	0.01	0.22	0.08