Science and Mathematics Education Centre

The Culture of Computer Classrooms in Single-sex and Mixed-sex Secondary Schools in Wellington, New Zealand

Kerina Ann Logan

This thesis is presented for the Degree of
Doctor of Science Education
of
Curtin University of Technology

November 2003

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: ..

Date: ......1 November 2003..........

ABSTRACT

The participation by females in computing education has become an issue in the Western world. Fewer females than males are observed at all levels of computer education. As the level becomes more advanced the loss of females is both cumulative and progressive. Reports from the United Kingdom, the United States, and New Zealand indicate that at secondary level boys significantly outnumber girls in higher-skill computing courses and at tertiary level the numbers of females enrolling has declined over the past decade. The motivation for this research was a desire to understand why females were not enrolling in computing classes, and when they did, why their retention was poor.

A review of the literature regarding females and computing indicated that there were certain features evident in the computing classroom believed to contribute to a unique culture existing in the computing learning environment. These included the context in which computing is historically embedded, the lack of female teachers as role models and the nature of the classroom itself, where male attitudes towards computers and games play a critical role. Throughout the literature the culture of computing was shown to be strongly embedded in male values, and unattractive to many females. For this reason, some researchers suggest that single-sex classrooms or schools may provide a more supportive learning environment for both female and male students. Therefore this study explored the computer classroom learning environment of senior secondary school students at three different types of school, single-sex girls' and boys' schools and mixed-sex schools.

A mixed-method research design was adopted to investigate the nature of the classroom learning environment in which computing is situated and to determine ways by which it might be made more equitable. A questionnaire with seven subscales was used to measure students' perceptions of the computer classroom learning environment. Data were collected from senior students taking computing at seven secondary schools in the central Wellington area, and the differences between the perceptions of girls and boys at single-sex and mixed-sex schools were analysed.

The results suggested that, on a number of subscales, students from single-sex schools were more satisfied with their learning environment than students from mixed-sex schools, and that girls were less satisfied than boys. These findings suggested that the sex of the student and the type of school attended were associated with students' perceptions of the computer classroom. The questionnaire data were supported by interviews with students and their teachers and by observations of some of the classes. The analysis of the qualitative data confirmed many of the concerns expressed in the research literature, and revealed significant differences in the behaviour of boys and girls in the computer classroom, thus leading to the proposition that both sexes might benefit from single-sex classes. The results also highlight the critical role played by the teacher in the transfer of cultural values in the classroom through the teaching style and organisation of class activities. Taken together, the findings from the study, in the context of the research literature, enabled recommendations to be made for providing a more equitable computer learning environment for both girls and boys. Suggestions for future research, particularly in light of the changing national computing curriculum, are made.

ACKNOWLEDGEMENTS

Many people have contributed to this thesis, and to all I would like to offer my thanks. In particular I would like to acknowledge and thank my supervisor, Professor Leonie Rennie, whose guidance, support, friendship and encouragement has made this thesis possible. Her patience was outstanding, her insight as a teacher brilliant, and her ability as a mentor has been an ongoing source of inspiration and motivation.

I am very grateful to all the teachers and schools who agreed to participate in this study. To those who so willingly permitted me into their classrooms to observe, and spent precious time taking part in interviews and answering questions, thank you.

I would like also to thank the students who contributed in many ways, and who helped to make the data gathering an enjoyable process.

To Professor Judy McGregor and Associate Professor Andrea McIlroy, thank you for your ongoing encouragement and support, and particularly for organising the Wellington Award which gave me the initial impetus to get started.

Finally, thank you to my daughters, Jenny and Rachel Cornes, my husband, Jim, Marion Cornes, Barbara Crump and other friends who have offered encouragement, support and assistance whenever necessary.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION TO THE STUDY

We live in an information based economy, where computing and information technology (IT) are core elements of modern life, and are instrumental in driving the global economy. It is therefore imperative that women gain the same technological knowledge and skills as males, for without the appropriate skills women will limit their career choices, and be excluded from the development of technologies which affect their lives. They will also continue to play only a minor role instead of an equal role as producers and decision makers in all aspects related to the shaping of IT policies and frameworks which affect their lives (AAUW, 1999; UNCTAD Secretariat, 2002).

Yet the disproportionately low number of females taking computing courses, and working in the IT industry, is well documented. While some research shows that women and girls originally participated equally in the computing workforce (Crump & Logan, 2000; Linn, 1985), in recent years concern has been expressed at all levels of industry, (including PITAC (1999) the US President's Information Technology Advisory Committee, regarding the under-representation of women. Claims have been made that the highest percentage of women working in computing are based in the lower skilled, lower paid areas with little prospect of career progression (Edwards, 1994; UNCTAD Secretariat, 2002), and that this acts as a means of job stratification based on gender. This is of concern because it means half of the population is not contributing to an industry that plays a very influential role in today's global society.

This under-participation of women in computing employment is reflected in similar imbalances in computer education. The level of enrolment and retention of female students in computer science courses in Western countries has dropped since the early 1980s and continues to do so. One cross-national study noted that in 12 countries, including America and New Zealand, the numbers of women enrolling in computing courses fell between 1985 and 1990 (Wright, 1997). There is evidence that this imbalance begins to become noticeable at secondary school, and, not surprisingly, continues right through to professorial level, increasing as the level of skill and knowledge becomes more advanced (Camp, 1997).

This gender gap in computer education is attributed to a variety of reasons that contribute to the shaping of the learning environment in which computing takes place. These include the historical link with mathematics, science and engineering (Clarke, 1996) and the learning environment itself (Brown, Andreae, Biddle, & Tempero, 1997). Research shows that the cultural and social environment of the computer classroom plays an important part in gender-related behaviour and attitudes of participants (Schofield, 1995). Some of the cultural attributes which are considered inherent in the computer classroom are generated by the behaviour of the boys, and the attitudes and beliefs of the teachers. If these claims are true, it would not be surprising that the computing culture impacts adversely on female students.

The purpose of this study was to investigate the perceptions of male and female students, and their teachers, regarding their computer learning environment. The identification of any differences in perceptions between male and female students will enhance understanding regarding the low enrolment of female students in computing classes and contribute to the development of strategies to increase female participation in computing. As it has been established that there is a distinct computer "culture" which both covertly and overtly works to discourage female students in other Western countries, a further purpose was to identify whether this culture exists in New Zealand secondary schools and if so, whether it exists in both single-sex and mixed-sex computer classroom environments.

Gender and the Culture of Computing

The culture of any community can be described in terms of the interactions between individuals and groups which lead to the development of common patterns of values. These values are characterised by the attitudes and beliefs held by members of that particular group and they provide the group with cohesion. Such values are historically derived, vary according to the different sub-cultures or environments in which they exist, and are tacitly agreed to by the individuals within a particular group (Hofstede, 1980).

As Hofstede (1980) explains, the values which characterise a particular culture or sub-culture are historically derived. Computing has a close historical alliance with mathematics, engineering and science, subjects that traditionally have had low female participation. During its early days of existence the computer industry developed a sub-culture which was "insular, esoteric and disproportionately populated by men" (Woodfield, 2002, p. 119). Similarly, since its inception as a part of the school curriculum, both in New Zealand and other parts of the Western world, computing courses have been dominated by male students and subsequently, male teachers. This is of major importance because of the role which teachers play in transmitting and reinforcing the cultural norms of the classroom as part of the spoken and, often, unspoken understanding they have with their students (Bowers, 1988). Such cultural norms are usually those of the dominant group and are regarded as "natural" by them (Ogbu, 1978).

As a consequence of this dominant male environment some researchers suggest that assessment tasks are often related to male interests, with the risk of ignoring and trivialising female interests and making knowledge assumptions based on male life experiences (Crump & Logan, 2000). It is also suggested that the pedagogy associated with computing does not focus on the social interactivity between the students, but rather on a teacher dominant environment whereby the students are instructed by an expert authority (Schofield, 1995). An additional factor is related to the computing curriculum. As a result of the relative newness of computer studies to New Zealand secondary schools, most teachers are self taught and have not been trained to teach computing. Where many male teachers have learned their computing skills through a recreational interest in computing, females do not usually have this same interest resulting in fewer female teachers, and hence fewer role models for girls (Schofield, 1995).

The lack of female teachers as role models for the female students is problematic in that it contributes to the perception of computing being a male experience (Byrne, 1993). This is particularly important during adolescence when girls' perceived lack of confidence in their abilities begins to manifest itself, and this appears to be the time when they begin to reject computing as an academic subject and career choice. At the same time the boys are beginning to find computers fascinating (AAUW, 1999) and some researchers suggest that boys develop a relationship with the computer during these years of adolescence (Furger, 1998; Margolis, Fisher, & Miller, 2000; Turkle, 1988). The boys also gain confidence and experience through the playing of games. Such games do not appear to appeal to females who, according to Schofield (1995), prefer to use computers for work related tasks such as word processing or doing assignments.

One reason put forward for girls' under-representation is that of "critical mass". This is based on the premise that until such time as critical mass is achieved for girls (when their numbers increase to 30%) the boys will continue to dominate the computer classroom (Byrne, 1993), the girls who take computing courses will continue to be isolated and marginalised (Craig, Fisher, Scollary, & Singh, 1998), and the culture will continue to self-perpetuate. Single-sex schools and classrooms have been suggested as a means of alleviating problems such as the differences in girls' and boys' behaviour, and as a means of creating a more suitable learning environment for girls, as have pro-active interventions favouring girls. However, such policies are not always well received by either sex, and can contribute to a perception of deficiency in the girls. Also, there appears to be no conclusive evidence that a single-sex environment ensures the students will perform better. Nevertheless, there has been some research into single-sex computing classes which suggests that the results are sufficiently positive to support further exploration of this issue as a means of understanding how best to attract and retain girls into ongoing study of computing.

Thus, it seems that a gender inequality in computer education exists in many Western countries including New Zealand and that the culture which is embedded in the computing classroom is influential in perpetuating this inequality. Consequently there is a need to look at ways in which to address this problem, and find solutions to attract more females into the computing classroom. Little research has been undertaken to establish whether this culture, with its negative aspects, exists in single-sex schools and classes, or whether it is unique to mixed-sex education. Whether or not this culture is only evident in a mixed-sex environment, the fact remains that females are not enrolling in elective computing classes. The assumption can reasonably be made that there is a difference in boys' and girls' perceptions of the computing environment, but there is little evidence of research in this area, particularly at the upper secondary level. Nor has previous research focussed on the influence which the teacher may have in imparting and fostering this culture. This study is designed to address these issues.

Research Questions

The purpose of this research was to explore the perceptions of students and their teachers in Level 12 and 13 computer classrooms in both mixed- and single-sex schools within the central Wellington district. Specifically, the study investigated the following issues:

1. What are the characteristics of the computer studies classroom?
2. What perceptions of the computer studies classroom are held by Level 12 and 13 secondary school computing students?
    a. What are the differences (if any) between male and female students' perceptions of the computer studies classroom?
    b. What are the differences in perceptions of the computer studies classroom (if any) between students attending single-sex and mixed-sex schools?
3. How can the learning environment of the computer studies classroom be designed to be encouraging of both female and male students?

Overview of the Research Design

The research used a mixed-method design (Greene, Caracelli, & Graham, 1989) which combined data from three sources. First, a survey instrument, the *College and University Classroom Environment Inventory* (CUCEI) was used to gather data pertaining to students' perceptions of the learning environment in their computer classroom. The CUCEI was chosen because it was developed specifically to measure the learning environment of small groups in upper secondary and tertiary classrooms and had been validated in previous research (Nair & Fisher, 2000). It also appeared to be an appropriate instrument because its sub-scales were designed to measure cultural attributes that, according to the literature, were relevant to this study.

Second, face-to-face interviews with students and their teachers were held. As well, informal discussions were held with teachers and students in the corridor while waiting for classes to commence and in the classroom itself. Interview questions, based both on the scales of the CUCEI, and on the attributes of culture as defined in the literature review, were developed and the interviews were built around these. During the interviews, participants' responses to questions were probed to elicit further information and greater depth on relevant aspects of the learning environment and the classroom culture.

Third, classroom observations were undertaken to describe the nature of the interactions between students, and between students and their teacher. As a non-participative observer, the researcher sought to take account of any differences that were affected by the physical layout of the room, and record the non-verbal reactions and responses which are a component of any classroom.

The participating schools ranged from decile 5 to decile 10, decile being a measurement of the socio-economic community from which the students are drawn (10 is the highest). Three single-sex girls' schools, three mixed-sex schools, and one single-sex boys' school agreed to participate. At Year 12 and 13 computing is an elective subject in most New Zealand secondary schools. A total of 265 Year 12 and 13 students (120 boys, 145 girls) from seven schools in the Wellington district completed the CUCEI, which was administered by the researcher. Four teachers from three schools were interviewed. Individual interviews were also held with 12 students, and a group interview with a further five. The classroom observations were undertaken in the same three schools in the classrooms of three of the teachers who had agreed to be interviewed. A variety of different classes and classrooms were observed.

Data collected from the CUCEI were analysed and used to construct profiles which represented the means of students' actual and preferred environment scores. This analysis also enabled identification of statistically significant differences between boys' and girls' perceptions, and between the perceptions of students attending single-sex and mixed-sex schools. Analysis of the qualitative data followed Patton's (1990) suggestions for content analysis, and the findings were used to describe the computer studies classroom culture and to expand the findings from the CUCEI.

A major benefit from the use of a mixed-method design was the ability to triangulate. By using the data from surveys, interviews and observations, convergence of the findings was sought. A mixed-method design meant the different types of data gathered could be used to complement each other, as well as identify where contradictions existed, thus extending the depth and breadth of the research overall.

Significance of the Study

The study is significant because it is the first study in New Zealand secondary schools to investigate the culture of the computing learning environment. Academic research has highlighted, and the industry itself has acknowledged, that over the years computing has developed a problematic culture, which tends to attract males who are "often not the most socially adept" (Woodfield, 2002, p. 1), and is thought to be a significant factor in girls electing not to take computing courses (Sproull, Kiesler, & Zubrow, 1987). Therefore it is imperative that research be undertaken to further investigate the culture, and find solutions to overcome this problem. It is envisaged that the results will assist teachers to recognise the impact that this culture has on students, and enable them to devise strategies to overcome the negative aspects of the culture.

The second significant aspect of the study is its focus on the sex of the student, particularly during adolescence which is a vulnerable time because of teenagers' need to be accepted by their peers. If girls make their decision to take computing courses based on peer group perceptions, then the results of the research may lead to a better understanding of what these perceptions are, and whether they impact on the enrolment and retention of female students in computing courses. Moreover, the focus on the sex of the student is important because it relates to the ways in which boys and girls behave in the computer classroom. If this study indicates different behaviours, then efforts can be made to ensure that teachers are aware of such differences, and that steps are taken to ensure these differences are taken into account in the development of curricula, assessments and classroom activities. The approach taken to teaching computing to boys and girls may need to be addressed.

Third, the study investigates whether the different types of school which students attend impact on their attitudes towards computing. Single-sex classrooms and schools may provide a more enhanced computer learning environment for both sexes, leading to more enrolments in computing electives, and providing an environment that is more appealing to students, thus creating an interest in computing. This could lead to more positive associations with computing and therefore students' ability to make more informed choices regarding their enrolment in computing courses at tertiary level.

Fourth, and of particular significance, is the fact that the research highlights the critical role that teachers play in the learning environment in their classrooms. Despite considerable research having been carried out on the learning environment, the results from this study may lead to a greater awareness of the need to develop different kinds of teaching for girls and boys in the computing classroom, thus developing a more positive and supportive computing classroom climate.

Finally, this is the first study where the CUCEI has been used to analyse secondary school students' perceptions in New Zealand. The results from this study will add to the body of knowledge that has been gathered through ongoing research in Australia and other countries, not only from the use of the CUCEI, but regarding the learning environment generally.

Limitations to the Study

There are several limitations arising from aspects of the participating sample, therefore, the ability to generalise the findings from the research across other countries, or even New Zealand, may be limited due to bias as a result of the following. First, the number of participating schools was small and selected from within the confines of Wellington city. The decile range of the participating schools (which indicates the socio-economic status of the community in which the school is positioned) was between 5 and 10, thus excluding schools within the lowest socio-economic districts.

Second, the sampling method was one of convenience and difficulty was experienced in recruiting schools. Only one single-sex boys' school was willing to participate in the research. Further, two of the single-sex girls' schools were private, religious-based schools and this may contribute to a certain bias due to the moral and ethical beliefs of the schools and the families. All of the other schools were public.

Third, the computing curricula at New Zealand secondary schools is not a Bursary subject, and in most schools computing is an elective, whereas in other countries computing subjects may be taken as a part of a recognised university entrance qualification. For example, in Great Britain computing can be taken for A-level examinations. For this reason, the type of student who takes computing at Levels 12 and 13 in New Zealand may be different to those in other countries.

For the above reasons the ability to generalise the findings from the research is limited. Nevertheless, care was taken in all aspects of the study to obtain the most trustworthy data possible. By gathering data to answer questions about the computing learning environment and its culture, this study will assist computing teachers to develop teaching approaches that are gender-inclusive and girl-friendly. Therefore the results gained will be able to be used to inform the computing society and improve female participation in computing and IT, whether at school, university or in the workforce.

Overview of the Thesis

Chapter 2 provides an examination of the related literature pertaining to the study. It contains sections dealing with the reasons for concern about the lack of females enrolling in computing courses and working in the industry, the concept of culture and, in particular, the features that make up the "culture" of computing. It then examines the learning environment, how it can be measured, and some specific instruments which have been used for this purpose.

In Chapter 3 the research design is explained and linked to the research questions. It explains who the participants are and how the sample was selected. A description of the development of the CUCEI, which was used to gather the quantitative data, is given, followed by an explanation of the different methods used for collecting the qualitative data. Ethical considerations are discussed, and the process used for gathering and analysing the data described.

Chapter 4 reports on the statistics used to confirm the validity and reliability of the CUCEI, based on the sample. It then presents the results for students' responses to both versions of the CUCEI. Differences between the Actual and Preferred Versions are measured and results discussed. This is followed by an analysis of students' perceptions of their computing learning environment using Sex and Type of School as variables.

Chapter 5 focuses on analysis and interpretation of the qualitative data gathered through interviews and observations. It begins by dividing the data into themes and sub-themes, which are then individually discussed.

The final chapter integrates and discusses the major findings from the study. This chapter and the thesis concludes with a discussion of the limitations of the study and recommendations for further research.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

This chapter presents a review of the literature relating to the computing culture and the lack of females in the computing classroom. The first section establishes why there is concern that women in general are not choosing to participate in the computing workforce, and reports some statistics relating to the low numbers. It continues with a review of the literature which highlights where women are in computing education from secondary school through to PhD level, and presents statistics from overseas and New Zealand. In the second section, the general meaning of culture, the nature of classroom culture and, in particular, what contributes to the computing classroom culture is discussed. Here are identified important aspects contributing to the computing classroom culture. The concept of "critical mass" is explained, together with the isolation which girls experience when they are in the minority in the classroom, and the extent to which single-sex classrooms and schools may be a solution is discussed. The third section relates to the nature and development of instruments to measure the learning environment, and in particular the CUCEI, which is used to gather data in this research. A brief history of classroom research is discussed. The final section of this chapter presents a summary of the ideas presented in this review and an explanation of how it applies to the research being undertaken.

Women in Computing

Information technology (IT) is increasingly viewed as a core element of modern life and one where academic qualifications and commercial innovations have both direct and indirect impacts on national economies (Rasmussen & Hapnes, 1991). We cannot escape from the fact that there has been a shift, particularly in the Western world, from an economy based on industry to one based on information (Millar, 1998). While there has been tremendous growth in the development of information technologies in general, since the early 1990s access to, and use of, the Internet has grown exponentially. Within this information-based economy, computer services has been one of the fastest growing industries (Kelinson & Tate, 2000) offering some of the highest paying, leading-edge jobs, the majority of which are held by males (Furger, 1998). As a result, computer proficiency has become a new limiting "filter" for students' educational and career choices.

Since the 1980s, concern has been expressed regarding the imbalance of females and males, both in the computer industry itself and at all levels of computer studies courses in the education system. This is disturbing because such a computer-related gender gap, where females are less proficient in the use of computers, will have negative effects on females' subsequent education, potential occupations and roles in society (Crombie, 1999; Sanders & Stone, 1986). Yet some research suggests that women bring a different perspective to programming and systems development (Woodfield, 2002) because they work more collaboratively, spend more time ensuring that the objectives of the system are being achieved and test more rigorously for errors (Crump & Logan, 2000).

This raises ethical issues. Without the same technological knowledge and skills, women will be shut out of the more lucrative careers and will not be part of developing the new technologies that will affect their lives. Without a basic understanding of information technology, women will also be left out of the decision making process when it comes to discussions and policy-making about technology (AAUW, 1999; UNCTAD Secretariat, 2002). Given that women are half the population of potential contributors, it is often argued that their exclusion from the field of computer science decreases its chances of further development (Pearl et al., 1990). The arguments for a more equitable balance of gender within computing are similar to those put forward for diversity of individuals contributing to the engineering fields, not just for fairness, but:

> Sans diversity, we limit the set of life experiences that are applied and as a result, we pay an opportunity cost – a cost in products not built, in designs not considered, in constraints not understood, in processes not invented. (Wulf, 1998, p. 1)

Women in the Computing Workforce

Concern has also been expressed that where women are in the computing workforce they tend to be concentrated in the lowest areas in terms of skill, status, mobility and pay (Bernstein, 1999; Edwards, 1994). For example, Edwards (1994) claims that in the United States around 65% of computer operators, 30-40% of programmers and 25-30% of systems analysts are female, but that women account for 95% of those who work in data entry, the least prestigious area of computer usage. As a result of concern regarding the IT industry in the United States, the President's Information Technology Advisory Committee (PITAC) presented a report in 1999 which stated:

> It is critical to tap all of this country's talent for the IT workforce. There is, without any doubt, a vast untapped talent pool in the US among women and minorities, currently under-represented in engineering and information sciences. (PITAC, 1999, p. 5)

In the late 1980s and 1990s the gender imbalance in European countries was claimed to be even greater than in the United States (Frenkel, 1990; Edwards, 1994), and in 1999 a study by industry analysts, Gartner Group, showed women made up only 9% of the worldwide technology workforce.

Some researchers go so far as to argue that computers have been a predominant factor in forcing women into low-paying, automated and low-skill jobs. They suggest that computers and computerisation of the workforce has acted, and is acting, as a vehicle for gender stratification (Jakobsdottir, 1996;Yeaman, 1993). For example, Edwards' (1994) report on computer-based restructuring in the banking industry argues that "a new gender division of labour also emerged, with more women working in the low-ceiling role of clerks and men clustering in what was known as the 'accelerated career' program" (p. 26). These researchers consider that the general trend is unmistakable: as the skill level increases, the number of women decline. This problem does not begin in the workforce. It is also evident at all levels of our education system. If females are to play a more powerful role in the computing workforce, then computing education must provide an equitable environment, and there are suggestions that this is not happening (Crombie & Armstrong, 1999; Pearl et al., 1990).

Women in Computing Education

The main reasons for using computers in education are to prepare students to live in an information-oriented society and to develop a more productive workforce. Most Western children these days have encountered computers well before entering secondary schools and many are very familiar with them through home, school, library and other usage. Nevertheless, the statistics disclose a disquieting situation regarding the participation by girls in computing activities at all levels of the education system.

A newspaper report released on 21 August 2001, revealed that in England, entries in physics and computing A-level exams consisted of 80% male students, and that male students made up 80% of the entries in the vocational A-level exams in information technology (Making science, 2001). The report of the American Association of University Women (AAUW) on Year 12 students in American schools showed that boys significantly outnumbered girls enrolling in higher-skill computer courses, and that the girls tended to cluster in the lower-end word processing and data entry classes. They comment that the courses students take in high school, and the level to which they take them, impact on the choices open to them for many years (AAUW, 1999). Statistics for secondary schools in New Zealand display a similar trend. In July 2001, official Ministry of Education figures show 44% (out of a total of 24,191 students) of females taking the national Computer Studies course, which involves higher-skill topics. Figures for the other national computing course, Text and Information Management, which involves lower-skill applications, show that, out of a total of 28,678 students, the proportion of female students was 70% (Ministry of Education, 2001).

As women progress from secondary school to University, they have become part of a smaller and smaller proportion of those studying computing. Camp (1997) refers to this decline as the "incredible shrinking pipeline". She says:

> Not only does the pipeline shrink from high school to graduate school, but it also shrinks at the bachelor's level ... Since the number of women at bachelor's level affects the number of women at levels higher in the pipeline and in the job market, these facts are of great concern. (p. 103)

For example, in the United States the numbers of women who received bachelor's degrees in computer science from PhD-granting universities reached a high of 35.7% in 1986 (Frenkel, 1990). Since then the numbers have steadily dropped until in 1996 the number was 16%, less than half of that 10 years previously (Camp, 1997; Furger, 1998). At PhD level the situation is no better, with the numbers of female recipients remaining at 10-12% between 1978 and the early 1990s (Edwards, 1994). In the United Kingdom, research by Grundy (1996) indicates that during the period 1988 to 1992 the number of women taking computer studies rose from 484 to 914 (12.2%), while the number of male students increased from 4,651 to 6,570. Since then, there is evidence that those figures have dropped (Millar & Jagger, 2001) and in some British institutions the percentages of female students studying computer science were as low as 2% (Grundy, 1996).

In Europe, a Norwegian study shows a radical decrease in female masters students at the University of Oslo between 1993 and 1995 – a drop from 21% to 6.5% (Stuedahl & Braa, 2000). The pattern in New Zealand Universities is also disquieting. At the University of Waikato women made up 26% of the 1994 programming methods class (Ryba & Selby, 1995) and at Lincoln University they composed only 23% of the 1998 introductory programming class. At Victoria University in Wellington the average figure for female enrolment over the 10 year period prior to 1997 was 21% (Brown et al., 1997). Carnegie Mellon University in the United States appears to be an exception, with an increase from 7% female enrolment in 1995 to 42% in 2000. However, they have been involved in a long term research study aimed at understanding the problem of the gender imbalance in their Computer Science Department, and developing a strategy which addressed selection criteria and retention (Margolis & Fisher, 2002).

Although gender gaps in participation are observed at all levels of computing education, it is more pronounced as the level becomes more advanced. That is, the loss of female participants is both cumulative and progressive (Camp, 1997). For example, for women who become faculty members, the numbers diminish through the academic ranks. According to the CRA Taulbee Survey, only 15.6% assistant professors, 9.4% associate professors and 5.7% full professors were women in Computer Science PhD-granting departments during the academic year 1993-94 (Andrews, 1997).

The under-representation of females in secondary and tertiary computer studies courses has been attributed to a number of reasons. These include the association of computing with mathematics, technology and maleness (Clarke, 1996), the manner in which the media portray computing and computing careers (Ryba & Selby, 1995; Silverman & Pritchard, 1996), beliefs about gender differences in ability (Ryba & Selby, 1995; Toynbee, 1993), the gender-orientation entrenched in computer games (Chambers & Clarke, 1990; Shashaani, 1994), and the learning environment itself (Brown et al., 1997; Byrne, 1993). All of the above contribute to shaping the social and cultural milieu of the computer classroom, which has been variously described as alienating and strange (Sproull et al., 1987); competitive, and an environment that supports fantasy behaviour (Schofield, 1995); individualistic, alien and dangerous (Turkle, 1988); insular, isolating and "out of balance" (Margolis et al., 2000) for many girls and some boys. These researchers believe that this environment is part of a distinct culture endemic to the computer classroom which is a strong contributing factor to the low enrolment and poor retention of females in computing courses.

The next section gives a brief outline of the generic attributes of culture, and identifies those aspects which contribute to the specific culture of the computer classroom.

The Culture of Computing

The Generic Attributes of Culture

One of the most widely read and replicated cross-cultural researchers, Hofstede (see for example, his works dated 1994, 1997, 2001) collected and analysed information from people working in multi-national corporations across 66 countries. He defines culture as "the collective programming of the mind which distinguishes the members of one human group from another" (Hofstede, 1980, p. 19). Such mental programming cannot be directly observed except in behaviour, words and deeds. This collective mental programming is shared with some but not with other people; it is common to people belonging to a certain group, but not to others belonging to different groups. Important to Hofstede's definition, culture is a pattern or system of values, which he describes as a "broad tendency to prefer certain states of affairs over others" (Hofstede, 1980, p.19). Other sociologists and anthropologists regard such patterns of values as the building blocks of culture (Geertz, 1973; Rokeach, 1972). Patterns of values can be characterised as being those values, attitudes and beliefs which are widely held by the members of a particular group or social system, and which become the standard or norm of behaviour (Hofstede, 1980).

Hofstede argues that culture assumes not only a collectivity, but historically derived and selected ideas and their attached values. It is a function of individuals and their interaction with their social environment. The behaviour of individuals varies according to the rules of various sub-cultures (Noddings, 1990), or the different social and physical settings in which they find themselves, mainly because the reinforcement consequences for particular behaviours also varies within different settings (Moos, 1979). It is this interaction between the person and their environment that causes the adaptation of the behaviour of the individual to fit those of the collective. These shared beliefs, values and norms to which the individual members of a group conform are very powerful (Taylor, 1996), in that when an individual either cannot, or will not, fit in with the group values they will either be rejected by that milieu or remove themselves from it.

The Relationship between the Culture of the Wider Society and Schools and Classrooms

Schools and classrooms tend to be a microcosm of the larger society and therefore reflect the attitudes and values of the wider society (Grundy, 1996). Patterns of values, social norms etc., are transmitted to the students as part of the environment of both the classroom and the school. Teachers transmit, and reinforce, these cultural norms as part of the tacit understanding they share with their students (Bowers, 1988). Ernest (1995) develops this theme when he refers to the "overt cultural dimension" (p. 472) of learning and the role of the teacher in developing cultural knowledge. He emphasises the importance of the social context in which one learns and the "socially situated nature of much knowledge and learning" (p. 472). Education, he believes, is value driven, based on what society and its culture considers valuable to teach. Tobin and Tippins (1993) also discuss the role of the teacher in structuring the learning environment to focus on what the dominant culture, or society, perceives as having the greatest viability at the time. Society depends on the vocalised and shared beliefs and values, and the education system is designed to ensure that students are imbued with these beliefs and values (Tobin & Tippins, 1993).

Language is a part of culture. It influences what we are able to think about, and enables our thoughts to be communicated to others (Schon, 1995). While values are the underlying building blocks that become the norm or standard of the culture, language is the tool which makes communication between human beings possible and the way in which culture is transmitted (Ernest, 1995). Much of the communication that makes up the exchange of information in a classroom involves communicating the patterns of values (including the individual's interpretation of them) which become the rules under which the norms and standards of behaviour in the classroom become socially acceptable (Bowers, 1988).

The Computer Classroom Culture

The popular press provided the first cultural descriptions of the computer environment portraying the undergraduate computer culture at an American university (Levy, 1984) and a similar culture in industry (Kidder, 1982). Kidder's story told about a group of very clever young engineers who were extremely competitive, who worked all hours of the day and night, who called themselves the "Hardy Boys" and the "Microkids", and who embarked on a crash program to design and build a radically advanced new computer. However, Sproull, Zubrow and Kiesler (1986) were among the earliest researchers to identify and describe what they referred to as the computer classroom sub-culture. Their research began in the early 1980s when computers were a relatively recent phenomenon in the classroom environment, and they were concerned that if the culture of computing was alienating towards girls, then it would effectively close women out of many career options in the future (Sproull et al., 1987). They described the culture as being embedded in a social system, distinguishing its members from non-members and sharing a special vocabulary, values and norms.

The Context in which Computing is Embedded

For those whose experience with computers is limited, attitudes and values often develop through mental associations (Clarke, 1996), and computers and computing are historically associated with mathematics, electrical engineering and the military (Edwards, 1994). The first programmable electronic digital computers were developed by mathematicians and used for repetitive calculations (Edwards, 1994). They were created by the United States and British military forces during WWII to automate the calculations of ballistics tables. Right through to the present day, US military sponsorship and influence has been widespread in the development of computers and computer software. Because computers continue to be strongly linked with these domains, long considered male territory, a natural connection is emphasised between mathematics, masculinity and computing (Shashaani, 1994; Mark, 2001). This connection has had an ongoing impact on computing, and contributes to the classroom culture in a variety of ways, both directly and indirectly.

The Relationship between Mathematics and Computing

There continues to be a common public perception that computing is about mathematics (Grundy, 2000) and one of the most frequent explanations for the lack of women in computing professions is the alleged prevalence of mathematical anxiety and inability in females (Bowers, 1988). While the perception of such anxiety and ineptitude arose from studies in the 1970s, which suggested that boys outperformed girls in mathematics, later research showed that once mathematics experience was taken into account, girls' and boys' grades were indistinguishable (Cottrell, 2000; Klein, 1992). However, many girls still choose to study mathematics to a lesser extent than boys once it ceases to be a compulsory subject (Lamb, 1997), and girls' confidence in their mathematical ability remains a concern (Grundy, 2000; Margolis & Fisher, 2002). For example, New Zealand statistics show that in 1995 boys at Bursary level (Year 13) were more likely than girls to take both mathematics with statistics (52% and 41% respectively) and mathematics with calculus (40% and 26% respectively) (Ministry of Education, 2001). It appears that although girls are now taking advanced mathematics and science classes in equal proportions to boys they often continue to underestimate their abilities in mathematics, particularly as they reach adolescence (Margolis & Fisher, 2002). This would suggest that boys develop more positive attitudes towards mathematics and of their mathematical learning capabilities (Lamb, 1997), and while the perception persists that computing is about mathematics, many girls, and some boys, will not take optional computer courses.

Margolis and Fisher in their book, *Unlocking the Clubhouse: Women in Computing* (2002), also comment that girls will hesitate to enrol in classes "reputed to be dominated by 'supersmart', 'logical' (read: unemotional), and competitive male students" (p. 40). A similar argument is put forward by Edwards (1994), who believes that the historically close association with mathematics and engineering has led, unnecessarily, to introductory computer science classes being taught in a highly abstract manner which is not appealing to women. While there is a degree of abstraction required, even in the use of word processing and simple spreadsheeting, the idea that computing (particularly programming) is a heavily abstract process requiring high levels of mathematics is not true.

Mathematics as a Pre-requisite for Computing

In secondary schools and tertiary institutions, computers were, and often continue to be, clustered in mathematics and science departments, and mathematics is still frequently a pre-requisite for studying computing. For example, Schofield (1995), in her ethnographic study of an American secondary school, highlights the fact that although mathematics was not a district requirement, Whitmore school required algebra as a pre-requisite for enrolling in programming courses. This use of mathematics as a pre-requisite to certain computing courses, combined with the historic and continued placement of computers in mathematics and science departments, has contributed to the widely held perception that a student must be good at mathematics in order to enrol in a computing course, and in particular, a programming course (Durndell, Glissov, & Siann, 1995; Sanders & Stone, 1986; Schofield, 1995). Yet there are many proficient programmers and systems designers who have no more than basic mathematics (Bernstein, 1997; Clarke, 1992), and there are other jobs in computing which require no mathematics at all (Grundy, 2001). In fact, Clarke (1992) argues that:

> Computers are not inherently mathematical. In fact, most work with computers involves manipulation of information and communication with people … the role of the systems analyst is to enter an organisation, find out about its organisational needs, and design a computing system that will meet those needs. (p. 72)

The Relationship between Mathematics and Computing Teachers

The AAUW Technology Commission (2000) described computer science classes as "bastions of poor pedagogy" (p. 41), with assignments and teaching exercises embedded in male-dominated interests and activities. This tends to encourage the interest of male students and conversely discourage that of the females. In turn, this leads to the under-representation of female students becoming self-perpetuating, and so becoming a contributing factor to the so-called "diminishing pipeline" (Camp, 1997), whereby the loss of female participants increases as the level of education advances.

One result of the above is the disproportionately large number of male computing teachers, contributing to the masculine image of school computing classes. Many of these teachers come from a mathematics, science or engineering background. This impacts on the culture in several ways. To begin with, the traditional methods of teaching such subjects tend to be perpetuated in the computing classroom. Grundy (2001) argues that the way in which males teach computing "is very close to what feminist researchers have found in the teaching of mathematics" (p. 9), and "a universal truth handed down by some disembodied, non-human force" (Becker, 1995, p. 168. as cited in Grundy, 2001). They argue that the pattern of interaction in the classroom highlights the teacher's superior status and is symbolised by the teacher standing at the front of the classroom and exercising control over the learning environment.

This style of teaching is said to lend itself to the logical, unemotional and objective male image, or culture, which is described as the valuing of independence, self-reliance, competition and power, and where abstract reasoning has a high value because of its association with masculinity (Byrne, 1993; Edwards, 1994; Grundy, 2000). Gilligan (1982) talks about the difference between students who prefer to learn in a separate, rather than a connected, manner. This learning style is associated with autonomy, separation, certainty, control and abstraction, and is often appealing to male students.

Role Models

Another impact of the proliferation of male computer teachers is the lack of female role models and mentors available to female students. Much that has been written about role models assumes the passive presence of a same-sex person. Role models could be defined as female computer teachers with whom female students can identify, and thus gain confidence through their visibility and example. Mentors, on the other hand, could be described as those computer teachers, both male and female, who, by their desire and ability to aid and support female students, enable these students to perform in an environment where they are a minority (Byrne, 1993).

Byrne discusses role models in her book, *Women in Science: The Snark Syndrome* (1993), and is sceptical about the suggested value of them in encouraging enrolment and increasing retention at tertiary level. While she does not believe that more female role models will, on their own, improve the interest of girls in non-traditional areas, she does agree that female role models can break the perceptive cycle that women do not participate in, or enjoy, mathematics, science and technology. While female role models can help to break the stereotype of masculinity she argues that to be truly successful, the students must be able to identify with the role model, and perceive a realistic similarity between the role model and themselves. In other words, if the students do not perceive the female computing teachers as "normal" in that they are similar to themselves, rather than exceptional, then they will not identify with them. Other researchers have found that, at least at secondary school, girls perform better and develop more positive attitudes towards computing when they have a female teacher (Corston & Colman, 1996) and the lack of visibility of female experts in the field must contribute to the continuation of the perception of computing as a male occupation.

Training of Computer Teachers

Computing in schools is a relatively new part of the curriculum and often concern is expressed about the lack of adequate computer training that primary and secondary school teachers receive. Schofield (1995) reports that for many teachers, their formal teacher training was either prior to the advent of personal computers being widespread, or it was not a part of their formal training. She argues that their lack of understanding of how computing classes can be used to enrich students' learning is a fundamental impediment to their effective teaching. She observed that such lack of training resulted in teachers feeling unprepared to teach computing, and often exposed them to the embarrassing situation where they were unable to help the students solve problems. The classroom situation became reversed from the traditional model, in that often the students (particularly the boys) appeared to know more than the teacher, thus changing aspects of classroom environment relating to the teacher's authority and control (Schofield, 1995). When specific training on computers has been received it is very often inadequate, because of the lack of time available and training sessions which are irrelevant to the immediate needs of the teachers and their present ability. Those teachers who have gained their knowledge from personal interest and recreational experience on home computers are usually male (Schofield, 1995). This is unfortunate, for when the female teachers display less knowledge than their male peers (or their students), or do not display the characteristics which the female students consider desirable, their role as a model for female students may well be negated.

To summarise, the above briefly defines the concept of culture and the value system and explains the context in which computing is placed within the educational system. Its historical association with mathematics, engineering and science, from whence it originated, has led to its continued placement in these areas in both schools and universities. Because these links are retained, they remain masculine, and the kind of dominant values which are stereotyped with respect to sex are often perpetuated, thus contributing to the lack of visible female experts in the field. Where female teachers are visible in the secondary schools, they have often had little or no computer training, which can act as a fundamental impediment to their teaching and their ability to break the stereotypical image of computing as a male domain.

The next section will address some of the specific cultural aspects associated with the computer classroom.

The Members of the Computer Classroom and Their Values

Adolescence

Adolescence is a time of intense self-consciousness and a need to fit in with one's peer group. It is a time when friends and peers are both important and influential, particularly when decisions are being made about which courses to take (Margolis & Fisher, 2002). Margolis and Fisher stated that "Girls' critical turning point is at adolescence, when they become increasingly aware of the culture that surrounds them" (p. 39).

According to the 1992 AAUW study of 3000 adolescents, it is a time when girls often suffer a drop in their confidence and perceived competence. This study indicated that between the ages of 9 and 15 years, girls were more inclined than boys to underrate their abilities and to feel that they are inadequate (AAUW, 1992). Seven years later, a further study by the AAUW reported that many girls started "turning off" technology sometime in early adolescence (AAUW, 1999). In other words, commencing around puberty girls begin to perceive that computing is not for them (Frenkel, 1990), while for many adolescent boys the computer appears to become especially appealing and a "safe haven" from the realities of life (Turkle, 1988). Byrne (1993) also discusses the changes which happen in adolescence and believes that a consensual approach "becomes more characteristic of female students than of male as they grow through adolescence" (p. 81).

Competitiveness

While much of the research shows that adolescent girls often prefer a more consensual approach to learning, the computer room itself has a reputation for being highly competitive, particularly at tertiary level. Numerous researchers (Bernstein, 1997; Crump & Logan, 2000; Schofield, 1995; Sproull et al., 1987) have commented on the fact that computer science programs are noted for their competitiveness. This competitiveness appears to have become a strong part of the tertiary computer culture. However, in her research at Whitmore secondary school, Schofield (1995) notes an apparent inconsistency in this argument. She found that in one class, where computers were used to help students solve problems, a strong, but friendly, competitiveness was noticeable as soon as the computers were introduced, particularly among the boys. This lead to greater interest in the classwork, and to greater cooperation among the students. In the computer science class there was also a notable increase in peer interaction and cooperation. Nevertheless it appeared that some pride was taken in being the first to finish an assignment, and a certain glory assigned to having to spend inordinately long hours in the computer laboratory.

Friendliness

There is no doubt that often the computer laboratory environment itself is not a friendly place for girls. The boys frequently dominate the classroom and some authors (such as Furger, 1998 and Grundy, 1996) believe boys consider the computer room to be their territory. They argue that girls are made to feel uncomfortable through both physical and verbal aggression by the boys, which can leave them marginalised in a physical sense, in that the girls are forced to the outside of the room. This appears to occur more frequently when the girls are in the minority. Bernstein (1999) comments on male students talking about computing "over and around a woman sitting between them to another male student about class work or a computing topic" (p. 6). In Schofield's (1995) book, she discusses how two girls who were in a computer science class were consistently the target of denigrating remarks. She says:

> Although the two girls were very different in many ways, they had one thing in common. They were both the object of a considerable amount of teasing, taunting, and even outright sexual harassment. (p. 178)

There is even some evidence that as early as pre-school, boys display aggressive behaviour around the computers. Kiesler, Sproull and Eccles, (1985) discuss this and say:

> In one preschool, the boys literally took over the computer, creating a computer club and refusing to let the girls either join the computer club or have access to the computer … When the teachers intervened … the girls spent as much time on the computer as the boys. (p. 254)

And more than 10 years later, Furger observed boys snatching the mouse from other pre-school students (Furger, 1998).

Games and Other Software

While the research shows that girls are beginning to turn off technology as they reach adolescence, it also shows that often, boys are developing more positive attitudes towards computers (Kadijevich, 2000). Two reasons commonly put forward for this are the greater experience boys get through playing games (Sproull et al., 1987), and the idea that males view computers differently to females (Furger, 1998; Margolis et al., 2000; Turkle, 1988).

Children frequently first encounter computers through games. They are an important means of access into the world of computing, but the cultural values embedded in computer games almost exclusively reflect what is commonly identified as adolescent male culture. Their predominant themes are war and destruction, or traditional male-oriented sports and hobbies. Even the names of the games are associated with aggression and domination, such as Exterminator and Destroyer. As Provenzo (1991) argues, their increasing sophistication, more realistic graphics, greater speed and relentless violence are expressly designed to appeal to the adolescent male and fulfil primarily male desires (Provenzo, 1991).

Companies today are developing software which targets girls (for example, in 1995 Mattel Media, Inc. introduced the Barbie Cool Looks Fashion Designer, a CD-ROM kit that enables girls to design clothes for Barbie in 3D on the computer), but historically, software developers actively targeted males in the belief that they were the ones who used the computers, and therefore played the games. It is even reported that in some cases they believed that if they targeted females, they would lose their male customer base (Frenkel, 1990). Because there are so few females developing software, the cycle of technological developments created by men, and targeted to men, repeats itself (AAUW, 1999). And as more games and software are developed with boys in mind, the more boys will use computers (Furger, 1998).

One interesting study was conducted by Huff and Cooper (1987). They asked teachers with programming experience to design software for either boys, girls or students. The software designed for boys and students was game-like, while the software designed for girls was more task-focused. They concluded that "male" became the default value for "student", and that software was designed according to the expectations and stereotypes of the designers (Huff & Cooper, 1987).

An example of the difference in the way in which boys and girls perceive computer games is cited in the investigation by Miller, Chaika and Groppe (1996) of a small group of 30 adolescent girls. The study investigated the girls' preferences about computer software available at the time, and future interactive software, with some interesting results. They observed that the girls did not seem to need to complete or win a game before moving into another environment, and that they appeared to enjoy the ability to "explore in an unstructured way" (p. 32). A second interesting finding was that many of the participants, while desiring a challenging game, did not see winning as the primary objective (Miller, Chaika, & Groppe, 1996). This is in direct contrast to what has frequently been observed of boys' attitudes towards games, where winning, or gaining the highest score, appears to be the objective (Schofield, 1995; Margolis & Fisher, 2002)

The report by the AAUW discusses the powerful effects of assigning labels, such as "sissy" or "girl" to boys who do not excel at boys' sports (AAUW, 1999). This is consistent with Schofield's (1995) research. She describes the lunch-time computer room as a temporary escape for the bright boys who do not have the physical presence of the traditional male ideal. They treated the computer room as a retreat from social pressures which they found difficult to handle. She highlights how the playing of games allowed the boys to fantasize about their image and to "assume fantasies of a tough, masculine type of person" (p. 148), and she describes the room as fostering competitive behaviours through the games the boys played. The computer room allowed them to strengthen their sense of masculinity. She points out that even the typing tutor program was masculinised through its name, Typo Attack, and its theme of destruction a means of adding excitement to the learning (Schofield, 1995). Turkle (1988) also discusses this aspect of boys' behaviour in the computer classroom. Their passion for playing games leads to them being more comfortable with the computer than their female peers, and gives them the confidence to explore other aspects.

Computing as "Fun"

Rather than playing computer games, the research points to girls preferring software which is useful and task-oriented (Schofield, 1995) (Bernstein, as cited in Frenkle, 1991). Schofield discusses the contrast of student behaviour in the classroom between the boys and girls. The girls were much more serious and task oriented, and tended to use word processing. They did not enjoy the noisy or crowded characteristics of the milieu, which is a result of competitive games being played in the computer room. While there is evidence to show that girls prefer to use the computer for less abstract and more useful purposes, if computers are continually represented as tools for girls and toys for boys, if males are the only ones shown as having "fun" on the computer, then it may be expected that girls will prefer to enrol in other electives. Margolis, Fisher and Miller (2001) cite a discussion between two computer science teachers at Carnegie Mellon University:

> I have any number of boys who 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 … My girls … look at me funny when I talk about it as fun. (p. 7)

Machine Fascination

The fascination does not stop with games. Some researchers believe that many men and boys develop a fascination with the computer as a machine, and ascribe almost personal attributes to the computer (Furger, 1998). Turkle (1986) goes so far as to suggest that the computer offers boys the "illusion of companionship without the complications of friendship in its activity and inter-activity" (p. 367). She discusses the fact that computers become particularly seductive to young male adolescents, and become a "safe haven" (p. 675) as they are faced with new social and sexual pressures. Furger (1998) also says "the computer becomes a [boy's] friend" (p. 51). In the report by the AAUW (1999), boys describe computers as "enjoyable", "special", and "important" whereas girls do not tend to use such emotive language.

The results of a four-year qualitative study carried out at Carnegie Mellon University Computer Science Department are of particular interest. In this research, Margolis et al. (2000) describe many male students recounting their "falling in love" with the computer the moment they first used one, and the "magnetic attraction between themselves and the computer, with the computer becoming an object of fascination and allure" (p. 4). Schofield (1995) also found that a number of male teachers spoke of what "they sometimes termed the almost addictive pleasure they or other males found in computing" (p. 161) while emphasising that not one female teacher spoke of a similar kind of fascination with the machine.

This fascination for the machine impacts in a number of ways. For the boys it leads to self-initiated exploration and learning, which in turn leads to greater confidence when using the computer, and greater knowledge when entering computer courses (Furger, 1998; Margolis et al., 2000). While there is a high possibility that male students exaggerate their knowledge, and may be unrealistically confident, when the female students perceive their male peers being so much more knowledgeable, and having such a fascination with, and attachment to, the computer, their confidence is often eroded (Margolis, Fisher, & Miller, 2001).

The Stereotypical Image of the Expert Computer User

The violent games, the fascination and absorption with computers which is common to some males, and the way in which computer users are portrayed in the media, have led to a common perception of the computer expert as the kind of person who would rather stay at home and play on the computer than go out and socialise (Schofield, 1995). There is a common stereotype of the computer expert as a nerd or a geek. According to the Oxford Diction definition, a nerd is a foolish, feeble, or uninteresting person, while a geek is a dull or socially inept person (Bernstein, 1999). These are not images which appeal to girls, nor to many boys. Margolis and Fisher (2000) discuss what they call "geek mythology" and "boy wonders" within the computer science environment – those boys who are adolescent hackers, or have been using computers since kindergarten. The comments they continually heard in their interviews referred to the single-minded focus required to take computer science, incessant talk about computing, that only really smart students enrolled in computing and the extremely heavy work-load requiring large amounts of time spent in the computer laboratory. This was also noted in a study by Crump and Logan (2000).

Television and the press have played a role in the perpetuation of the typical image of the computer user. Since the 1970s television advertising and trade publications have portrayed males as the typical computer user, both in terms of their target audience and the content. Males were more likely to be portrayed using the computer, while females were more likely to be standing by, observing. A recent study shows that while females are much more likely to be shown using computers on television now, they are still significantly less likely to be depicted surfing the net or playing games, and much more likely to be using it for normal business (White & Kinnick, 2000).

Language of the Computing World

Language is an essential element of culture. Dale Spender (1982) considers that "language helps form the limits of our reality" (p. 3). If that is so then the language of computing, which is largely drawn from the male environment, and very often an engineering and military environment, is bound to shape the image of computing. Grundy (1996) suggests that names like science and engineering which are often attached to computer subjects (eg computer science, software engineering) deter women and girls from entering the world of computing. Other words associated with computing such as tools and toolkits, are regularly used in the computer classroom and laboratory, and are a part of the Microsoft suite of software. An expert in computing is often described as a guru or a wizard and while such terms are seldom applied to girls, boys are happy to be referred to by such terms. The imagery of many of the words which are commonly associated with computer software, such as "abort", "execute", "kill" are likely to impact on the perceptions women have of the computing environment (Bernstein, 1999). The reference to the internet as the "information superhighway" suggests images of fast cars. This language is emotive and is consistently indicative of underlying male attitudes of violence, aggression and domination.

As well, technical jargon and acronyms are frequently used within the industry. These can give the speaker an appearance of legitimacy and power and can make the inexperienced listener feel excluded. Some researchers believe that such jargon and acronyms are often used as a means of maintaining control and stratification of power along gender lines (Currie, 1993).

Critical Mass

From her research in some Australian Universities, Byrne (1993) puts forward the concept of "critical mass" as a fundamental reason for the low enrolment and retention of girls in male-dominated courses in Australian Universities. She describes critical mass as being when the number of a minority is below a certain threshold, and suggests that the threshold is 30%. Where a minority group is under 30% then that group does not see itself as normal and members will continue to drop out or under-achieve (Byrne, 1993). They do not feel themselves to be real members of the dominant group and suffer from "imposter" phenomenon where they distrust their own skills and abilities (Clarke & Chambers, 1989). Byrne (1993) also highlights the fact that critical mass is an essential element of providing satisfactory role models as it is only when there are a sufficient number of women on the staff that female students will perceive computing as sex-normal.

When the numbers of females in courses is very small, Byrne (1993) suggests they are seen as being untypical or acting in an abnormal way for their "societally ascribed sex role" (p. 12). Byrne also discusses sex normality and sex neutrality in terms of how various courses are perceived and highlights the fact that physics and mathematics are regarded as sex-normal for boys but sex-abnormal for girls, while English is considered normal for both sexes. This is critical because in adolescence sex-role identity becomes an important issue, and adolescents do not want to be perceived as sex-abnormal. She argues that until critical mass is achieved, not only will women's retention in male dominated courses remain poor, but the growth of numbers enrolling in such courses will not occur (Byrne, 1993).

Isolation

The lack of critical mass in a classroom, and the marginalisation which may occur, can result in girls feeling isolated when taking computing classes (Craig et al., 1998). Schofield (1995), in her qualitative study of a Whitmore high school in the USA, comments at length on the isolation experienced by the girls in mixed-sex computing classes where they were the minority. She highlights the fact that to be accepted by the boys often required the girls to get involved in traditional male interactions, and even this did not guarantee their ability to become a part of the social activities of the classroom. She says:

> Not one of the four girls entered into the kind of continuing working partnership with peers that a large number of their male class-mates did. With the exception of Terry, who managed at least some task-oriented give-and-take with her male peers, they worked alone, almost exclusively, being isolated to a very marked degree. (p. 185)

The classroom is as much a social setting as a place of learning. The fact that cooperative learning helps all students, not only girls, has been widely acknowledged (De Lisi, 2002). Yet when girls are a minority in the computer classroom, they often become isolated, often develop minimal social interaction with peers, and therefore are forced to work on an individualised basis. This may well contribute to their more task-focused orientation, and use of word processing to complete work. Computing is not fun for girls in such a situation, but a means of achieving a specific objective, such as completing a work assignment (Schofield, 1995).

Single-sex and Co-educational Schools and Classrooms

A common suggestion to alleviate such problems as boys' behaviour towards girls in the classroom is that perhaps girls are better off in single-sex schools and isolated from the boys' environment (Grundy, 1996). While there has been considerable research on the benefits, or otherwise, of single-sex schools, there is no conclusive evidence which shows that girls always do better in an all-girl environment. What can be concluded is that single-sex schools and classrooms provide an environment in which social interaction and discourse is different to either mixed-sex or single-sex boys' schools (Byrne, 1993; Shmurak, 1988). While there is some evidence suggesting that girls in single-sex schools do get more computing experience, and feel more positive and confident about computing, there are other factors that should be taken into account. Single-sex schools tend to attract students from higher socio-economic backgrounds; parents may be more aware of the importance of education and therefore be more supportive; and single-sex schools often have religious affiliations which would impact on student behaviour (Jones, 2000). However, in New Zealand the evidence from research over the years suggests that the achievement of boys and girls is not affected significantly by whether they attend single-sex or mixed-sex schools. Where it can be shown that students in single-sex schools are more successful, it is more related to the fact that such schools tend to attract students from higher socio-economic levels (Alton-Lee & Praat, 2001). In fact, Byrne (1993) contends that enrolling girls in single-sex schools shelters them from the real world and perpetuates the idea that girls must be protected from boys and their "dominant, loud and territorial behaviour and their contempt for girls and sexual crudeness" (p. 185).

Perhaps a better solution for mixed-sex schools, is the setting up of optional computer classes which are all female. Research which has been carried out in Australia comparing single-sex and mixed-sex mathematics and science classes, showed that most female students preferred the single-sex classes and believed they received greater support and less harassment in them (Rennie & Parker, 1997; Parker & Rennie, 2002). These researchers also found that instruction was more orderly in all-female classes and the girls were on task and learned more. However, the all-boys classes created some management problems, and in one school behaviour was so poor that the class was abandoned after one semester. Crombie and Armstrong (1999) investigated the effects of operating an all-female computer class at a high school in Canada. Their research also pointed to an increase in female enrolment, and indicated that students from the all-female class (and male students from mixed-sex classes), perceived their teacher support as being significantly higher than those female students from a mixed-sex class. This research also indicated that the all-female class provided the girls with a positive learning experience.

However several researchers question whether separating boys and girls into single-sex classes will simply perpetuate the problems, in that such an environment may encourage girls to only participate in an all-female environment (Clarke, 1991). A better solution may be to employ intervention strategies which modify boys' behaviour to become more acceptable (Byrne, 1993) and to ensure that the classroom has equal numbers of boys and girls (Clarke, 1991). Such interventions, however, are not always well received by either males or females. Rennie (1998) highlights the problem:

> In the case of gender interventions, the spotlight usually falls on women and girls, and they do not enjoy the attention. It seems that by apparently isolating one group (such as females) in an intervention and pointing out aspects of disadvantage, there is an implication that the other group (in this case, males) is somehow to blame. (p. 954)

Another aspect of gender intervention is that it often focuses on the idea that there is something wrong or missing with girls (such as anxiety about mathematics, or inherent differences in spatial ability) which needs to be remedied; that the girls are somehow to blame, and that something in the behaviour and attitudes of girls is responsible for their lack of interest (Byrne, 1993). Putting girls into single-sex classes or single-sex schools perpetuates the idea that girls must be sheltered and helped rather than the boys modify their behaviour.

According to Byrne (1993), a more holistic approach is to change the learning environment to cater for a "gender-neutral, student-centred and well-controlled learning environment" (p. 186). By this she means that the school and the teachers are responsible for ensuring by their attitudes and teaching methods that the learning environment focuses on the needs of all the students, and that boys do not take over the classroom. This requires that the classroom activities are carefully managed to ensure that girls play an active part in the class, and that different subjects are not stereotyped as being more suitable for one sex rather than the other.

Summary

The above section has discussed some of the specific elements believed to contribute to the unique culture of the computing classroom. Adolescence is a particularly vulnerable time for students; a time when both girls and boys are precariously balanced, needing to be accepted by their peers, yet trying to establish their individuality. The language, the competitiveness, and the unfriendliness combine to marginalise and isolate those girls who do take computing. This leads to a perpetuation of the problem, as the number of girls electing to take computing classes remains below critical mass. While there may be an argument for providing single-sex classrooms for computing, in reality this deals with the symptoms, not the causes of the problem and therefore, it is the responsibility of teachers and schools to ensure that they provide a learning environment in which all students can feel equitable.

It becomes clear through the literature, that the computer classroom has a distinct type of learning environment. Therefore, studying and analysing the classroom learning environment is one approach whereby the differences in the patterns of values which are preferred by individual groups within the classroom can be highlighted. By studying the classroom learning environment it should be possible to discover the degree to which a distinct culture exists in the computer classroom, and whether boys and girls perceive this culture differently. The following section will briefly describe the learning environment, and discuss the development of some instruments used to measure classroom learning environments and how they have been used to analyse and improve participants' perceptions of such environments.

The Learning Environment

The learning environment can be described as the tone, ambience or atmosphere of a classroom or school. It concerns the kinds of things that are rewarded, encouraged and emphasized in the classroom. In other words, the culture, or the pattern of values which are accepted as the norm within a classroom, is a dominant aspect of the learning environment. The learning environment emphasises the relationships between students, and between the teacher and students. It is the measurement of the social climate, or psychosocial characteristics, and is one of many ways in which educational environments may be characterised (Moos, 1973).

However, the classroom, like any social setting, does not stand on its own. It is impacted on by many other aspects of the participants' lives. It can also be affected by physical surroundings such as the size and shape of the classroom, the size of the class, the ability and experience of the teacher in establishing different learning environments (Moos, 1991; Wubbels, Levy, & Brekelmans, 1997).

The formal study of learning environments from the student perspective is relatively recent (Ellett, Loup, & Chauvin, 1991). While surveys are the oldest ways in which educational research has been undertaken (De Landsheere, 1993), research into the learning environment in the early part of the 20th century consisted mainly of descriptive accounts that used specific, relatively objective observations of classroom behaviour recorded as frequency counts by an observer (Chavez, 1984). Research into learning environments, carried out over the last four decades, is now firmly established and a variety of different instruments have been developed to measure cleassroom learning environments (Fraser, 1994). While the classroom learning environment may be a somewhat nebulous and intangible concept, the accumulated research continues to show that (a) the learning environment can be conceptualised and measured, not only in the normal classroom but also in special educational settings, (b) that the perceptions of different sub-groups can be identified and measured, and (c) students' perceptions of their sociological environment reflect on their cognitive and affective outcomes, such as attitudes, self-concepts and well-being (Clarke, 1995; Fraser, 1989; Taylor, Fraser, & Fisher, 1997). Therefore, studying the classroom learning environment is a valid way of assessing where male and female students' perceptions vary, and how such variance impacts on their affective outcomes.

Background to Development of Learning Environment Survey Instruments

Walberg began developing his first version of the *Learning Environment Inventory* (LEI) as part of the research and evaluation activities of the Harvard Project Physics (Walberg & Anderson, 1968). This instrument asked students for their perceptions of the whole-class environment. At about the same time, Trickett and Moos (1973) were developing a series of environment measures which concluded with the *Classroom Environment Scale* (CES). These two questionnaires provided considerable impetus for the study of the classroom learning environment. Moos worked in a variety of different social milieus which he classed as (1) Treatment Environments such as hospital based treatment programs, (2) Total Institutions such as correctional institutions, (3) Educational Environments such as school classrooms, and (4) Community Settings such as industrial or work milieus, and families.

Moos' influence is particularly important because of his identification and development of three broad categories which are the basis for many survey instruments, including the CUCEI which is used in this research. These categories are: (1) relationship dimensions, which measure the extent to which people are involved in the environment, support and help one another, their spontaneity of expression, and the extent to which people work with each other and get to know each other within the environment; (2) personal development dimensions which assess the basic directions along which personal development and self-enhancement tend to move in an environment; and (3) system maintenance and system change dimensions which assess the extent to which the environment is orderly, clear in its expectations, maintains control and is responsive to change (Moos, 1973; Trickett & Moos, 1973). Sub-concepts, including involvement, affiliation, teacher support, goal and task orientation, order and organisation, and clarification of rules, evolved from these categories (Moos, 1980).

Measuring Instruments

Examples of some of the instruments that have been developed to measure classroom learning environments from primary to tertiary level, and which are based on Moos' three dimensions are: at primary level, the *My Class Inventory* (MCI) (Anderson, Walberg, & Fraser, 1981), at secondary level, the *Classroom Environment Scale* (CES) (Moos & Trickett, 1974), the *Learning Environment Inventory* (LEI) (Walberg, 1971), and the *Individualised Classroom Environment Questionnaire* (ICEQ) (Rentoul & Fraser, 1979), and at upper secondary and tertiary level, the CUCEI (Fraser & Treagust, 1986). These instruments attempt to measure the psycho-social characteristics of the learning environment. They have been used to compare student cognitive and affective outcomes in different countries (Fraser & Treagust, 1986), and have shown that the environmental setting varies between different types of schools, different classroom sizes, and different subjects (Moos, 1979).

Most of these instruments measure perceptions using two different forms; the actual version which measures the classroom as participants actually perceive it to be, while the preferred version measures perceptions of the classroom environment ideally liked or preferred by the participants (Fraser & Treagust, 1986). The forms use matching sets of questions, and generally use a four- or five-point rating scale. Profiles of actual-preferred discrepancy scores provide a method of highlighting where the actual environment is perceived as divergent from the preferred environment. It is also possible to measure the difference between the students' perceptions and the teachers' perceptions, and this has very often shown that teachers' perceptions of their learning environment are more positive than their students' (Fraser, 1994).

By using assessments of students' perceptions of both actual and preferred classroom environments, associations have been discovered between the learning environment and teacher personality, class size, and the ratio of boys to girls in the class. For example, among other findings, Moos (1980) identified that classes with a large proportion of female students had more innovative classroom environments. Other research has identified that females enjoy cooperative classrooms, while males enjoy greater competition and individualisation (Anderson et al., 1981). Some studies have reported sex-related differences in science students' perceptions of their learning environment, in particular that girls generally have more favourable perceptions of their science classrooms than do boys in the same classes (Henderson, Fisher, & Fraser, 1998). Other studies have consistently identified that females perceive their teachers in a more positive way than males (Fraser, Giddings, & McRobbie, 1992). These studies are of particular value because they are able to identify differing perceptions among sub-groups of students. Because of this ability to measure where differences occur in a variety of settings, it is possible to use the results to guide improvements in the learning environment (Fraser, 1994).

An analysis of three case studies which combined the use of both qualitative and quantitative methods, highlighted the fact that the way many of the instruments were designed, and the data analysed, did not allow for the differences between either individuals or sub-groups within a classroom (e.g., males and females) to be taken into account (Fraser & Tobin, 1991). They concluded that the items in the existing learning environment instruments were worded so as to elicit a student's view of the classroom as a whole, rather than the view of the individual student's perception of the classroom. Fraser, Giddings and McRobbie developed a new form which contained not only actual and preferred versions, but also separate forms for measuring both class and personal perceptions (Fraser et al., 1992). They changed the items in the following way to reflect the student's perceptions of how they personally were affected by the classroom learning environment:

Item 1 in the class version would read: *The instructor considers **students'** feelings.*
Item 1 in the personalised version would read: *The instructor considers **my** feelings.*

They found that student scores on class versions were more favourable than on the personalised versions and that it was possible to examine differences in perceptions of individuals and sub-groups within the whole group when using the personalised format.

The CUCEI is one of the instruments which has been developed to measure the learning environment. Because it was designed specifically for use at upper secondary and tertiary level, it was perceived as being an appropriate instrument for measuring the learning environment of the computer classroom for Year 12 and 13 students.

The CUCEI

The CUCEI was initially developed by Fraser and Treagust for use in small, seminar type classes of about 30 at upper secondary and tertiary level (Fraser & Treagust, 1986). The original survey instrument contains seven, seven-item scales. These scales cover the three general categories of dimensions identified by Moos. They are: *Personalisation, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation,* and *Individualisation.* Table 2.1 shows the seven scales used in the original form of the CUCEI and how they relate to Moos' three dimensions.

Table 2.1

Descriptive Information for the Original CUCEI

Scale Name	Moos' category	Scale description (Fraser & Treagust, 1986)
Personalisation	Relationship	Extent to which individual students interact with the teacher, and concern for student's personal welfare
Innovation	System maintenance and system change	Extent to which new or unusual activities, assignments or teaching methods are employed by the teacher
Student Cohesiveness	Relationship	Extent to which students help each other and are friendly
Task Orientation	Personal development	Extent to which class activities are clear and well organised
Individualisation	System maintenance and system change	Extent to which students are allowed to make decisions and are treated differently according to ability, interests and rate of working
Involvement	Relationship	Extent to which students participate actively and attentively in class discussions and activities
Satisfaction	Relationship	Extent to which students enjoy their classes

This instrument has been used in a variety of situations to assess the learning environment and has proven to be a valid and reliable instrument for measurement of students' and teachers' perceptions in both secondary and university classes. Fraser and Treagust (1986) used the CUCEI to evaluate the perceptions of 372 postgraduate and undergraduate students from a variety of different disciplines from two institutions in Western Australia, and an institution in Illinois, USA. They also surveyed 30 teachers from these classes. One of the significant results from this survey was that perceptions of Satisfaction were greater in classrooms with higher perceived Cohesion and Task Orientation. Another result was that on six of the seven dimensions, students preferred a more favourable environment than they actually perceived as being present, but there was very little difference between the actual and preferred versions of the Personalisation dimension. A comparison of students' and teachers' perceptions indicated that the teachers preferred a more favourable environment in all of the dimensions except Task Orientation. Overall findings therefore indicated that both teachers and students would prefer a more positive environment than they actually perceived was present.

The CUCEI was also used to evaluate the classroom environment at the senior high school level in 1986 (Williamson, Tobin, & Fraser, 1986). This research involved the evaluation of 742 adolescent and adult learners from high schools in Perth. They found it to be a suitable and useful instrument for measuring students' perceptions in the upper secondary classes and for adults at alternative high schools.

In 1987 a further study was undertaken in Western Australia, using a sample of 536 senior college students in alternative high schools which catered for adult learners (Fraser, Treagust, Williamson, & Tobin, 1987). Three control samples from evening technical colleges, a conventional high school which catered for adult students, and a conventional high school which catered for adolescents only were used as comparisons. The results revealed clear patterns of differences in the different classroom environments, showing the most favourable environments in the technical colleges and the least favourable in the conventional high school catering for adult students. The only scale which was an exception to this trend was Student Cohesion, where cohesiveness was higher in the conventional high schools than in the other two school types.

A further study undertaken at a Western Australian institution's School of Oral Health Sciences in 1997 used the CUCEI to evaluate the perceptions of participants when changing from teaching in a formal lecture mode to a more interactive mode. The major outcome was that students' ratings of all scales improved as a result of action taken (Booth, 1997). In 1998 another study utilised the CUCEI to evaluate the learning environment of two groups of Registered Nurses on block courses to enable a change in teaching method from the traditional lecture mode to a more interactive method. As a consequence changes were made and much greater motivation and cooperation were detected (Fisher & Parkinson, 1988).

Modified Version of the CUCEI

In 1999 Nair and Fisher modified the CUCEI. Firstly, they personalised the items of the questionnaire by changing the wording in order to identify the perceptions of different sub-groups, particularly males and females. Secondly, they replaced the Involvement and Satisfaction scales with two new scales, Cooperation and Equity, both relating to Moos' Relationship category. The Cooperation scale was included because the previous research suggested that cooperation declined as students moved from upper high school to university. The Equity scale was used to measure the degree to which students perceived that they were treated equally by their teachers, and to allow investigations of students' perceptions of their learning environment with respect to social grouping variables, such as sex. Thirdly, they replaced the four-point rating scale with a five-point scale because this was considered to give participants a greater choice in their responses and was also deemed to better represent the personalised format of the questionnaire (Nair & Fisher, 2001). A fourth change, which they do not discuss, was a change from the cyclic order used in the original version, to having all items relating to one scale grouped together.

Using this modified form, 504 students from a variety of science subjects in Canadian and Australian institutions took part in a study comparing changes in students' perceptions of their classroom environment between senior high school and university, as well as whether the sex of the student impacted on their perceptions (Nair & Fisher, 2001). The results identified a number of differences in perceptions between male and female students. While all students agreed generally as to what their preferred classroom should be like, female students appeared to prefer less individualisation, and greater cooperation. Female students also perceived their classroom environment more favourably than the males at both the senior secondary and tertiary levels. Their study confirmed both the reliability and validity of the modified and personalised version of the CUCEI at senior secondary level, and also demonstrated that it was capable of distinguishing between the perceptions of male and female students. Therefore, as there was no specific instrument developed to investigate the concept of the culture of the secondary school computer classroom, the CUCEI was deemed to be a suitable instrument for use in this research.

Over the last four decades considerable research has been successfully carried out on the development of valid and reliable instruments to measure the learning environment in the classroom. However, another approach to studying such environments is the application of qualitative techniques, particularly for identifying patterns of values relating to culture, which as Hofstede (1980) says, can be observed in behaviour, words and deeds.

The next part of this section gives a brief explanation of the differences between quantitative and qualitative enquiry in the educational sector, and discusses some case studies where a combination of methods was successfully used in researching classroom environments.

Qualitative and Quantitative Research

During the late 19th and throughout most of the 20th century, research has been dominated by what has been termed positivism, based on the epistemological position that research is only valid and reliable if it is based on logic and mathematical, empirical observation (Schon, 1995). Until the last 40 years, therefore, most educational research has been of a quantitative nature. Quantitative research requires the use of standardised measures, which can be used to gather data from a large number of people. The results of such methods are believed to be valid and objective because they can be replicated across a similar sample and produce the same or similar findings. Such results can then be generalised across the population using probability statistics (Schofield, 1993).

In comparison, qualitative research produces findings through the analysis of data which has been collected by more subjective methods, such as interviews, observation and written documentation, instead of using statistical procedures or other means of quantification to arrive at the findings (Patton, 1990; Strauss & Corbin, 1990). Qualitative research allows the researcher to study selected issues in depth, typically producing a wealth of detail about a small number of people or situations. In qualitative inquiry "the researcher is the instrument" (Patton, 1990, p. 14), and one of the major arguments against qualitative research is its subjectivity caused by the reliance on the researcher and the researcher's interpretation of the data. Subjectivity implies irrationality, biasedness and unreliability. Patton (1990) addresses this issue, concluding that "intellectual rigor and professional integrity" (p. 476) are overriding features required of a qualitative researcher. He believes that qualitative inquiry methods have proven themselves to be valid ways of investigating what is happening in social settings.

Since the 1970s there has been a shift to an increasing use of qualitative inquiry within the education sector (De Landsheere, 1993). This acceptance of qualitative research has evolved from a critique of positivism by social scientists and other researchers (Dunne, 1996). For example, in 1974 Cronbach and Campbell, two of the best-known American educational researchers, wrote independent papers stressing the critical importance of alternatives to the quantitative methods of inquiry and the traditional positivist emphasis that had been placed on educational research (as cited in De Landsheere, 1993). Cronbach stated that statistical research was unable to take full account of the interaction effects that take place in social settings and that the null hypothesis had outlasted its time. He claimed that because of findings of statistical insignificance, quantitative research ignored variables that may be important.

This shift has given rise to debates about methodological concepts such as validity and objectivity (De Landsheere, 1993), leading to qualitative and quantitative methods becoming dichotomised and some researchers continuing to acclaim one epistemological research method over another (Greene et al., 1989; Patton, 1990). However, for a number of years now, educational researchers have advocated the use of both quantitative and qualitative methods within the same study. For example, Fraser and Tobin (1991) cite three successful case studies where both methods have been used in research into the classroom environment. These case studies focused on higher-level cognitive learning in the classroom, the nature and role of target students, and exemplary teachers (Fraser & Tobin, 1991). The first case study used participant observer data collection strategies. Based on the results of the qualitative data, selected scales from two relevant questionnaires were used to gather quantitative data and statistically analysed. These results supported the qualitative results. The second case study employed an interpretive approach using interviews and observations, while the quantitative data were collected using a variety of questionnaires to assess student perceptions of their learning environment. The third case study involved qualitative data gathered through observation of classes, and interviews with teachers, while the quantitative component employed the CES to gather students' perceptions. Fraser and Tobin concluded that the combined use of qualitative and quantitative methods in these case studies provided a complementarity which added to the richness of the data and provided triangulation leading to greater credibility of the results.

Summary

Computers are an integral part of today's society and it is therefore important that women have input in the formulation and development of computer systems. Yet the number of women employed in the higher-skilled, higher-paid sector of the computer industry is few, and girls are turning their backs on computing courses at all levels of the education system. This under-representation has been attributed to a number of reasons, one of which is that there is a culture which is endemic to the computer classroom and which is off-putting to many girls and some boys. This culture is said to stem from the historic connection between computers and the mathematics, science and military domains. This has resulted in the majority of teachers being male and who are said to teach in a traditional way, which is not appealing to girls. It also leads to a lack of female role models and mentors.

The computer classroom itself is considered to be competitive and unfriendly towards girls, when they are in the minority. Games play an important role in boys' learning, and gaming software is usually violent, designed to appeal to adolescent boys, and unappealing to girls. As well as their passion for games, many males appear to have a fascination with the machine itself, thus contributing to the stereotypical image of the expert computer user as a "nerd" or "geek". The language associated with computing is often very masculinised. All these factors contribute to a computer classroom culture, said to be isolating to those girls who do enrol. One suggestion that is made to overcome this problem is to provide single-sex classrooms or send students to single-sex schools. Studying and measuring the learning environment is one way in which it is possible to identify the culture, and patterns of differences between different types of school.

Research into the classroom learning environment is now firmly established. Traditionally research into the learning environment has been focused on quantitative measures, but there has been a more recent move towards a combination of both qualitative and quantitative research designs. Many different instruments have been developed to measure the quantitative aspects of the learning environment, and one such instrument is the CUCEI. This was designed for use in small classes at upper secondary and tertiary level and has been used and validated in a variety of different situations. Combined with observations and interviews, the CUCEI was therefore considered to be a useful tool for this study.

The following chapter describes the research design of the study, including the administration and use of the CUCEI, as well as classroom observations, and interviews of students and teachers, to gather data to answer the research question.

CHAPTER 3

RESEARCH DESIGN

Introduction

This chapter presents a discussion of the research design used in this study. The research questions are first restated and the reasons for using a mixed-method approach are provided. The samples used in the study are then described together with a description of the types of schools participating in the research. The selection of the CUCEI, its published reliability and discriminant validity are discussed. Explanations as to why observations and interviews were considered important are given, and the ethical safeguards are explained. Next follows a description of how the data were collected. The way in which the CUCEI was distributed and analyzed is explained, as is the method of conducting and analysing the observations and interviews. The chapter concludes with an overview of the analysis of the interview and observation data.

Research Questions

The purpose of this research is to identify the degree to which "computer culture" exists in secondary schools and whether it may contribute to the lack of female enrolments in computing classes. Specifically the research investigates:

1. What are the characteristics of the computer studies classroom?
2. What perceptions of the computer studies classroom are held by Level 12 and 13 secondary school computing students?

a. What are the differences (if any) between male and female students' perceptions of the computer studies classroom?
b. What are the differences in perceptions of the computer studies classroom (if any) between students attending single-sex and mixed-sex schools?

3. How can the learning environment of the computer studies classroom be designed to be encouraging of both female and male students?

Research Design

This research uses a mixed-method design, involving both quantitative and qualitative approaches to data gathering and analysis through the use of surveys, observations and interviews. All research approaches have inherent biases and limitations (Denzin, 1988), whether these draw from the researcher's personal perspective, or from the use of one particular method which yields a certain type of result. For this study, data were gathered from more than one perspective as a way of adding depth and richness to the data and strengthening the results. Also, because the research is classroom-based, where meaning is socially constructed and changing constantly, it was considered that no single research method could capture the complexity of features in the classroom.

While Erickson (1986) states his pessimism about the possibility of combining contrasting methods, and Guba and Lincoln (1989) believe that naturalistic research is the only valid method of enquiry, other researchers, such as Patton (1990), are more pragmatic and believe the important issue in research is to choose the most appropriate method for the purpose of the enquiry, if necessary combining the strengths of both qualitative and quantitative approaches. However each research paradigm embodies disparate assumptions about the nature of the world, and the types of questions asked from the different methods are fundamentally different and produce different understandings (Guba & Lincoln, 1989; Patton, 1990), often leading to divergent and discrepant findings.

Greene, et al. (1989) discuss the problems of expecting data from mixed methods to converge and set out a conceptual framework describing how they may be used. They identify and explain five distinct purposes for the use of a mixed-method design. This framework is based on the similarity of the methods used, the phenomena researched, the paradigms used, the status applied to each method, the timing of the individual methods and whether they are implemented independently or interactively. The five purposes of mixed-method designs are triangulation, complementarity, development, initiation and expansion, and four of these have been used to guide the research design, data gathering and analysis in this study.

Triangulation

One commonly cited reason for using a mixed-method design is as a means of triangulation, a concept originally developed by Campbell and Fiske (1959), but the term is derived from navigation where the process involves using two, or preferably three, reference points as sources to find one's position (Mathison, 1988). In research this is achieved by intentionally using more than one method of gathering and analyzing data about the same phenomenon in order to seek convergence (Denzin, 1988). Such methods should be implemented simultaneously and independently to provide triangulation (Greene et al., 1989). This study has used survey data, as well as interviews of teachers and students, and observations of classrooms. These methods were implemented independently, at about the same time, and used to provide different kinds of data that could result in convergence of findings. However, the assumption that the inherent bias of any particular research method will be negated by the use of triangulation is not necessarily true, because triangulation seeks convergence.

Complementarity

This research has a complementarity aspect because the interviews and observations, while assessing the learning environment of the computer classroom, also assess more specifically the computer culture that may exist in the classroom. Thus both the quantitative CUCEI results and the qualitative interviews and observations were used to measure overlapping but different aspects of the same experience, and the results from the qualitative data were used to complement the results from the quantitative data.

Initiation

In a mixed-method design with an initiation intent, the aim is to seek areas of non-convergence; and discover where and why such contradictions exist. Initiation requires an iterative approach and Greene et al. (1989) suggest that "mixing paradigms in this design is acceptable and even encouraged" (p. 268) because of the ability to maximize the possibility of discovering inconsistencies. In this study, the perceptions of students and teachers were sought through interviews and the type of information gained was different to that from the CUCEI, giving the researcher fresh insights into the computer culture in the classroom. Observation of the classrooms also provided a greater understanding of the different ways in which boys and girls operate in the computer classroom, and led to additional questions and probing in the interviews, particularly in the early stages as a result of observations in the first school. This led to an increase in breadth and depth in the analysis of the data.

Expansion

With an expansion intent, the different methods are used for different components of the enquiry in order to extend the overall research. Very often each method quite separately investigates individual aspects of the research. The researcher sought to extend the scope and breadth of the study by using interviews with both teachers and students, thereby gaining insight from their different perspectives, and by observation of the classrooms that provided data from the researcher's perspective. While the CUCEI asked set questions about the learning environment, the interviews and observations enabled the researcher to look for meanings to interpret differences and make sense of the happenings in the classroom.

Therefore the CUCEI, observations and interviews were used in order to triangulate (by seeking to corroborate the results obtained between the different methods), complement (by using the different methods to investigate overlapping but different aspects of the research), initiate (by seeking new and fresh perspectives) and provide expansion (as a means of extending the research). Equal emphasis was placed on each aspect of the data collection. In sum, a mixed-method design was used in an attempt to eliminate bias and provide a broader and more in-depth analysis of the computer learning environment.

Sample

The sampling method used was one of convenience or opportunity. While using such a method may not be useful for generalising the results of the study to the larger population, it was necessary to take this course because of the difficulty in enlisting participation from both schools and students. This may lead to a certain bias in that the sample of volunteers may not represent other "typical" members of the population, and the results must be interpreted with this in mind.

CUCEI Student Sample

The sample selected for the CUCEI comprised students from seven central Wellington secondary schools, who had elected to take a computer studies course in 6^{th} and 7^{th} form (Years 12 and 13, the last two years of secondary school). Most schools mixed their Year 12 and 13 classes for electives such as computer studies, and many of the classes were very small. The schools consisted of three co-educational schools (referred to as C1, C2 and C3), three single-sex girls' schools (referred to as G1, G2 and G3) and one single-sex boys' school (referred to as B1) (see Table 3.1).

New Zealand schools are classified into deciles as a way of funding schools and enabling them to overcome the barriers to learning faced by students from low socio-economic communities. The lower the school's decile, the more funding it receives. Decile 1 schools are the 10% of schools with the highest proportion of students from low socio-economic communities, whereas decile 10 schools are the 10% of schools with the lowest proportion of these students (see Table 3.1). The socio-economic indicator consists of six factors: household income, household crowding, occupation, parental educational qualifications, income support, and ethnicity. Census information and school ethnicity data are used to calculate the deciles. All three of the single-sex schools for girls were decile 10, while the single-sex school for boys was decile 5. The co-educational schools were decile 10, 8 and 7 (Ministry of Education, 2002).

Computing is an elective subject for Year 12 and 13 students in most New Zealand secondary schools, and it is not a Bursary subject. The Bursary examination is the entrance qualification to New Zealand Universities. Individual schools offer different types of computing courses, and the following describes how the subject was offered at the participating schools. All classes, except those at Schools C1 and G3, were enrolled in the Unit Standards computing subject. The prescription for Unit Standards is set by the Ministry of Education, and the certificates are granted by them. The subject covers a variety of computer software applications, the history and some basic theory of computing, web development and an introduction to programming (although this was often HTML, which is not a true programming language). School C1 offered three different classes, one called Project Management, a second called Computer Studies and a third called Information Management. Only the Information Management class was a Unit Standards programme. School G3 offered to their Year 13 students, for the first time in 2001, the opportunity to gain the International Computer Driver's License. This is based on a successful European scheme which operates in many countries around the world, including Australia and New Zealand. In New Zealand it is managed, and certificates are awarded, by the New Zealand Computer Society. In order to gain the License, students must pass tests on seven competencies which include basic applications and concepts. This was made a compulsory subject at this school and, initially at least, many of the students were not happy about being compelled to take it. Students in one of the classes at School G2 were also competing in the New Zealand NetGuide Schools Web Challenge, whereby groups of three or four students take any topic they have studied and build a web site of up to 10 pages.

Table 3.1

Sample Size for the CUCEI, indicating School Type and Decile Rating, Numbers of Students Surveyed at each School, Sex of Students and Subject Name

Type of School	School Code	Decile Rating	Numbers of students		Subject name
			Male	Female	
Co-educational	C1	8	30	4	Computer Studies and Project Management
Co-educational	C2	10	15	9	Unit Standards
Co-educational	C3	7	34	38	Unit Standards
Single-sex girls'	G1	10		36	Unit Standards
Single-sex girls'	G2	10		25	Unit Standards
Single-sex girls'	G3	10		33	International Computer Driver's Licence
Single-sex boys'	B1	5	51		Unit Standards
Total			130	145	

Interview Sample

Initially, four schools agreed to participate in this aspect of the research, but, due to staff changes, School G1 withdrew from further participation in the research after administration of the CUCEI. Therefore, interviews were conducted in one co-educational, one single-sex girls' school and the single-sex boys' school (schools C1, G2, and B1). Individual interviews were conducted with four teachers, three of whom were Heads of the Computing Department at their schools, and the other one who was a teacher of Levels 12 and 13 computer classes.

From School C1 two teachers were interviewed, Mr Smith and Ms Cornell (all names used are pseudonyms). Mr Smith had a degree in pure mathematics, and had taught at the school since the late 1970s, initially teaching mathematics and physics. He began teaching computing in the early 1980s, and was very experienced and knowledgeable. Ms Cornell had a degree in English. She had become involved with computers while teaching at another school where she had library responsibilities, and was in charge of the library computers. She said that one of the major reasons and was in charge of the library computers. She said that one of the major reasons she had been employed at School C1 was to provide a role model for the female students.

The teacher from School G2, Ms Watson, had commenced her career as a teacher of shorthand and typing. She had progressed from teaching typing to word processing, and then to other computer applications and had gained a Bachelor of Arts and completed a Post Graduate Diploma in Teaching. She was also in charge of the school's Computing Department.

At School B1, the teacher, Mr Adamson, had a Masters degree in Forestry Science from The Netherlands, which was based on mathematics and statistics. He began his teaching career with mathematics and science and reluctantly moved to computing because of the shortage of computer teachers, eventually becoming Head of the Computing Department at this school.

Individual interviews were held with 12 students, and a group interview was held with five students from one school (G2). Partly because the sample of students for interview was small, it was decided to keep records of other informal discussions with students associated with the classroom observations, for example, conversations in the corridors while waiting for class to begin. Difficulties associated with arranged student interviews are discussed later in the chapter. Table 3.2 shows the breakdown of interviewees.

Table 3.2

Composition of Interviewee Sample

School	Teachers			Students	
	Position	Male	Female	Male	Female
C1	Head	Mr Smith		1	4
	Teacher		Ms Cornell		
G2	Head		Ms Watson		3 5 (Group)
B1	Head	Mr Adamson		4	
Total		2	2	5	12

Observation Sample

As with the interviews, four schools initially agreed to the researcher observing in the computer classroom but one school (G1) withdrew from this aspect of the research because they had a number of staff resignations and temporary replacements. The Head of Computing felt that observation of the classroom environment would not show a normal picture, and may cause stress to the participants, particularly the temporary teachers. Therefore, observation was conducted in three schools (C1, G2 and B1). At School C1 a Programming class and a Project Management class were observed over a three week period in October/November 2000, for a total of 10 hours. The teacher of both these classes was Mr Smith. At School G2, two separate Unit Standards classes were observed over one week in August 2001, for a total of 10 hours. The teacher of both these classes was Ms Watson. At School B1, four separate Unit Standards classes were observed over a one week period in September 2001, for 14 hours. All classes were taught by Mr Adamson.

The teachers at these three schools were very willing to have the researcher in the classroom and expressed great interest in the research topic and the results.

Instrumentation

This section provides an overview of the methods used to gather the data. These ranged from the use of the CUCEI to gather quantitative data from all seven schools, to observation of classrooms in three of the schools, and interviews with teachers and students in three of the schools.

The CUCEI

Based on the literature review, it appeared that there were no survey instruments developed specifically to measure computer classroom culture. However, because the CUCEI was developed to measure the psychosocial perceptions of students at upper secondary level and in small classes, and the scales in the modified version appeared appropriate instrument to use in conjunction with classroom observation and interviews.

The Actual (see Appendix 3A) and Preferred (see Appendix 3B) personalised Versions of the CUCEI were used to survey students. As mentioned in Chapter 2, the CUCEI consists of seven, seven-item scales. Each item in the CUCEI is responded to on a five-point rating scale as follows: *Almost Never, Seldom, Sometimes, Often, Almost Always*. Item responses are scored, 1, 2, 3, 4, and 5, with the scoring direction reversed for some items so that 5 always represents the most positive response.

The properties of the instrument were examined before it was chosen for this research. Nair and Fisher (1999) had reported its reliability and validity when used on an initial student sample of 504 students in a variety of science classes. Cronbach's alpha is a measure of internal consistency in scales and 0.60 is considered to be an acceptable value for research purposes (Nunnally, 1978). The values obtained for the seven scales of the instrument in Nair and Fisher's 1999 research ranged from 0.73 to 0.93 for the Actual Version of the CUCEI and 0.76 to 0.94 for the Preferred Version, using the individual as the unit of analysis, indicating acceptable internal consistency. These values are shown in Table 3.3.

Table 3.3

Reliability, Discriminant Validity (Mean Correlation with Other Scales) for the Actual and Preferred Versions of the CUCEI, and the Ability to Differentiate between Classrooms (ANOVA) (Nair & Fisher, 1999)

Scale	Cronbach Alpha Coefficient		Mean correlation with other scales		Eta^2
	Actual	Preferred	Actual	Preferred	
Personalisation	0.87	0.84	0.34	0.45	0.23**
Student Cohesiveness	0.82	0.83	0.20	0.47	0.28**
Task Orientation	0.77	0.79	0.27	0.44	0.27**
Cooperation	0.92	0.93	0.25	0.45	0.11*
Individualisation	0.82	0.80	0.15	0.25	0.22**
Equity	0.93	0.94	0.30	0.42	0.09*
Innovation	0.73	0.76	0.22	0.43	0.13**

$^{**}p < 0.001$ $^{*}p < 0.01$

To determine whether the scales of the CUCEI were measuring different aspects of the learning environment, Nair and Fisher (1999) computed correlation coefficients between the separate scales. The mean correlation of each scale with the others was used as a measure of discriminant validity and these values are shown in Table 3.3. They reported a range from 0.15 to 0.34 for the Actual Version and from 0.25 to 0.47 for the Preferred Version and concluded that each scale appeared to measure distinct although somewhat overlapping aspects of the classroom learning environment.

Nair and Fisher also examined the capability of the CUCEI to differentiate between classrooms using a one-way ANOVA with class membership as the main effect and the individual as the unit of analysis. Eta^2 was calculated for each scale to determine the proportion of variance in the scores attributable to class membership. These results are also shown in Table 3.3 and indicate that each scale differentiated significantly ($p<0.01$) between classrooms.

Nair and Fisher (1999) concluded that these results indicated that the CUCEI was a valid and reliable instrument, and these results suggested that it could be suitable for use in this study.

Interviews

The second component of the mixed-method design used in this research was open-ended, semi-structured interviews with both staff and students. The researcher was aware of criticisms of this mode of data gathering in that the interviewee may not tell the truth, instead saying what it is thought the interviewer wants to hear, for example, and that the questions asked may not elicit important information unless they are correctly framed. It was hoped that this interview design would permit the interviewees the freedom and comfort to shape their own accounts, but also allow the researcher to maintain control over the direction of the interview. This approach enabled the researcher to examine the perspectives of the staff and students.

It was intended that interviews should be in-depth, but in practice this was possible only with the teachers and some of the students, as it proved difficult to achieve with all of them. This was mainly because some students were shy and the researcher had all of them. This was mainly because some students were shy and the researcher had not had sufficient time to establish a good rapport. This meant that interviews were generally quite structured with the students, and also resulted in one group interview of 5 students at School G2. However, the researcher was able to probe interviewees' replies and follow up on topics that were not a part of the prepared set of questions. Informal conversational interviewing in the classroom while observing, and in the corridors while waiting for classes to commence, were also used to elicit information from both students and teachers. Notes were taken of these informal interviews and conversations immediately after they occurred as part of the day's field notes.

Both teachers and students from School C1 were interviewed in the researcher's office, as the school and the university are situated on the same block of land. Other interviews were conducted either in the school library, or in a room which was provided by the school, and at all times the researcher and the participants were visible to the public. The interviews were carried out over the time period of the observations. The time spent in interviewing the individual participants varied from approximately 1 hour to as little as 15-20 minutes.

The interviews began with the researcher asking straightforward background questions in an attempt to make the interviewees feel at ease, and to encourage the participant to talk freely. This was particularly important because some of the students were initially nervous of the tape recorder, although all gave consent to its use.

A series of questions was developed for the interviews to reflect the scales of the CUCEI. Additional questions were designed to discover whether the interviewees perceived any of the dimensions of the so-called "computer culture" in their individual classrooms, or experienced any other aspects attributable to the culture (see Appendices 3C and 3D). The interviews followed Patton's (1990) suggestions as to what questions to ask and were aimed at understanding the participants' thoughts and feelings about issues associated with the computer learning environment and culture. There were also some demographic questions for teachers concerning their qualifications and teaching background.

Observation

Non-participative observation was chosen because it was non-interventionist, yet would allow the researcher to not only observe the behaviour and deeds, but also to listen to the verbal interactions, witness the activities, and make links regarding the cause and effects of behaviour. It seemed a particularly useful way of addressing the classroom culture issue, especially in light of Hofstede's (1980) belief that it is in the behaviour, words and deeds that culture may be identified. The ways in which students organized themselves into groups and sub-groups, and the interactions between the students and the teacher were of particular interest, as were the different methods of teaching, and the impact of this on the behaviour of the students. Field notes were made about the physical environment in which the teaching took place, including the size, design and shape of the rooms, and the placement of the computers and the students. Observing the physical environment was perceived to be important because of its ability to impact on the socialization and participation of the students.

One issue with the use of observation is the fact that notes taken cannot include everything that has transpired in the classroom and the occurrences that are captured are only a part of the behaviours occurring therein. There is also the possibility that the researcher is selective in taking the notes, thus creating a bias. A second issue is that the presence of the researcher may provoke uncharacteristic behaviour in both the students and the teachers under observation, although Patton (1990) believes that such changes in students' patterns of behaviour that may occur are limited in length of duration. However the researcher was aware of this possibility and for this reason was very careful to cause as little disturbance as possible. Thirdly, observation is also limited in that the observer can only see the external behaviour and is not privy to students' internal feelings or thoughts. Consequently, there is potential for the interpretation, which must be made by the researcher, to reflect her own biases. The researcher was aware of these issues and attempted to record objectively and as completely as possible.

Field notes were taken during the observations and typed up immediately afterwards. They were then entered into NUD*IST (*Non-numerical, Unstructured, Data:*

Indexing, Searching and Theorising) (Corston & Colman, 1996) software for later analysis.

Ethical Considerations

Because the research involved in-depth interviews with, and observation of, human beings, it was essential to conform to common ethical standards in order to ensure that participants' rights were not infringed. This meant ensuring that participants were aware of the purpose of the research, their right to withdraw from the research at any time, and that informed consent was gained in an appropriate fashion. To this end, consent was obtained first from the Principal of each participating school, and then from the teachers and students involved. The students were aged 17 and 18 years, and considered old enough to provide their own consent to their participation in the research. Students were given a letter of explanation on the front of both versions of the CUCEI (see Appendices 3A, Actual, and 3B Preferred). As they were fully informed of their rights it was considered that by completing the Versions, consent had been given. Prior to carrying out observations and interviews, participants were given a letter which explained the purpose of the research, how the results would be used, and gave a guarantee of anonymity (see Appendix 3E), as well as a copy of the Consent Form to sign (see Appendix 3F). All participants were also reminded verbally of their right to withdraw from the research at any time. All interviews were undertaken in a place where the participants could be seen by other people.

The teachers informed their students that observation would be taking place, and asked for any student who objected to notify them. There were no objections.

All information relating to the collection of data (i.e., tapes, survey forms and transcripts) is kept in the researcher's office in a locked cabinet. All teachers and students were given a copy of the transcription of the interviews and asked to make alterations and additions, to ensure that the transcript did not in any way misrepresent what they intended to say. While there was no misrepresentation, two teachers returned the transcript with minor alterations and additions.

Data collection

Data were collected between October, 2000 and November, 2001. As mentioned earlier, data from School C1 were collected over a three week period in October/November, 2000. At School G2 data were collected over one week in August, 2001 and in School B1 data were collected over a one week period in September, 2001. Students at the other schools only completed the CUCEI. This was usually completed over a one week period – at Schools C2 and C3 in October 2001, School G1 in October 2000, and School G3 in November 2001.

Initially, (see Appendix 3G) a letter was sent to five schools in the Central Wellington basin enquiring as to their willingness to participate in the research. Schools C1 and G1 responded positively. The other three schools did not respond, and when further contact was made via the telephone, declined to take part in the research. A further fifteen schools were contacted and five more schools agreed to participate in the research.

Once approval was gained from the Principal, contact was made with the relevant teachers, and appointments made to discuss the survey Version, the process for distribution of the CUCEI, selection of students for interviews, and to negotiate mutually suitable times and dates for distribution of the survey form and observation of the classes. Careful consideration was given to the timing of all aspects of the data collection. Students needed to have been in the class long enough to have formed opinions regarding the environment and it was also necessary to ensure that the data collection did not conflict with assessments and exam preparation.

Administration of the CUCEI

The researcher personally administered the CUCEI in all schools. Initially, the teacher made introductions. An explanation of the purpose of the research was given and the process explained. At the first school where the Actual Version was distributed (School G1), students were asked to write their names on the forms, so that they could be matched with the Preferred Version. This resulted in a number of students not wanting to fill in the form because they felt they would be able to be identified. As a result it was decided to ask students to use a pseudonym that they would remember. The Actual Versions were then handed out to students to complete and collected by the researcher. Usually the next day, but on some occasions where there was a repeat of the same class on the same day, the Preferred Version was distributed. Again, the teacher introduced the researcher, and a brief explanation was given for those students who may not have attended the class where the Actual Versions were distributed. A number of students did not fill in the Preferred Version because they said they could see no point in completing a form that was so much like the previous one. Once collected, the researcher matched the Actual and Preferred Versions with the pseudonyms, and the results were coded and analyzed using the software program SPSS *(Statistical Package for the Social Sciences)*.

Interviews

All interviews were undertaken by the researcher. At the beginning of each interview, the purpose of the research was again explained and the individual participants were given an Information Sheet and Consent Form (Appendices 3E and 3F) to sign. The interviewer emphasized the confidentiality and anonymity of the interviews, but most participants were not concerned about these issues, and were quite happy for their own name to be used. Participants were also asked whether they objected to the use of the tape-recorder, but none did.

Interviews were undertaken with participants from Schools C1, G2, and B1. Students were asked to indicate their interest in being interviewed at the time of handing out the CUCEI. This elicited a little interest at one school (G2), but no interest from the boys at Schools C1 or B1. In response to this lack of interest the researcher then proceeded to ask individual students during the observation periods whether they would like to participate in an interview. Some students were very agreeable, while others were not. Very often, particularly with the boys, appointments would be made and the student would fail to turn up.

The teachers who were the original contact were all agreeable to being interviewed. In addition, one other teacher at School C1 (the only other computing teacher taking Year 12 and 13 classes) readily agreed to participate. School G2 had only one teacher at these levels and she was very willing to participate. While School B1 had three teachers at Year 12 and 13 level, only Mr Adamson was willing to be interviewed.

All formally arranged interviews were tape recorded, and the tapes were immediately transcribed, resulting in 65 single-spaced A4 pages of verbatim transcripts. The immediate transcription allowed feedback on accuracy to be obtained from the participants as soon after the interviews as possible. Where informal conversations occurred in the classroom and corridors, verbatim notes were either taken in shorthand, or they were written up as soon as possible after they occurred. As with the observation data, they were later coded and entered in the software application, NUD*IST.

Observation

Observation began at the three schools after the administration of the Preferred Version of the CUCEI. The researcher sat at the back of the room and took field notes as unobtrusively as possible. In one school, C1, it was initially evident that the presence of the researcher had an effect on the behaviour of the students, leading to considerable noise, bad language and showing off, but this did diminish over the period of observation.

Eight different classes were observed, and a total of 34 one-hour observations were made (see Table 3.4).

Table 3.4

Participating Schools, Class Type, Times of Observation, Numbers of Classes Observed and Numbers of Male and Female Students Enrolled and Attending

School	Class name	Teacher	Times of observations	No of sessions observed	No of students attending	
					Male	Female
C1	Project Management	Mr Smith	1120-1220 1430-1530 0945-1045	5	11	3
C1	Programming	Mr Smith	1320-1420 0845-09.45 1420-1520	5	9	1
G2	Level 1 & 2 Unit Standards	Ms Watson	1100-1200 1330-1430 0930-1030 1415-1515	5		19
G2	Level 2 Unit Standards Web Challenge	Ms Watson	0930-1030 1100-1200 1415-1515	5		9
B1	Level 1 Unit Standards	Mr Adamson	0900-1000 1000-1100 1315-1415	4	9	
B1	Level 1 Unit Standards	Mr Adamson	1000-1100 0900-1000 1115-1215 1315-1415	4	17	
B1	Level 1 Unit Standards	Mr Adamson	1115-1215 1415-1515	4	14	
B1	Level 1 Unit Standards	Mr Adamson	1000-1100 1415-1515	2	14	
Total				34	74	32

At the end of each day the notes were transcribed, resulting in 38 single-spaced A4 pages of transcript. They were later coded and entered in the software application, NUD*IST, to help in the analysis of the data.

Analysis of Interviews and Observation

Analysis of the data began as soon as the notes had been transcribed, and continued throughout the observation and interview period. This enabled the researcher to make comparisons between different classes in individual schools, and the different schools, and to ask further questions where clarification was required regarding the interviews.

Patton's (1990) suggestions for content analysis were used as an initial guide in identifying, coding and categorizing the data. The researcher read through the verbatim transcriptions, making notes where items of interest arose. These were then organized into broad themes, initially based on emerging patterns associated with the concept of culture as discussed in the literature review, but also relating to the scales of the CUCEI. From these broad themes, sub-themes were developed.

As mentioned above, the software program NUD*IST was used to help analyse the qualitative data generated by the interviews and observations. NUD*IST works with textual documents and facilitates the indexing of components of these documents. It was able to search for words and phrases very quickly and allowed the researcher to save time by identifying and clustering phrases and paragraphs from all the data into the various themes and sub-themes. While this computer program provided a tool which allowed the researcher to ask questions and seek answers to those questions which could not easily be done manually, they did not release the researcher from having to engage in the coding and sorting of the data. This process is described more fully in Chapter 5.

CHAPTER 4

RESULTS FOR THE CUCEI

Introduction

The CUCEI was used to gather quantitative data relating to the perceptions of students of their classroom environment. Section one of this chapter reports the results from the questionnaire and the statistics used to decide whether the questionnaire was a sufficiently reliable and valid instrument to use in this study. Section two describes the results from the use of the CUCEI in assessing students' perceptions of their computer classroom learning environment, and the relationship between the sex of the student and whether the school attended is single-sex or mixed-sex.

Item Analysis of the CUCEI

The item analysis discussed in this section was carried out on the entire sample that completed each form of the CUCEI. Table 4.1 displays the means and standard deviations for the Actual Version of the CUCEI, while Table 4.2 displays the means and standard deviations for the Preferred Version. There were approximately 45 less responses for the Preferred Version compared with the Actual Version because, as mentioned in Chapter 3, some students did not wish to respond to both, and also due to greater absence on the second period of administration. These results have negatively worded items reverse scored so that a high mean represents a positive response. The distributions of the frequencies for the response choices are included for reference in Appendix 4A. Every item has a reasonably wide spread of responses, as can be seen by the standard deviations. For the Actual Version of the CUCEI, these are mostly about 1 or more, ranging from 0.96 to 1.32. There is a broader range for the Preferred Version, 0.74 to 1.43, with items for the Equity scales all below 1, as are five items of the Personalisation scale, indicating less variation in responses on these items. The item means range from 2.32 to 4.29 for the Actual Version and 2.24 to 4.51 for the Preferred Version. While the mean for most items varies between 2 and 4, five items in the Actual Version, and a number of items in the Preferred Version, measure over 4. However, all response choices attracted some responses (see Appendices 4A and 4B) so there are no serious ceiling or floor effects, and the overall results indicate that the 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 teacher considers my feelings	A1	3.50	1.07	256
The teacher is friendly and talks to me	A2	3.93	0.96	256
The teacher goes out of his/her way to help me	A3	3.63	1.07	256
The teacher helps me when I am having trouble with my work	A4	4.00	1.01	256
The teacher moves around the classroom to talk with me	A5	3.69	1.08	256
The teacher is interested in my problems	A6	3.11	1.21	256
The teacher is unfriendly and inconsiderate towards me	A7*	4.29	1.00	255
Innovation				
New ideas are seldom tried out in this class	A8*	3.41	1.02	255
My teacher uses new and different ways of teaching in this class	A9	2.92	0.98	256
The teacher thinks up innovative activities for me to do	A10	3.02	1.09	256
The teaching approaches used in this class are characterised by innovation and variety	A11	3.37	1.10	254
Seating in this class is arranged in the same way each week	A12*	2.54	1.50	256
The teacher often thinks of unusual activities	A13	2.57	1.15	256
I seem to do the same type of activities in every class	A14*	3.16	1.18	256
Student Cohesion				
My class is made up of individuals who don't know each other well	A15*	3.72	1.32	256
I know most students in this class by their first names	A16	4.30	1.03	256
I make friends easily in this class	A17	3.68	1.23	256
I don't get much of a chance to know my classmates	A18*	3.91	1.17	256
It takes me a long time to get to know everybody by his/her name in this class	A19*	4.00	1.16	255
I have the chance to know my classmates well	A20	3.47	1.31	256
I am not very interested in getting to know other students in this class	A21*	3.78	1.25	255

Task Orientation				
I know exactly what has to be done in the class	A22	3.75	1.03	256
I find getting a certain amount of work done is important in this class	A23	3.63	1.10	256
I often get sidetracked in this class instead of sticking to the point	A24*	2.88	1.12	256
This class is always disorganised	A25*	3.83	1.13	256
Class assignments are clear and I know what to do	A26	3.62	1.14	256
This class seldom starts on time	A27*	3.13	1.26	256
Activities in this class are clearly and carefully planned	A28	3.79	0.93	256
Cooperation				
I cooperate with other students when doing assignment work	A29	3.83	1.02	256
I share my books and resources with other students when doing assignments	A30	3.41	1.24	256
I work with other students on projects in this class	A31	3.29	1.22	256
I learn from other students in this class	A32	3.68	1.13	256
I work with other students in this class	A33	3.64	1.10	256
I cooperate with other students on class activities	A34	3.71	1.04	256
Students work with me to achieve class goals	A35	3.33	1.17	256
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*	2.43	1.16	256
I am generally allowed to work at my own pact in this class	A37	3.62	1.19	256
I have a say in how class time is spent	A38	2.35	1.08	256
I am allowed to choose activities and how I will work	A39	2.62	1.14	256
Teaching approaches in this class allow me to proceed at my own pace	A40	3.41	1.07	255
I have little opportunity to pursue my particular interests in this class	A41*	3.12	1.12	255
My teacher decides what I will do in this class	A42*	2.32	1.09	255
Equity				
The teacher gives as much attention to my questions as to other students' questions	A43	3.84	1.07	256
I get the same amount of help from the teacher as do other students	A44	3.80	1.12	256
I am treated the same as other students in this class	A45	4.09	1.02	256
I receive the same encouragement from the teacher as other students do	A46	4.07	1.02	255
I get the same opportunity to answer questions as other students	A47	4.00	1.04	255
My work receives as much praise as other students' work	A48	3.91	1.08	256
I have the same amount of say in this class as other students	A49	4.05	1.05	241

* 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 teacher would consider my feelings	P1	4.20	0.91	212
The teacher would b friendly and would talk to me	P2	4.28	0.86	212
The teacher would go out of his/her way to help me	P3	4.21	0.91	212
The teacher would help me when I am having trouble with my work	P4	4.42	0.78	212
The teacher would move around the classroom to talk with me	P5	4.08	0.91	212
The teacher would be interested in my problems	P6	3.55	1.37	212
The teacher would be unfriendly and inconsiderate towards me	P7*	4.43	1.11	211
Innovation				
New ideas would be seldom tried out in this class	P8*	3.38	1.33	211
My teacher would use new and different ways of teaching in this class	P9	3.87	1.04	212
The teacher would think up innovative activities for me to do	P10	3.81	1.12	212
The teaching approaches used in this class would be characterised by innovation and variety	P11	3.88	0.97	211
Seating in this class would be arranged in the same way each week	P12*	2.86	1.40	212
The teacher would often think of unusual activities	P13	2.24	1.32	212
I would do the same type of activities in every class	P14*	2.25	1.17	211
Student Cohesion				
My class would be made up of individuals who don't know each other well	P15*	3.91	1.25	191
I would know most students in this class by their first names	P16	4.36	0.96	211
I would make friends easily in this class	P17	4.10	1.21	212
I would not get much of a chance to know my classmates	P18*	3.99	1.27	212
It would take me a long time to get to know everybody by his/her name in this class	P19*	3.72	1.39	212
I would the chance to know my classmates well	P20	3.98	1.22	212
I would not be very interested in getting to know other students in this class	P21*	3.64	1.50	212
Task Orientation				
I would know exactly what had to be done in the class	P22	4.21	0.96	211
Getting a certain amount of work done would be important in the class	P23	3.86	1.09	211
I would often get sidetracked in this class instead of sticking to the point	P24*	3.51	1.13	211
This class would always disorganised	P25*	3.84	1.42	210
Class assignments would be clear and I would know what to do	P26	4.15	1.14	211
This class would seldom start on time	P27*	3.14	1.42	211
Activities in the class would be clearly and carefully planned	P28	4.17	0.95	211

Cooperation				
I would cooperate with other students in my class when doing assignment work	P29	4.05	1.04	211
I would share my books and resources with other students when doing assignments	P30	3.89	1.22	211
I wouldwork with other students on projects in the class	P31	3.98	1.12	211
I would learn from other students in the class	P32	4.01	1.07	211
I would work with other students in the class	P33	4.15	0.98	211
I would cooperate with other students in my class on class activities	P34	4.18	0.96	211
Students would work with me to achieve class goals	P35	3.88	1.15	211
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*	2.30	1.22	210
I would generally be allowed to work at my own pace in this class	P37	4.07	0.95	210
I would have a say in how class time is spent	P38	3.68	1.08	211
I would be allowed to choose activities and how I would work	P39	3.71	1.12	211
Teaching approaches in this class would allow me to proceed at my own pace	P40	3.79	1.13	210
I would have little opportunity to pursue my particular interests in the class	P41*	3.54	1.22	210
My teacher would decide what I would do in this class	P42*	2.74	1.18	211
Equity				
The teacher would give as much attention to my questions as to other students' questions	P43	4.40	0.79	210
I would get the same amount of help from the teacher as do other students	P44	4.42	0.80	210
I would be treated the same as other students in this class	P45	4.49	0.82	210
I would receive the same encouragement from the teacher as other students do	P46	4.51	0.74	210
I would get the same opportunity to answer questions as other students' do	P47	4.42	0.84	210
My work would receive as much praise as other students' work	P48	4.44	0.81	210
I would have the same amount of say in this class as other students	P49	4.40	0.87	189

* Reverse Scored Items

Principal Component Analysis

Principal component analysis uses the correlations among items to determine how many dimensions, or components, are represented by the items. The components have eigenvalues, which indicate how much common variance among the items they represent. Each version of the CUCEI was examined using principal component analysis. The CUCEI contains seven scales so to determine whether the intended scales were consistent for the current data set, seven components were initially selected for varimax rotation. Table 4.3 reports the initial statistics for the first 12 (unrotated) components of the Actual Version of the CUCEI, that is, all those with eigenvalues greater than unity, and Table 4.4 reports the loadings on the seven rotated components of each item for the Actual Version. Table 4.5 reports initial statistics for the parallel analysis for the Preferred Version, while Table 4.6 reports the loadings on the seven rotated components of each item for the Preferred Version. To assist interpretation, Tables 4.4 and 4.6 report loadings ≥ .30. The full matrix of loadings for the Actual Version of the CUCEI is reported in Appendix 4C.

Table 4.3

Eigenvalues and Percent of Variance Accounted for by the First 12 Principal Components Extracted from the Actual Version of the CUCEI

Component	Eigenvalue	% Variance	Cum % Variance
1	10.80	22.00	22.0
2	3.78	7.70	29.8
3	3.29	6.70	36.5
4	2.64	5.40	41.9
5	2.05	4.20	46.1
6	1.89	3.90	50.0
7	1.57	3.20	53.2
8	1.42	2.90	56.1
9	1.32	2.70	58.8
10	1.21	2.50	61.3
11	1.11	2.30	63.6
12	1.00	2.10	65.6

Table 4.3 shows that the principal component analysis for the Actual Version of the CUCEI extracted one large component with eigenvalue = 10.80 which accounts for 22% of the variance. Twelve components had eigenvalues equalling one or greater, accounting for a total of 65.6% of the total variance. The large first component indicates that there is considerable inter-correlation among the items and the pattern of eigenvalues suggests that there are not seven clean components. To test this suggestion, seven components were extracted for varimax rotation (see Table 4.4)

Table 4.4

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	A1	0.35			0.61			
	A2	0.48			0.50			
	A3	0.57			0.53			
	A4	0.56			0.44			
	A5	0.36			0.57			
	A6				0.38			
	A7			0.54				
Innovation	A8							0.53
	A9				0.62			
	A10				0.76			
	A11		0.30		0.58			
	A12						0.32	0.43
	A13				0.51			
	A14							
Student Cohesion	A15			0.69				
	A16			0.57				
	A17		0.40	0.64				
	A18			0.61				0.36
	A19			0.65				
	A20			0.69				
	A21		0.32	0.54				
Task Orientation	A22					0.54		
	A23					0.67		
	A24					0.59		
	A25			0.35		0.52		
	A26					0.60		
	A27					0.39		
	A28	0.30			0.30	0.46		
Cooperation	A29		0.68					
	A30		0.65					
	A31		0.77					
	A32		0.64					
	A33		0.80					
	A34		0.71					
	A35		0.74					
Individualisation	A36							0.54
	A37			0.32			0.54	
	A38						0.68	
	A39						0.61	
	A40						0.56	
	A41			0.40			0.32	
	A42						0.35	0.39
Equity	A43	0.78						
	A44	0.74						
	A45	0.71						
	A46	0.81						
	A47	0.76						
	A48	0.74						
	A49	0.72						

Note: Loadings $\geq .30$ reported

It can be seen in Table 4.4 that only two scales, Cooperation and Equity, have all items loading substantially on only one component. The questions posed in these scales are quite distinct, with those for Cooperation being about student-to-student relationships, and those for Equity being about how the teacher treats the student, compared to other students (see Table 4.1 for item wording). However Items A1-A5 in the Personalisation scale, as well as all of the items of the Equity scale, load on the first component. Perhaps this is not surprising, as analysis of the wording of the items shows that both scales measure the relationship between the student and the teacher. The Personalisation scale is intended to measure how the individual student is treated by the teacher, while the Equity scale is intended to measure whether or not the teacher treats the student in a similar way to other students. While Items A1-A5 load on the first component, Items A1-A6 also load on the fourth component and Item A7 loads on the third component, so the Personalisation items clearly do not form a single, unique dimension.

The same is true for the Innovation scale, where items load across four components, with Item A11 split between Components II and IV and Item A12 split between Components VI and VII. Item A11 relates to the teaching approaches being characterised by innovation and variety. This item may be unsuitable for a computer classroom, because the nature of the subject means that students work fairly independently on their individual computer, very often progressing through set exercises. Item A12 refers to seating arrangements. It is interesting that this item has a large standard deviation of 1.50. Of course seating arrangements in a computer classroom do not change, and therefore this question may not be relevant in such a situation. Item A14 did not load significantly ($\geq .30$) on any one component. The item refers to students performing the same type of activities every day, and this would be expected in most computer classrooms. Although the actual application being learned may change, the activities undertaken by the students probably would not vary much.

All of the items for Student Cohesion loaded on Component III, with four other items. There is no obvious reason for this in terms of the item content. The Task Orientation items are the only ones loading on Component V, and six of the seven items for Individualisation load on Component VI. Item A36 loaded only on

Component VII, in a similar way to A8 from the Innovation scale. The Cohesion, Task Orientation and Innovation scales all have items with split loading on two components. Items A37 to A42 of the Individualisation scale loaded on Component VI, while Item A42 split-loaded on Component VII with Item A36. This scale deals with how much freedom a student has to choose their class activities, and it would be expected that while most computer classrooms have a certain degree of freedom, in order to meet the criteria for passing assignments, what goes on in most classes would be controlled by the teacher.

Table 4.5

Eigenvalues and Percent of Variance Accounted for by the First 12 Principal Components Extracted from the Preferred Version of the CUCEI

Component	Eigenvalue	% Variance	Cum % Variance
1	14.23	29.1	29.1
2	3.36	6.9	35.9
3	3.25	6.7	42.6
4	2.39	4.9	47.5
5	1.86	3.8	51.3
6	1.66	3.4	54.7
7	1.39	2.9	57.5
8	1.23	2.5	60.0
9	1.21	2.5	62.5
10	1.10	2.3	64.8
11	1.06	2.2	66.9
12	1.03	2.1	69.0

The full matrix of loadings for the Preferred Version of the CUCEI is shown in Appendix 4D. As can be seen from Table 4.5, the principal component analysis extracted one large component with eigenvalue = 14.23 accounting for 29.10% of the variance. Twelve components were extracted with an eigenvalue greater than 1, and these account for 69% of the total variance. As with the Actual version, this large, first component indicates that there is considerable inter-correlation between items, and that there are not seven clean components. Again, seven components were extracted for varimax rotation (see Table 4.6).

Table 4.6

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	P1				0.65			
	P2				0.70			
	P3		0.33		0.60			
	P4		0.32		0.71			
	P5			0.40	0.52			
	P6			0.62				
	P7				0.34		0.41	0.46
Innovation	P8						0.46	
	P9			0.56		0.37		
	P10			0.60		0.42		
	P11			0.63		0.36		
	P12							0.36
	P13			0.64		0.31		
	P14							-0.58
Student Cohesion	P15			0.32				0.49
	P16		0.40					0.34
	P17	0.30		0.62				
	P18							0.63
	P19					0.34		0.41
	P20			0.62				
	P21						0.37	0.59
Task Orientation	P22		0.30		0.48		0.48	
	P23						0.41	
	P24					0.32	0.53	
	P25			0.40			0.59	
	P26						0.55	
	P27						0.58	
	P28		0.30		0.39		0.44	
Cooperation	P29	0.77						
	P30	0.77						
	P31	0.81						
	P32	0.76						
	P33	0.83						
	P34	0.79						
	P35	0.76						
Individualisation	P36							0.37
	P37					0.47		
	P38					0.71		
	P39					0.80		
	P40					0.55		
	P41					0.33		
	P42					0.49		0.40
Equity	P43		0.56		0.31		0.34	
	P44		0.72					
	P45		0.81					
	P46		0.76					
	P47		0.73					
	P48		0.74					
	P49		0.76					

Note: Loadings ≥ .30 reported

Table 4.6 reports the loadings on the Preferred Version of the CUCEI. It can be seen that item loadings of the first four scales are rather scattered. Cooperation shows the most coherence as a scale with all the items loading on component I. Equity also shows promise as all the items load on component II, although item P43 also split-loads on to components IV and VI, and some items from other scales have moderate loadings on the same component.

Items P6 and P7 on the Personalisation scale are weak items in terms of forming a scale. Item P6 loads on a different component to Items P1 to P5, and P7 splits over three components. On the Actual Version A7 was the only item in this scale that loaded on component III, and A6 had a small loading. It seems that items 1-5 are the strongest for the Personalisation scale over both versions.

Four items in the Innovation scale load strongly on component III, and have weaker loadings on component V. Item P8 loads on component VI and items P12 and P14 both load on component VII. Comparison with the results for Innovation on the Actual Version shows that in both versions, Items 9, 10, 11 and 13 seem to be the four that load together, although in the Preferred Version these items have small loadings on the fifth component with the Individualisation items. The Student Cohesion scale in the Preferred Version has not performed well. Five items load on component VII, but these items also load on other components. In fact the seven items loaded on six of the seven components! This scale was more coherent in the Actual Version.

All items in the Task Orientation scale load on component VI, but items P22 and P28 split load on components II and IV, while item P24 loads also on component V, and item P25 on component III. Items P22 and P28 both relate to how clearly the students understand what they have to do in the class. Both items also load moderately on the same components as Equity and Personalisation, but there appears to be no obvious explanation as to why this should be so.

The Individualisation scale has six items loading on Component V. One item, P36, loads only on component VII as it did on the Actual Version. Item P42 also loads with Item P36, splitting its loading in the same way as it did in the Actual Version. In both versions Item 41 had a low loading on the main component.

The principal components analyses have shown clearly that the seven scales established by earlier researchers (Fraser & Treagust, 1986; Nair & Fisher, 1999) have not held up in the data collected here, so if the CUCEI is to be used, then some changes will need to be made. It seems that there are consistent problems over the two versions, which suggests that the scales may be improved by omitting some items. Given the consistency of these results, and that the reason for using the CUCEI was to examine students' perceptions of their learning environment on a number of dimensions, it was decided to modify the CUCEI to see whether some useful scales could be obtained. While it is acknowledged that modifying scales based on a single data set capitalises on chance, it was anticipated that the possibility of using data from both the Actual and Preferred versions which were administered at different times, and to somewhat different samples, would help to counterbalance the chance aspect. It also appeared to be the most practical way of obtaining some useful information from these results.

The structure of the CUCEI was therefore initially modified by deleting a total of eight items. This 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 items of the Cooperation and Equity scales were coherent in both versions of the CUCEI, so they were retained. Although the Student Cohesion scale performed poorly in the Preferred Version, it was retained because the items loaded together in the Actual Version. Even though a number of items of the Task Orientation scale split-loaded in both versions, their highest loadings were all on the same component so this scale was also retained. The other scales were reduced by deleting the poorest performing items. These were Items 6 and 7 in Personalisation, Items 8, 12 and 14 in Innovation, and Items 36, 41 and 42 from the Individualisation scale. It is worth noting that seven of these eight items were negatively worded, perhaps indicating that negatively worded items are difficult to understand.

Tables 4.7 and 4.8 report the rotated component loadings for the reduced Actual and Preferred Versions of the CUCEI. Full loading matrices are reported in Appendices 4E and 4F. Tables 4.7 and 4.8 show that the scales are more coherent with a number of items omitted, in that each scale loads on an individual component, but they are still not perfectly clean.

Table 4.7

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	A1	0.36			0.51			0.44
	A2	0.50			0.40			0.34
	A3	0.57			0.42			0.35
	A4	0.55			0.31			0.46
	A5	0.36			0.49			0.33
Innovation	A9				0.66			
	A10				0.79			
	A11				0.60			
	A13				0.57			
Student Cohesion	A15			0.69				
	A16			0.61				
	A17		0.34	0.70				
	A18			0.64				
	A19			0.65				0.31
	A20			0.73				
	A21		0.31	0.55				
Task Orientation	A22					0.55		
	A23					0.70		
	A24					0.55		
	A25			0.31		0.48		0.36
	A26					0.62		
	A27							0.57
	A28				0.30	0.55		
Cooperation	A29		0.66					
	A30		0.66					
	A31		0.76					
	A32		0.66					
	A33		0.81					
	A34		0.72	0.30				
	A35		0.73					
Individualisation	A37						0.52	0.33
	A38				0.30		0.73	
	A39						0.69	
	A40						0.62	
Equity	A43	0.78						
	A44	0.77						
	A45	0.70						
	A46	0.82						
	A47	0.79						
	A48	0.75						
	A49	0.70						

Table 4.8

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	P1				0.66			
	P2				0.74			
	P3		0.32		0.60			
	P4		0.33		0.70			
	P5			0.39	0.53			
Innovation	P9			0.65	0.31			
	P10			0.74				
	P11			0.70				
	P13			0.74				
Student Cohesion	P15					0.64		
	P16		0.40			0.37		
	P17			0.52		0.49		
	P18					0.60		
	P19					0.65		
	P20					0.48		
	P21					0.79		
Task Orientation	P22		0.30		0.43			0.39
	P23							0.50
	P24						0.39	0.54
	P25			0.37		0.35		0.56
	P26							0.49
	P27							0.61
	P28				0.42			0.43
Cooperation	P29	0.76						
	P30	0.78						
	P31	0.82						
	P32	0.75						
	P33	0.82						
	P34	0.79						
	P35	0.76						
Individualisation	P37						0.60	
	P38						0.75	
	P39						0.81	
	P40						0.57	
Equity	P43		0.56		0.32			0.31
	P44		0.71					
	P45		0.81					
	P46		0.75					
	P47		0.74					
	P48		0.75					
	P49		0.76					

The Personalisation scale has performed in an unusual way. In the Actual Version all the remaining items have split over three components. While on examination of the item content it is possible to see the relationship between Personalisation and Equity, it is difficult to explain a sensible connection between Personalisation and

Innovation. It is also difficult to see a connection between the Personalisation items and Item A27 (The class seldom starts on time) which is the other main item loading on Component VII. Personalisation has performed better on the Preferred Version, in that the largest loadings for each item are on Component IV. The three second loadings of items are all less than 0.40. Overall it seems that the Personalisation items correlate with others, especially in the Actual Version.

The four items remaining in the Innovation scale have held together well in the Actual Version, and also in the Preferred Version, although Item P9 has a trivial second loading on another component. The seven items of the Student Cohesion scale load on one component in each version but Item P17 has a strong loading on another component and there are one or two other small split loadings in the Preferred and Actual Versions, respectively.

The Task Orientation scale has several items with split loadings. In the Actual Version, A27 loads on a different component, A25 has two small loadings on other components and A28 has one. In the Preferred Version P27 has the highest loading on the component, but P22, P24, P25 and P28 have moderate loadings on other components. This scale is not performing well.

In contrast, the Cooperation scale is the most coherent with all its items loading strongly on Component II. The remaining four items for Individualisation also load on one component in each version but two items have small second loadings in the Actual Version. All of the Equity items load cleanly on Component I in the Actual Version but in the Preferred Version Item P43 has small loadings on two other components.

In sum then, the rotated component solutions of the reduced set of scales are much cleaner, but the Personalisation scale still presents a problem as it continues to split load over three components, especially in the Actual Version. For both the Actual and Preferred version, each of the other scales is the basis of a different component, and most items which load on more than one component have minor loads on the second component. Task Orientation still has inconsistency, and has split-loads on four items in the Preferred Version.

The main problem in the two sets of solutions reported so far relates to the Personalisation scale which does not form its own clean factor, and may draw other items away from their own scales. Interestingly, other analyses shows that it has good internal consistency, but correlates quite highly with Equity on both the Actual ($r = 0.62$) and Preferred ($r = 0.57$) Versions of the CUCEI. At this stage it was decided to completely omit the Personalisation scale from the analysis and examine a six-component solution. These results are reported in Tables 4.9 and 4.10. The full loading matrices are reported in Appendices 4G and 4H.

Table 4.9

Loadings on Six Components of the Reduced Actual CUCEI without Personalisation (Varimax Rotation)

Scale	Item	I	II	III	IV	V	VI
Innovation	A9					0.68	
	A10					0.78	
	A11					0.61	
	A13					0.63	
Student Cohesion	A15			0.67			
	A16			0.60			
	A17			0.68			
	A18			0.67			
	A19			0.68			
	A20			0.71			
	A21			0.56			
Task Orientation	A22				0.55		
	A23				0.69		
	A24				0.54		
	A25				0.57		
	A26				0.62		
	A27				0.45		
	A28	0.30			0.52		
Cooperation	A29		0.66				
	A30		0.67				
	A31		0.76				
	A32		0.67				
	A33		0.81				
	A34		0.72				
	A35		0.74				
Individualisation	A37			0.30			0.55
	A38					0.33	0.72
	A39						0.68
	A40						0.65
Equity	A43	0.77					
	A44	0.79					
	A45	0.72					
	A46	0.83					
	A47	0.79					
	A48	0.77					
	A49	0.71					

As can be seen in Table 4.9, the reduced Actual Version scales now load cleanly on a single component except for three items which have small loadings on a second component. The results for the Preferred Version are not as clean. There are still a number of items from the Student Cohesion and Task Orientation scales loading on several other components. However, the other scales have performed well.

Table 4.10

Loadings on Six Components of the Reduced Preferred CUCEI without Personalisation (Varimax Rotation)

Scale	Item	I	II	III	IV	V	VI
Innovation	P9			0.67		0.30	
	P10			0.75			
	P11			0.71			
	P13			0.76			
Student Cohesion	P15				0.65		
	P16		0.40		0.36		
	P17	0.30		0.54	0.47		
	P18				0.62		
	P19				0.67		
	P20			0.52	0.46		
	P21				0.69		
Task Orientation	P22		0.40			0.36	0.40
	P23						0.51
	P24					0.36	0.54
	P25			0.38	0.35		0.54
	P26				0.31	0.30	0.48
	P27						0.61
	P28		0.37				0.44
Cooperation	P29	0.77					
	P30	0.79					
	P31	0.83					
	P32	0.76					
	P33	0.82					
	P34	0.80					
	P35	0.77					
Individualisation	P37					0.61	
	P38					0.75	
	P39					0.80	
	P40					0.59	
Equity	P43		0.62				0.30
	P44		0.74				
	P45		0.82				
	P46		0.77				
	P47		0.73				
	P48		0.77				
	P49		0.77				

Summary of Findings from Principal Component Analysis

The analysis of the original CUCEI versions indicates that a number of items did not perform as expected in terms of forming coherent scales. To obtain some usable scales, a series of principal component analyses was performed resulting in the deletion of eight of the original 49 items. Additionally, the Personalisation scale has not performed well on either the Actual or Preferred Versions of the CUCEI. When it was omitted from the principal component analysis the other scales performed better, except for some scattering of items on Student Cohesion and Task Orientation on the Preferred Version. Given their acceptable performance on the Actual Version it was decided to retain these scales and examine their internal consistency. Personalisation was also retained in the next analysis, but with the expectation that it would correlate quite highly with some other scales.

Internal Consistency of New Scales of CUCEI

The Cronbach alpha coefficient is a measure of internal consistency often used for rating scales like those of the CUCEI. The closer the alpha coefficient is to 1.0, the more highly the items inter-correlate and the more internally consistent the scale. While there is no set rule as to the threshold which should be used to constitute good internal consistency, 0.80 is commonly used (Kidder, 1982). However Nunnally (1978) suggests that 0.60 is acceptable consistency for research purposes. It should be noted that shorter scales tend to have lower alpha coefficients because of lower variance.

Tables 4.11 and 4.12 report the results of the analyses to determine the internal consistencies of the new scales. The results for the five items in the Personalisation scale have been included because they show good internal consistency. The final column of these tables reports the alpha coefficients for the seven different scales of the CUCEI for both the Actual and Preferred reduced versions. Alpha coefficients for the reduced Actual Version of the CUCEI ranged from 0.64 to 0.91 and for the reduced Preferred Version ranged from 0.73 to 0.93. It is interesting to note that, at 0.64, the internal consistency of the Individualisation scale in the Actual Version is only marginally higher than Nunnally's (1978) suggested minimum value of 0.60, and the Task Orientation scale also shows rather low internal consistency. Tables 4.11 and 4.12 also provide mean item scores for the reduced versions of the CUCEI. The mean item score is used because the scales have different numbers of items and this enables easier comparisons between scales. It can be seen from the means in Tables 4.11 and 4.12 that students are scoring more highly on the Preferred Version of the scale. However, the Actual and Preferred Versions were completed by overlapping but different samples. More valid comparisons can be made on the sample which completed both versions and this is reported later in the chapter.

Table 4.11

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 Item Score	Standard Deviation	Alpha
Personalisation *n*=257	A1	0.64	0.85			
	A2	0.70	0.83			
	A3	0.72	0.82			
	A4	0.71	0.83			
	A5	0.66	0.84	3.74	0.84	0.87
Innovation *n*=255	A9	0.52	0.63			
	A10	0.64	0.55			
	A11	0.46	0.66			
	A13	0.37	0.72	2.97	0.79	0.71
Student Cohesion *n*=255	A15	0.58	0.81			
	A16	0.47	0.82			
	A17	0.74	0.78			
	A18	0.47	0.82			
	A19	0.59	0.81			
	A20	0.68	0.79			
	A21	0.53	0.82	3.83	0.86	0.84
Task Orientation *n*=257	A22	0.44	0.64			
	A23	0.41	0.64			
	A24	0.28	0.68			
	A25	0.47	0.63			
	A26	0.48	0.62			
	A27	0.27	0.68			
	A28	0.41	0.64	3.51	0.65	0.69
Cooperation *n*=257	A29	0.59	0.85			
	A30	0.57	0.85			
	A31	0.70	0.83			
	A32	0.56	0.85			
	A33	0.74	0.83			
	A34	0.67	0.84			
	A35	0.62	0.84	3.55	0.84	0.87
Individualisation *n*=256	A37	0.31	0.64			
	A38	0.51	0.49			
	A39	0.39	0.58			
	A40	0.45	0.54	3.01	0.77	0.64
Equity *n*=240	A43	0.72	0.89			
	A44	0.69	0.90			
	A45	0.69	0.90			
	A46	0.81	0.88			
	A47	0.75	0.89			
	A48	0.74	0.89			
	A49	0.68	0.90	3.96	0.86	0.91

Table 4.12

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 Item Score	Standard Deviation	Alpha
Personalisation	P1	0.60	0.82			
n=212	P2	0.70	0.80			
	P3	0.66	0.81			
	P4	0.66	0.81			
	P5	0.65	0.81	4.24	0.69	0.85
Innovation	P9	0.70	0.74			
n=211	P10	0.73	0.72			
	P11	0.63	0.78			
	P13	0.54	0.83	3.70	0.90	0.82
Student Cohesion	P15	0.52	0.72			
n=191	P16	0.33	0.75			
	P17	0.54	0.72			
	P18	0.43	0.74			
	P19	0.46	0.73			
	P20	0.55	0.72			
	P21	0.53	0.72	3.94	0.84	0.76
Task Orientation	P22	0.59	0.68			
n=210	P23	0.40	0.70			
	P24	0.27	0.73			
	P25	0.56	0.65			
	P26	0.56	0.66			
	P27	0.38	0.71			
	P28	0.40	0.70	3.84	0.72	0.73
Cooperation	P29	0.76	0.92			
n=211	P30	0.72	0.92			
	P31	0.83	0.91			
	P32	0.75	0.92			
	P33	0.84	0.91			
	P34	0.82	0.91			
	P35	0.72	0.92	4.02	0.91	0.93
Individualisation	P37	0.52	0.66			
n=210	P38	0.62	0.60			
	P39	0.56	0.64			
	P40	0.38	0.74	3.81	0.80	0.73
Equity	P43	0.66	0.91			
n=189	P44	0.73	0.90			
	P45	0.78	0.89			
	P46	0.78	0.90			
	P47	0.71	0.90			
	P48	0.74	0.90			
	P49	0.78	0.89	3.96	0.86	0.92

Correlations between Scales

The correlations between the scales of the CUCEI indicate the degree to which the scales overlap. Low inter-scale correlations indicate that the scales are measuring separate constructs and is one way of demonstrating discriminant validity. Researchers using learning environment instruments often use the average inter-scale correlation as a measure of discriminant validity, and Nair and Fisher (1999) used this for their version of the CUCEI.

Tables 4.13 and 4.14 report results for the inter-scale correlations of the Actual and Preferred versions of the CUCEI. The correlations for the Actual version range from 0.11 to 0.62, and for the Preferred version from 0.29 to 0.57. The mean correlation values for the Actual Version range from 0.21 to 0.39 and for the Preferred Version from 0.35 to 0.47. A correlation of 0.45 indicates that scales have about 20% of common variance. If this is taken as an acceptable overlap, then most of the scales can be considered reasonably distinct. In the Actual Version of the CUCEI, the correlation coefficients between Personalisation and Equity, and Personalisation and Innovation exceed this value, suggesting that these scales are not independent. In the Preferred Version, the scales showing inter-correlations higher than 0.45 are Personalisation with Innovation, Task Orientation, Cooperation and Equity. Similarly Innovation with Individuality, Cohesion with Task Orientation, and Cooperation with Equity also show considerable overlap. Overall then, a number of the scales overlap, especially on the Preferred Version, and this must be taken into consideration when interpreting the results, especially for the Personalisation scale.

Table 4.13

Correlation Coefficients for Scales of the Actual Version of the CUCEI

	Person	Innov	Cohes	Task O	Coop	Indiv	Mean Corr
Person							0.39
Innov	0.48						0.29
Cohes	0.26	0.12					0.24
Task O	0.40	0.28	0.32				0.28
Coop	0.23	0.34	0.32	0.15			0.25
Indiv	0.36	0.25	0.12	0.11	0.20		0.21
Equity	0.62	0.27	0.30	0.43	0.27	0.24	0.35

Note: $r = .12$ is statistically significant $p < .05$.

Table 4.14

Correlation Coefficients for Scales of the Preferred Version of the CUCEI

	Person	Innov	Cohes	Task O	Coop	Indiv	Mean Corr
Person							0.47
Innov	0.49						0.41
Cohes	0.39	0.30					0.35
Task O	0.46	0.40	0.57				0.42
Coop	0.49	0.41	0.29	0.30			0.39
Indiv	0.41	0.52	0.24	0.35	0.36		0.36
Equity	0.57	0.34	0.30	0.45	0.49	0.29	0.40

Note: $r = .12$ is statistically significant $p < .05$.

The next section reports on the results from the use of the CUCEI in assessing students' perceptions of their computer classroom learning environment. Thus far, the analyses have been based on data from the entire sample responding to each version of the instrument. This provides an overview of the results, as given by the means and standard deviations, but a more valid comparison can be made on the sample completing both versions of the CUCEI. Thus, an analysis of the paired data is undertaken, followed by analysis of boys' and girls' perceptions in mixed- and single-sex schools.

Results for Students' Responses to the Actual and Preferred Versions of the CUCEI

Students' responses to the Actual and Preferred Versions of the CUCEI provide the answer to the second research question: What are the perceptions of Year 12 and 13 students of the computer classroom environment? Both the sex of the student and the type of school attended (single-sex or mixed-sex) were variables of interest, as well as differences between students' actual and preferred perceptions of their learning environment. Table 4.15 reports means, standard deviations and differences between means for the seven scales of the Actual and Preferred Versions of the reduced CUCEI. The differences are computed by subtracting the Actual score from the Preferred score so positive differences indicate that the mean score is higher on the Preferred Version. These data are based on the sample completing both versions of the instrument and so the statistical significance of the differences between them can be examined. Prior to these analyses, it is helpful to obtain an overview of the results and this is the purpose of the statistics in Table 4.15 and the graph of the means in Figure 4.1.

Table 4.15

Means (Standard Deviations) and Mean Difference Scores of Paired Samples for the Actual and Preferred Forms of the CUCEI

Scale	Actual		Preferred		Difference Actual-Pref
Personalisation	3.75	(0.84)	4.23	(0.69)	0.48
Innovation	2.96	(0.79)	3.67	(0.91)	0.71
Student Cohesion	3.91	(0.81)	3.96	(0.84)	0.05
Task Orientation	3.54	(0.68)	3.86	(0.71)	0.32
Cooperation	3.57	(0.84)	4.06	(0.86)	0.49
Individualisation	2.96	(0.75)	3.80	(0.79)	0.84
Equity	4.03	(0.83)	4.46	(0.66)	0.43

$n = 188$

The mean scores for the Actual Version of the CUCEI range from 2.96 to 4.03 and for the Preferred Version from 3.67 to 4.46. In the Actual Version, the means for Innovation and Individualisation scales are slightly below 3 (of a possible maximum score of 5), while all the others are above 3.5, thus indicating that students are reasonably satisfied with their actual learning environment. In the Preferred Version, the means for Personalisation, Cooperation and Equity scales are all above 4, while the others are all between 3.5 and 4, indicating that students would prefer a more positive learning environment than they perceive that they actually have. There is, however, very little difference between the means of the Actual (3.91) and Preferred (3.95) Versions of the Student Cohesion scale.

As can be seen from Figure 4.1 the pattern of the means is rather similar for both the Actual and Preferred Versions, except for Student Cohesion where there is only a marginal difference between the two Versions, indicating that students are satisfied with their learning environment as measured by this scale. The largest differences between the means are for Innovation and Individualisation, indicating that students are less satisfied with their actual learning environment than their preferred learning environment on these scales.

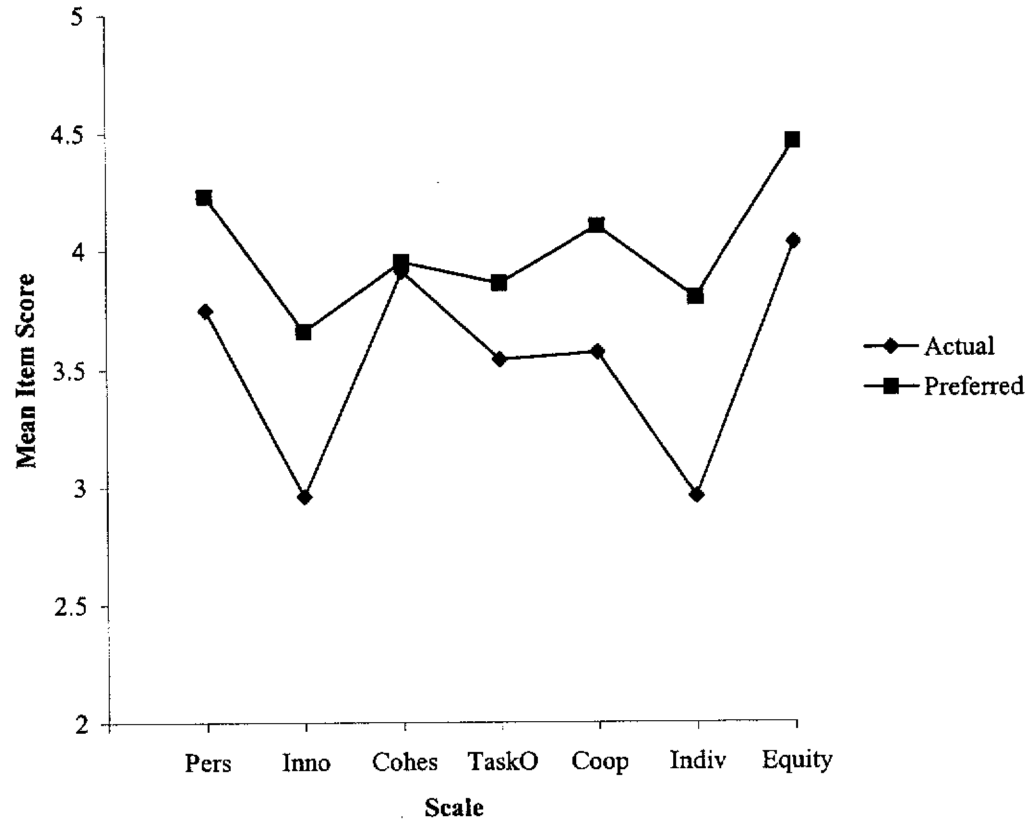

Figure 4.1. Scale mean profile for students responding to both the Actual and Preferred Versions of the CUCEI

The statistical significance of the difference between the results for the Preferred and Actual Versions of the CUCEI was examined using multivariate analyses of variance (MANOVA) with a repeated measures design. MANOVA was necessary to take account of the inter-correlations among the seven scales of the Actual Version and among the seven scales of the Preferred Version. Account was taken of the paired data by using the difference (Preferred-Actual) scores of the set of seven dependent variables and testing the constant effect, that is, testing the null hypothesis that the difference is zero. Tests for the homogeneity of variances (Bartlett-Box) and the homogeneity of dispersion matrixes (Box's M) indicated MANOVA was appropriate. The Wilks' lambda multivariate test of significance gave $F = 29.43$ ($df = 7, 181$), $p < .0005$ indicating that the null hypothesis be rejected. The effect size calculated from Wilks' lambda is 0.532, a very large effect. The univariate F tests were then examined and the results are reported in Table 4.16.

Table 4.16. *Univariate F-tests for Preferred-Actual Difference Scores*

Scale	SS	Error SS	F	Eta-square
Personalisation	44.63	148.33	56.27*	0.231
Innovation	91.98	203.02	84.72*	0.312
Cohesion	0.30	119.00	0.47	0.003
Task Orientation	18.97	112.50	31.53*	0.144
Cooperation	46.71	133.29	65.54*	0.260
Individualisation	133.63	180.75	138.25*	0.425
Equity	34.49	125.52	51.38*	0.216

* $p = <.005$

As Table 4.16 shows (and this is clear in Figure 4.1) there are statistically significant differences between the Preferred and Actual mean scores on every scale except Cohesion. For the other six scales the effect sizes (measured by eta-square as a proportion of the variance accounted for) are large, from 0.144 for Task Orientation, to 0.425 for Individualisation.

The remainder of this chapter examines students' responses to the CUCEI taking into account their sex and the type of school attended. The results for the Actual Version are examined, followed by results for the Preferred Version. Finally, the differences between responses to the Actual and Preferred Versions are analysed, to discover whether the differences are affected by students' sex and the type of school they attend.

Perceptions of Boys and Girls in Mixed- and Single-Sex Schools of Their Actual Learning Environment

Results for Sex and School Type for the Actual Version of the CUCEI

Table 4.17 reports the mean item scores and standard deviations for boys and girls in mixed- and single-sex schools for the reduced Actual Version of the CUCEI. The values of the means for boys in mixed-sex schools ranges from 2.89 to 3.84 and the standard deviations are all below 1, ranging from 0.67 to 0.92. The mean scores for girls in mixed-sex schools range from 2.63 to 3.87 and standard deviations between 0.71 and 1.01, suggesting that girls are a little more variable in their perceptions. The mean scores for boys in single-sex schools range from 2.88 to 4.27 and for girls in single-sex schools, from 2.84 to 4.13. The standard deviations are all 1 or below, with those for the boys ranging from 0.60 to 0.81, and for the girls from 0.66 to 0.93, again suggesting a little more variation in girls' perceptions.

Table 4.17

Means (Standard Deviations) for Boys and Girls in Mixed- and Single-Sex Schools for the Actual Scales of the CUCEI

Scale	Mixed-Sex				Single-Sex			
	Boys		Girls		Boys		Girls	
Personalisation	3.67	(0.85)	3.46	(1.01)	3.98	(0.60)	3.86	(0.76)
Innovation	2.89	(0.69)	2.63	(0.90)	2.88	(0.74)	3.30	(0.69)
Cohesion	3.84	(0.81)	3.82	(0.71)	4.20	(0.66)	3.86	(0.93)
Task Orientation	3.54	(0.67)	3.45	(0.77)	3.84	(0.55)	3.45	(0.66)
Cooperation	3.30	(0.92)	3.35	(0.78)	3.58	(0.81)	3.87	(0.76)
Individualisation	2.96	(0.82)	2.86	(0.83)	3.30	(0.64)	2.84	(0.67)
Equity	3.81	(0.84)	3.87	(0.90)	4.27	(0.73)	4.13	(0.80)

Figure 4.2 shows the mean profiles for boys and girls in mixed- and single-sex schools for the seven scales of the reduced Actual Version of the CUCEI. The pattern of means is fairly similar for all groups, except that the girls at single-sex schools perceive their environment as being more cooperative than the other groups. Overall, the boys from single-sex schools perceive their actual learning environment more positively than the other schools in all the scales except Innovation and Cooperation. However, there is little difference between their perceptions and the single-sex girls' perceptions on the Personalisation and Equity scales. The Innovation scale has low scores (below 3) for all groups except the single-sex girls who appear reasonably satisfied with this scale at just under 3.5. This scale is related to teaching approaches, and the nature of the computing classroom does not lend itself to a variety of different and innovative teaching methods. The Individualisation scale also has low scores for all groups, although the single-sex boys' mean were slightly higher than the other three. This scale relates to the degree to which students have control over their classroom activities. There is very little difference between the mixed-sex boys and girls on any of the scales, and their scores are virtually identical on Cohesion, Task Orientation, Cooperation, Individualisation and Equity.

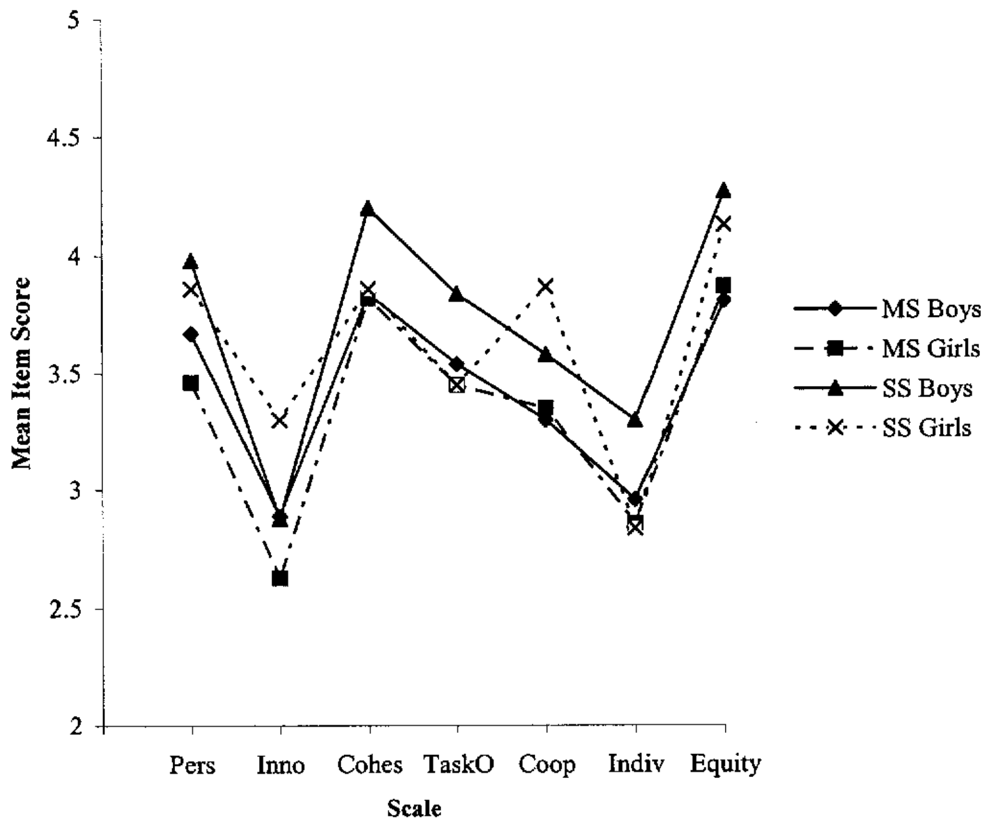

Figure 4.2. Mean profiles for boys and girls in mixed- and single-sex schools for the Actual scales of the CUCEI

Results for Sex and School Type for the Preferred Version of the CUCEI

Table 4.18 reports the mean item scores, and standard deviations, for boys and girls in mixed- and single-sex schools on the reduced Preferred Version of the CUCEI. The values of the means for boys at mixed-sex schools range from 3.60 to 4.22 and the standard deviations are around 1 or below, ranging from 0.62 to 1.03. For girls at mixed-sex schools the mean values are a little higher, ranging from 3.79 to 4.47, and the standard deviations from 0.70 to 0.98. The mean values for boys at single-sex schools range from 3.27 to 4.42 and for girls from 3.70 to 4.60. Again the girls' means are a little higher. The standard deviations for the boys at single-sex schools ranged from 0.66 to 0.92 and for girls at single-sex schools from 0.53 to 0.91.

Table 4.18

Means (Standard Deviations) for Boys and Girls in Mixed- and Single-Sex Schools for the Preferred Scales of the CUCEI

Scale	Mixed-Sex				Single-Sex			
	Boys		Girls		Boys		Girls	
Personalisation	4.11	(0.67)	4.30	(0.81)	4.01	(0.73)	4.38	(0.53)
Innovation	3.60	(1.03)	3.79	(0.96)	3.27	(0.92)	3.82	(0.73)
Cohesion	3.92	(0.79)	4.16	(0.79)	4.19	(0.68)	3.70	(0.91)
Task Orientation	3.84	(0.71)	4.05	(0.73)	3.87	(0.66)	3.74	(0.71)
Cooperation	3.85	(0.76)	4.00	(0.98)	3.79	(0.88)	4.37	(0.74)
Individualisation	3.85	(0.80)	3.81	(0.84)	3.58	(0.80)	3.88	(0.75)
Equity	4.22	(0.62)	4.47	(0.70)	4.42	(0.69)	4.60	(0.63)

Figure 4.3 shows the mean profiles for boys and girls in mixed- and single-sex schools for the Preferred scales of the CUCEI. As can be seen, the pattern of the means is fairly similar for all except for Student Cohesion and Cooperation. On these two scales the girls at single-sex schools have responded differently to the other groups. For the Student Cohesion scale their mean is lower than the means of the students from mixed-sex schools, in that they would prefer less Cohesion, and they would prefer greater Cooperation than the other groups. However all scores are over 3 (out of a maximum of 5).

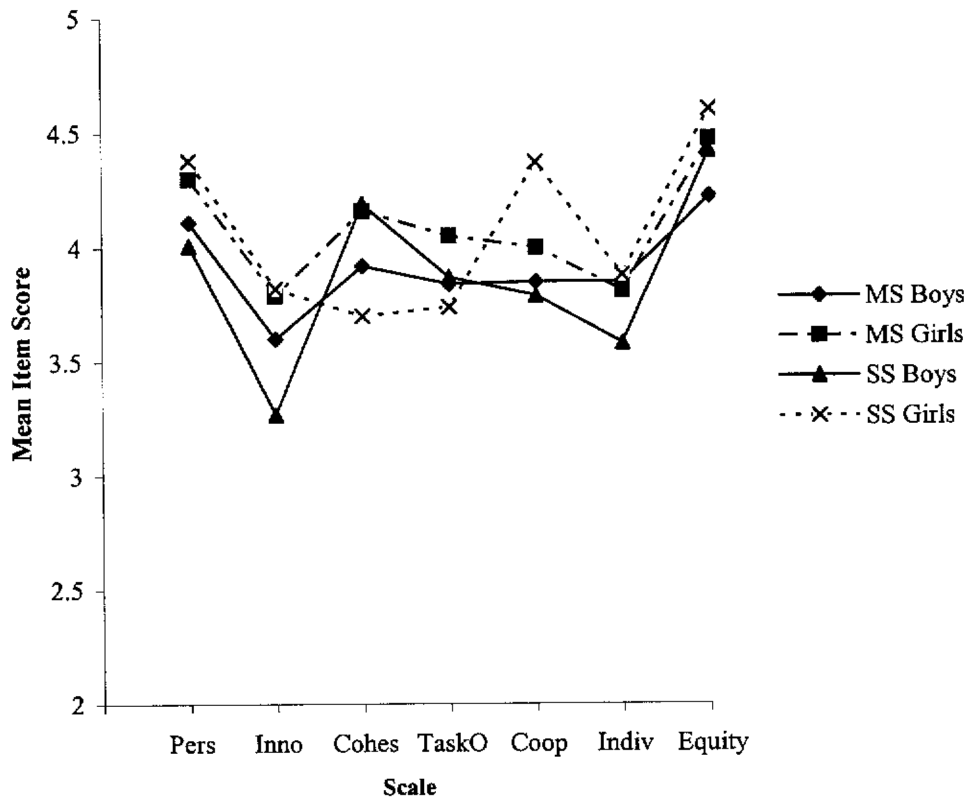

Figure 4.3. Mean profile for boys and girls in mixed- and single-sex schools for the Preferred scales of the CUCEI

Differences between Perceptions of Actual and Preferred Versions of the CUCEI

The results just reported for the Actual and Preferred Versions of the CUCEI suggest that the sex of the student, or the type of school attended, may have some overall effect on students' perceptions of the learning environment in their computer classrooms, and it seems the effects vary within different scales. The earlier presentation of results comparing the means on the Actual and Preferred Versions of the CUCEI suggested some quite large differences, except for the Cohesion scale (see Figure 4.1). The appropriate design to examine the pattern of effects in these comparisons is a repeated measures multivariate analysis of variance, with one within-subjects factor (the seven scales on the CUCEI, represented by the difference scores) and sex and type of school as the two between-subjects factors. A MANOVA takes into account correlations among the dependent variables and tests the statistical significance of the effects on the difference scores of the between-subjects factors, that is, the sex of students, the type of school attended and the interactions between them. The MANOVA results are reported in Table 4.19.

Table 4.19

MANOVA Results for Preferred-Actual Difference Scores for Type of School and Sex

Effect	Wilks' Lambda	*F*	Effect Size (Wilks')
Sex x Type of School	.92	2.11*	.077
Type of School	.92	2.31*	.083
Sex	.91	2.50*	.089

df = 7, 178
* *p* <.05

As shown in Table 4.19, the interaction between students' sex and type of school attended, and both main effects, are statistically significant at the 0.05 level, with effect sizes indicating around 8% of the variance in the difference scores overall are accounted for by each effect. These effect sizes are much smaller than for the differences overall discussed earlier.

Given these results, the univariate tests for each effect were examined. Tables 4.20, 4.21 and 4.22 report the results for Sex x Type of School, Type of School and Sex effects, respectively.

Table 4.20

Univariate Tests for Sex x Type of School on Preferred-Actual Difference Scores

Variable	SS	Error SS	*F*	Eta-square
Personalisation	0.09	135.20	0.13	0.001
Innovation	1.11	187.64	1.09	0.006
Cohesion	1.92	111.92	3.15	0.017
Task Orientation	0.02	105.67	0.03	0.001
Cooperation	0.43	129.22	0.61	0.003
Individualisation	5.57	166.30	6.16*	0.032
Equity	0.19	121.14	0.29	0.002

df (1, 184)
* *p* <.05

Table 4.20 shows only one scale, Individualisation, has a statistically significant interaction effect with an (eta-square) effect size of 0.032. The difference scores are plotted in Figure 4.4 and show the interaction occurs because of the similarity of the large difference-scores for boys and girls in the mixed-sex schools, and the small difference for boys in the single-sex schools. These differences can also be seen by Figures 4.2 and 4.3.

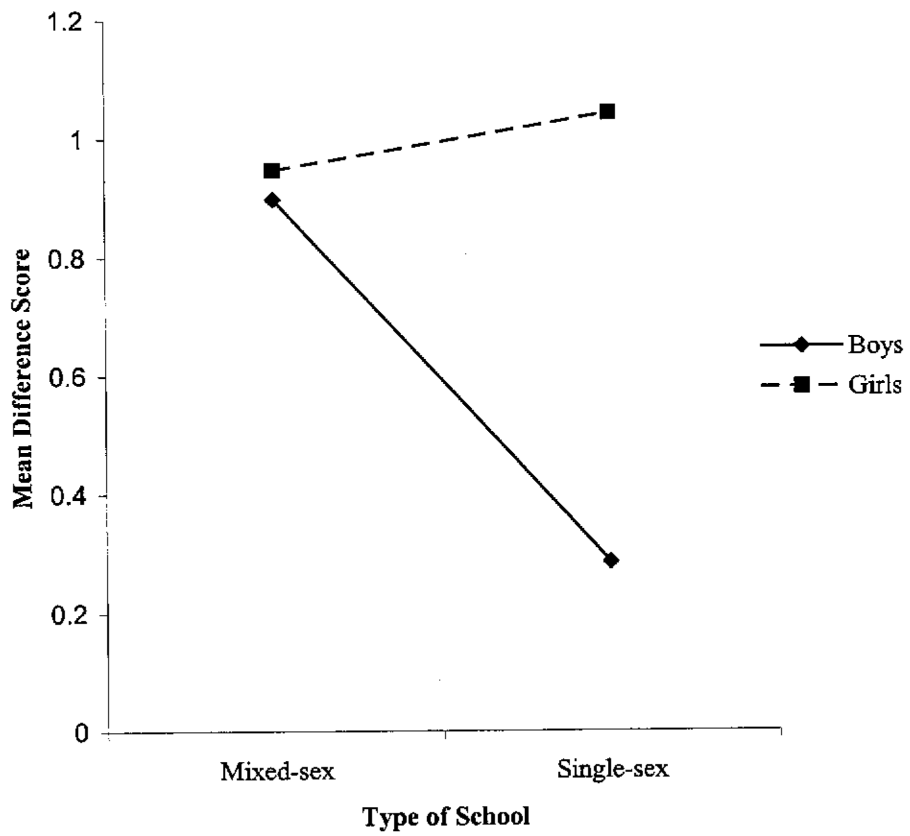

Figure 4.4. Mean difference scores on the Individualisation scale for boys and girls in mixed-sex and single-sex schools

Table 4.21

Univariate Tests for Type of School on Preferred-Actual Difference Scores

Variable	SS	Error SS	*F*	Eta-square
Personalisation	5.80	135.20	7.90*	0.041
Innovation	10.25	187.64	10.04*	0.052
Cohesion	3.89	111.92	6.40*	0.034
Task Orientation	3.90	105.67	6.80*	0.036
Cooperation	2.63	129.22	3.75	0.020
Individualisation	2.97	166.30	3.29	0.018
Equity	1.74	121.14	2.64	0.014

df (1, 184)
* $p < .05$

Table 4.22

UnivariateTests for Sex on Preferred-Actual Difference Scores

Variable	SS	Error SS	*F*	Eta-square
Personalisation	8.58	135.20	11.69*	0.060
Innovation	3.79	187.64	3.72	0.020
Cohesion	0.15	111.92	0.25	0.001
Task Orientation	3.44	105.67	5.98*	0.032
Cooperation	1.61	129.22	2.29	0.012
Individualisation	7.19	166.30	7.95*	0.041
Equity	2.95	121.14	4.49*	0.024

df (1, 184)
* $p<.05$

The results for the Type of School effect in Table 4.21 show that four scales, Personalisation, Innovation, Cohesion and Task Orientation have a statistically significant effect. Table 4.22, which displays the results for the Sex effect, shows a statistically significant effect for four scales: Personalisation, Task Orientation, Individualisation and Equity. The effect for Sex on the Individualisation scale is spurious because of the interaction, and, as shown in Figure 4.4, the sex difference is present only for students in single-sex schools.

Figures 4.5 to 4.9 represent graphs for the results for the Personalisation, Innovation, Student Cohesion, Task Orientation, and Equity scales, respectively, where there is at least one statistically significant difference.

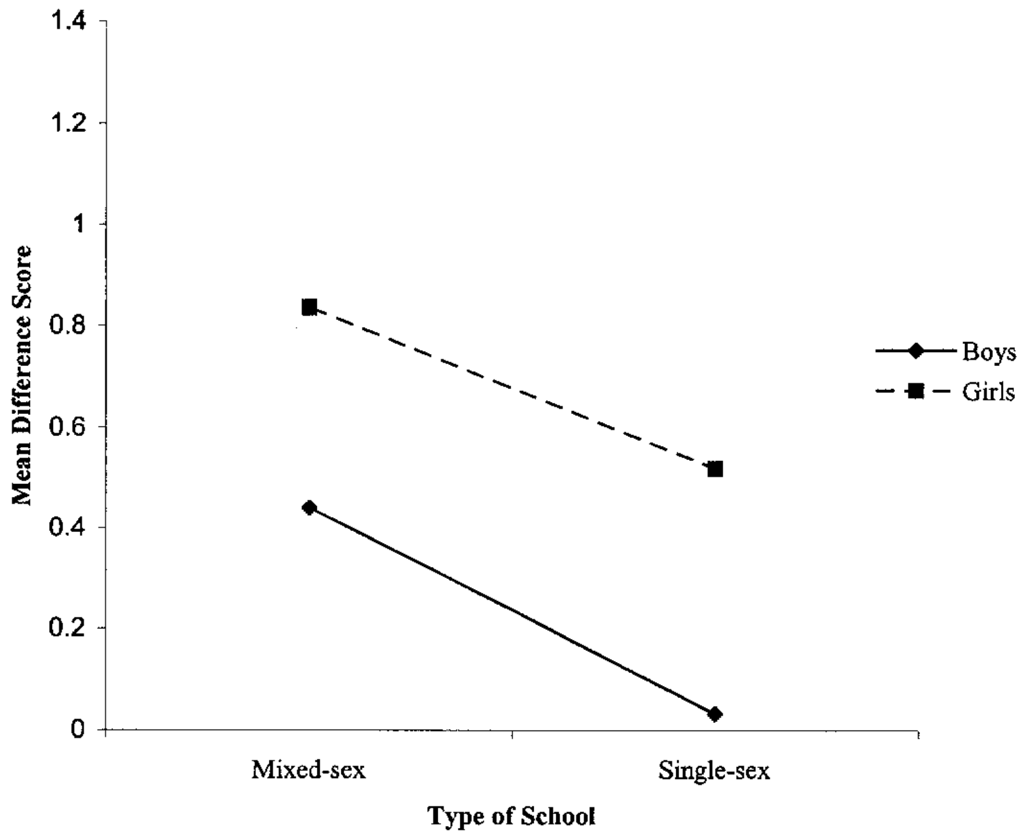

Figure 4.5. Mean difference scores on the Personalisation scale for boys and girls in mixed-sex and single-sex schools

The mean difference scores for the Personalisation scale are plotted in Figure 4.5. Boys in the single-sex school reported the least difference between the Preferred and Actual versions on this scale. For each of the other groups the difference is quite large, particularly for the girls in mixed-sex schools. Although girls in mixed-sex schools displayed a greater difference between their actual and preferred perceptions of this scale, girls in single-sex schools reported a difference which was comparable to boys in mixed-sex schools. The Type of School effect (4%) was smaller than the Sex effect (6%) but both are statistically significant (see Tables 4.21 and 4.22).

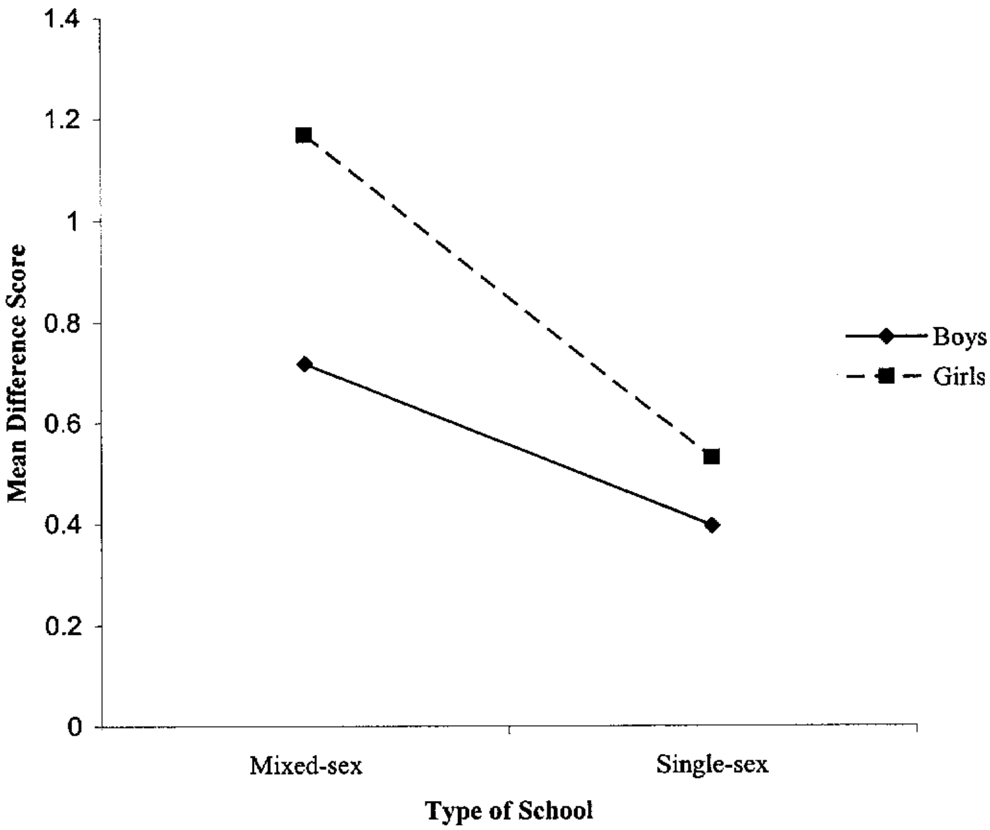

Figure 4.6. Mean difference scores on the Innovation scale for boys and girls in mixed-sex and single-sex schools

The mean difference scores for the Innovation scale are plotted on Figure 4.6. The sex difference is greatest between girls in mixed-sex schools and boys in single-sex schools. The difference between students in single-sex schools is smaller than that between boys and girls at mixed-sex schools indicating that they are more satisfied with this aspect and perhaps contributing to the statistically significant Type of School effect of 5.2% as shown in Table 4.21.

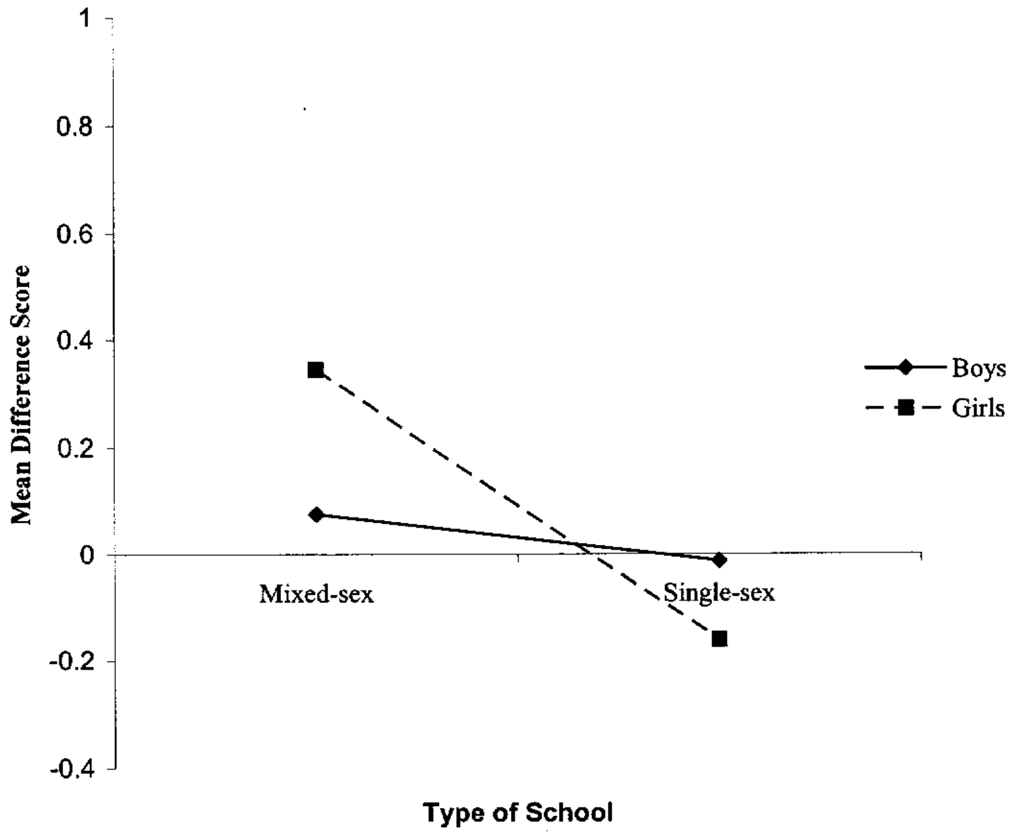

Figure 4.7. Mean difference scores on the Student Cohesion scale for boys and girls in mixed-sex and single-sex schools

The mean difference scores for the Student Cohesion scale are plotted in Figure 4.7. There was an interaction effect but this was not statistically significant (see Table 4.20). However it has contributed to the statistically significant Type of School effect of 3.4% (see Table 4.21). The most notable difference here is that students from mixed-sex schools would prefer a little more cohesion, particularly the girls, and this can be observed in Figures 4.2 and 4.3. The differences were greatest between the girls at mixed- and single-sex schools and this is mainly responsible for the type of school effect.

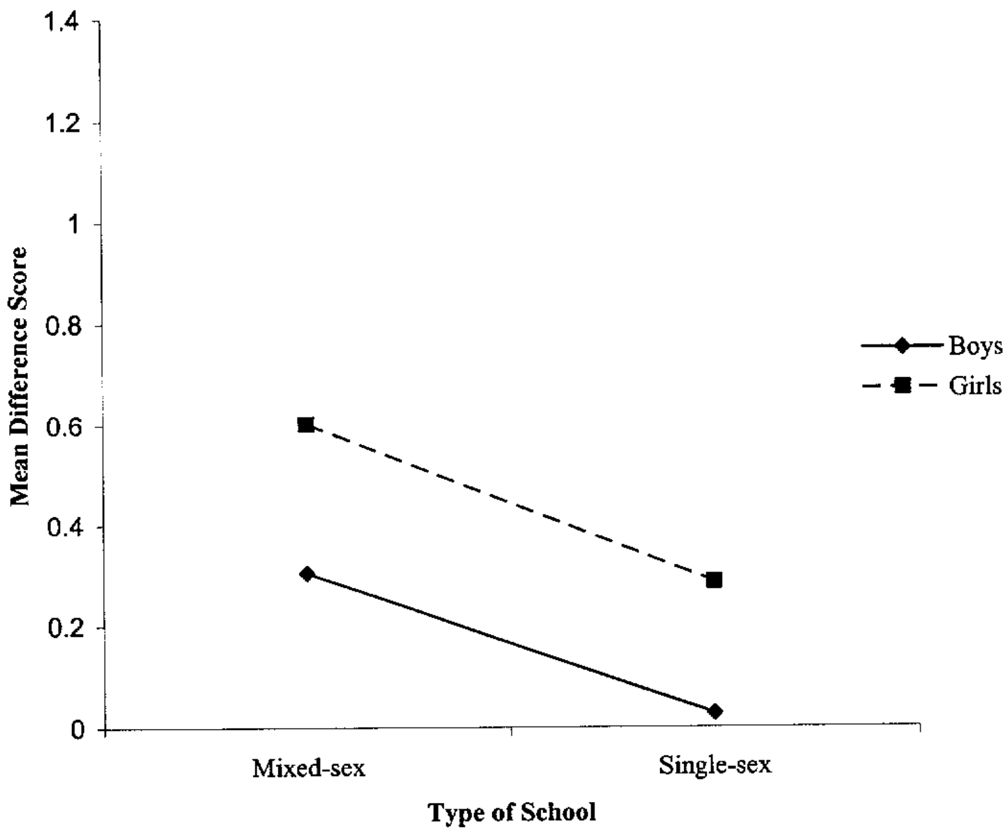

Figure 4.8. Mean difference scores on the Task Orientation scale for boys and girls in mixed-sex and single-sex schools

Figure 4.8 plots the mean difference scores between the Preferred and Actual Versions for the Task Orientation scale and illustrates that girls at mixed-sex schools display the greatest difference, while boys at single sex schools report the least difference. The Type of School effect accounted for 3.6% of the variance, while Sex accounted for 3.2% (see Tables 4.21 and 4.22).

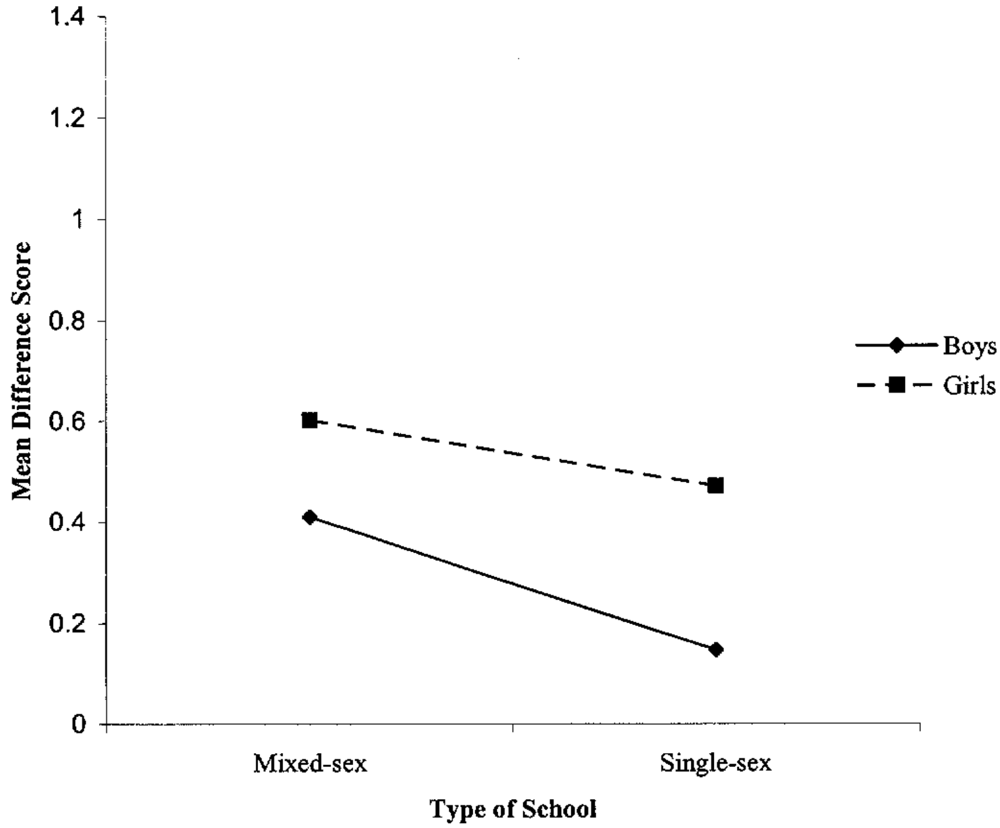

Figure 4.9. Mean difference scores on the Equity scale for boys and girls in mixed-sex and single-sex schools

As can be seen in Figure 4.9, which plots the mean difference scores for the Equity scale, the effect for Sex is small at 2.4% (see Table 4.22). Boys from single-sex schools show the least difference, while girls at mixed-sex schools display the larger difference, with very little between the boys at either type of school.

Summary

This chapter reported the overall results for students' responses to the Actual and Preferred Versions of the CUCEI, followed by an analysis of the results for Sex and Type of School (single-sex or mixed-sex).

The principal components analysis indicated considerable inter-correlation among the items, and, in both the Actual and Preferred Versions, seven clear scales were unable to be established. As a result 8 of the original 49 items were deleted. While the Personalisation scale did not perform well, it was retained for the internal consistency analysis (where it showed good internal consistency of 0.87 on the Actual Version, and 0.85 on the Preferred Versions). Both Individualisation and Task Orientation showed rather low internal consistency in the Actual Version. In the analysis of the correlations between scales, Personalisation showed a considerable overlap with Innovation and Equity in the Actual Version, and Innovation, Task Orientation, Cooperation and Equity in the Preferred Version.

An overview of the results for students' responses to the Actual and Preferred Versions of the CUCEI was provided. A MANOVA indicated that the mean difference score over the seven scales was statistically different from zero, with an effect size (Wilks') of 0.532. The results of the univariate *F*-tests suggested that the sex of the student or the type of school attended did have some statistically significant effects on students' perceptions of their computer learning environment, except for the Cohesion scale. For this reason a MANOVA was used to examine the pattern of effects. These results showed effect sizes that were around 0.08 for each effect. The univariate tests for Sex x Type of School, Type of School and Sex were then examined. Only one scale, Individualisation, displayed a statistically significant interaction effect caused by the similar, large difference scores for boys and girls in mixed-sex schools and a small difference for boys in single-sex schools, but a large difference for girls in single-sex schools. It must be remembered that a relatively small number of schools completed the CUCEI (seven), and only one school was a single-sex boys' school.

On four variables, Personalisation, Innovation, Cohesion and Task Orientation, small to medium size effects (0.034 to 0.052) were found relating to School Type (see Table 4.21). In each case students in mixed-sex schools displayed a larger difference between the Preferred-Actual versions, than students in single-sex schools. These results suggest that students in mixed-sex schools perceive less Personalisation, Innovation, Cohesion and Task Orientation than they would prefer.

In the univariate tests for sex effects, small to medium effects were found for four variables, namely, Personalisation, Task Orientation, Individualisation and Equity. Only the effect size for the Personalisation (6%) scale exceeded 4% of variance, while the effects for the other two (excluding Individualisation as this had shown an interaction effect) were, at 3.2% and 2.4%, quite trivial. On each of these scales, girls had the larger difference between their responses to the Preferred and Actual Versions of the CUCEI, suggesting that they perceived their learning environment to be less personalized, individualized and equitable, and to be less task oriented than they would like. Interestingly, on every scale, the boys in the single-sex school had the difference score closest to zero.

The next chapter reports the analysis of students' and teachers' perceptions gathered from individual and group interviews, and the researcher's perceptions gathered from observations in each type of school. This analysis will be related to the scales of the CUCEI, as well as focussing on the concept of computer culture in the classroom environment.

CHAPTER 5

FINDINGS FROM INTERVIEWS AND OBSERVATIONS

Introduction

The findings presented in this chapter come from the interviews and observations carried out in three schools; one co-educational school, one single-sex girls' school and one single-sex boys' school. Four teachers and 15 students were interviewed and three teachers and their classes were observed. The Chapter opens with a description of the approach to the analysis of these data. Using the interviews and class observations, word pictures are drawn to depict the nature of the computing classrooms in the three schools. Following that, and based mainly on the data from the interviews, students' and teachers' perceptions of the class environment are discussed using the CUCEI scales as foci for the discussion. Data from the observations (which reflect the researcher's own perceptions) are also included.

Approach to Analysis of Interviews and Observations

An interpretive approach, guided by Patton's (1990) suggestions for analysing content, was taken in the analysis of the qualitative data. As described in Chapter 3, the semi-structured interviews were audio-taped either at the school or in the researcher's office. Students' responses to the interviews at both male and female single-sex schools seemed quite reserved and unforthcoming, perhaps indicating shyness and unfamiliarity with the researcher. It was interesting to note that the most vocal and reflective responses were from students attending the mixed-sex school. In some respects observations of the classes generated more information than interviews with the students. Here the researcher was able to observe the subtle variations in behaviour and attitude of the students and their interactions with each other, and their teachers. It also gave rise to informal discussions with students, who were much more willing to converse informally with the researcher, both in class and in corridors while waiting for class to begin, than were the students who had initially volunteered for interview.

In analysing the results of the interviews and observations the researcher used NUD*IST to help establish themes and sub-themes of the computer classroom culture according to the contributing factors identified by Sproull et al. (1986), that is, "the context in which computing occurs, the kinds of people who compute, the social organisation of computing and the values associated with computing." Table 5.1 sets out the themes and the sub-themes that were identified.

Table 5.1

Themes and Sub-themes Identified through Qualitative Analysis

Method used	Themes	Sub-themes
Classroom observations and interviews	The Context	Teachers' background Teaching styles Physical resources
	The Students	Student composition Student ability
	Socialisation	Student behaviour E-mail and games Machine fascination
CUCEI	Personalisation	Friendliness Helpfulness and support
	Innovation	Problem solving Practicality Boredom
	Student Cohesion	Friendliness with peers
	Task Orientation	Work pressure Order, organisation and control
	Cooperation	Helping Collaboration and group work
	Individualisation	Self paced learning Choice of activity
	Equity	Recognition of bias Demanding nature of boys

The analysis therefore begins by focusing on the context in which computing occurs. In the following section background information about the teachers, the classrooms in which they teach, their students, and the way in which socialisation occurs will be discussed.

The Context

Teachers' Background

Mr Smith began teaching at School C1 in the 1970s. At that time there was no computing, but by the early 1980s computing was introduced into the senior mathematics class by Mr Smith, who had taken a programming course at University which had engendered an ongoing interest in computers and computing. It was grounded in mathematics at that time and Mr Smith said:

> We taught Pascal as the programming language and it was heavily math based so it was programming, a look at computer arithmetic and how it works, a look at the types of errors that occur in computer maths and very little of anything else.

This content was common in schools which taught computing at that time. In 1982 computing was split from the senior mathematics class and became a subject in its own right, but was still similar to what had been taught in the mathematics class. At the same time computing was introduced as a compulsory four-week introduction to Year 9 students (3rd form). The school was one of the most forward in Wellington in its offering and development of computer facilities, largely due to Mr Smith's interest and knowledge and support from the Principal. The ratio of girls to boys taking both mathematics and computing was relatively even, as far as Mr Smith could recall, until 1984, when an optional class was introduced for Year 11 students. It was at this point that it was noticed that the boys were choosing to take the computer course and the girls were not. A variety of tactics were used in an attempt to attract girls. He says:

> We tried a whole variety of things like girls-only days at lunch time. We thought the atmosphere in the room might be putting the girls off. We tried to look for girl-friendly games, and in those days there was nothing. We tried having a girls-only computer course and it didn't fill.

The second teacher, Ms Cornell, was employed at School C1 to teach Computer Science, and for her this had meant learning such things as Pascal, database design and about logic gates. It was, she said, a huge learning curve, "but one of the reasons I was actually employed was the whole thing of a role model in the computing field. I totally agreed with that as a lot of it is seen as nerdy men" (Ms Cornell, School C1). She had been employed as a secretary when younger and at her previous school was in charge of the library.

Ms Watson, from School G2, felt unsure about aspects of her computer knowledge, and she was concerned that often when students found themselves in difficulties she was unable to help them. Ms Watson believed that offering computing as an elective was important for students, and while she was competent to teach the subject, she was self-taught with a secretarial background, and this was the major cause of her feelings of inadequacy. The fast changing nature of the topic also contributed to this. She felt she would be a better role model if she had a more in-depth understanding of computing. Computing was a relatively new elective that had been driven by Ms Watson, but not promoted heavily by the Head Teacher or the Principal. Nevertheless, there were two classes being run at Year 12 and 13, one of 19 students, and a higher level one of 9 students.

Mr Adamson from School B1 had studied Forestry in the Netherlands where he was introduced to programming and from whence he developed an ongoing interest in the subject. He began his teaching career at a private single-sex girls' school in Wellington teaching mathematics and science for the first six years, and reluctantly taking over the computer course in his seventh year. After teaching computing for 18 months at this school, he worked in the computer industry for three years before returning to teaching as Head of Department at School B1. At that time the school had 29 computers in two rooms on a peer-to-peer network. In the two and a half years he had been there he had established a proper network, comprising 6 rooms with 20 computers in each. He commented that he had "huge support" from the Principal for the computing program and the computing laboratories were very well-resourced.

Teaching Styles

The observations revealed that the personalities of the teachers, and their individual teaching styles, differed considerably. Mr Smith was very casual about student behaviour in the classroom, from tolerating the bad language which the male students commonly used, to condoning the continuous playing of games by them while he was teaching. He commented that he needed to treat the girls differently to the boys in that with the boys he could say "Try this or that" whereas he usually sat down and showed the girls what to do. On the other hand, in Ms Watson's class the girls were almost always polite, focused and well-behaved. It was particularly noticeable that Ms Watson continually made positive comments to students regarding their work, and reinforced to them how good their work was. Both these teachers always began the class by either teaching the students something new, or reviewing what activities were to be undertaken, but Ms Watson also clarified what they were expected to achieve at the end of the class. They did not use a text book of any description, and at both schools instructions for class activities were written on the board and explanations were verbal.

At School B1, Mr Adamson provided the boys with a booklet with very clear step-by-step instructions for all the Units, allowing the students to work at their own pace. This meant that there was less need for him to give formal lessons, unless he wanted to revise a particular aspect in preparation for an assessment. He was very strict about language, behaviour and dress standards and on several occasions made students tuck in their shirts, and fix their shirt collars. On one occasion a student was made to apologise for chewing gum in the classroom. There was one networked game on the system and he permitted the students to play this in one class per week.

All the teachers when interviewed commented on how their teaching style in the computer studies classroom had changed over the years, from a formal, structured format, to a more unstructured format which allowed the students to work at their own pace, and to solve their own problems. For example, Mr Adamson said:

> At that point [some years ago] I was still teaching very structured lessons – much less free-flowing than it is now. And trying to keep the full class together at the same bit of curriculum. I was much more rigid then.

He said he realised that trying to keep students at the same level in the computer classroom meant that he was holding back the knowledgeable ones, and they were getting bored. Because computing is a subject where exercises can be developed so that students can work at their own speed, he decided that would be a more suitable approach.

Ms Watson (School G2) stated that her teaching had changed dramatically in that when she first started teaching word processing, she would stand at the front of the room and give instructions. Nowadays, she adopts a more problem solving approach which allows the students to work at their own rate. She commented that while some of the students had trouble moving out of their "comfort zone" (in that they were forced to solve the problems on their own), they got a sense of achievement when they were successful.

Mr Smith from School C1 explained that he tended to use a problem solving approach because he found that students learnt more if they could discover it for themselves. He said that very often when students asked him a question he would not give them an answer but tell them to try something and see what happened.

Physical Resources

The computing facilities provided by all three schools were excellent, with up-to-date hardware, software and networking systems. All schools used personal computers and ran Microsoft applications, as well as some other programs. Good sized classrooms were provided with sufficient space between computers for students to spread out their books and work comfortably, but still communicate easily with each other.

The classrooms were arranged differently in different schools, and sometimes this contributed to different types of student behaviour. At School B1, four classrooms were used for these students. Each day the students would go to a different room. Two of the rooms in which the classes took place had computers arranged around the sides of the rooms, and two had a row of computers down the centre as well. When the computers were arranged around the sides of the room, and the centre of the room was free, there appeared to be much less interaction between students, whereas when computers were also placed in the centre of the room, and students were facing each other, and closer to each other, there was much more interaction, and more noise. Another interesting behaviour pattern was that in this school the students tended to move around the room while seated on their wheeled chairs in the two classrooms with no computers in the centre of the room.

At School C1, where Mr Smith taught, the classroom was arranged with a row of computers down one wall, a double row facing each other in the middle, and on the other side three computers facing the back wall (meaning students sat with their back to the front of the room) and another three facing out of the window, with their backs to the rest of the class. It was interesting to note that invariably the girls always sat in this particular area, which more or less physically separated them from the boys who sat down the middle rows or the side row. Janet was usually the only girl attending in her class and she began sitting next to the researcher after the first day.

Ms Cornell from School C1 thought that the computer labs were a "deadly environment", commenting:

> There's nothing there. I can't stand that. I think the rooms have got to be inviting and warm and you know you go into some of the computer labs and you know it smells, there's no air, there's no windows open, there's mess, junk, the rooms have got that uncared for, unkempt (dare I say it) male environment. As a woman I walk into a lab and think I don't really want to teach in here because it's an untidy, unpleasant place to work. It really is a male scene. It certainly affects me as a teacher and I know it does with Natalie as a teacher.

Natalie is another computing teacher at this coeducational school. Ms Cornell's comment raises an interesting and relevant aspect that may be considered as contributing to the computer culture because of the perceived maleness of the physical environment.

At School G2 the desks and computers were arranged down each wall, with two groups of four in the middle of the room. This was very conducive to the sharing of information and collaboration, an aspect very much encouraged by their teacher, Ms Watson.

The Students

Composition of Classes

The numbers of students in classes in the three schools where qualitative data were gathered were relatively small, ranging from 9 (at School G2) in the smallest to 19 (also at School G2) in the largest. All of the schools had a small component of International students in the computer classroom. They were guided into computer classes because it was considered that computing (a) helped their English, and (b) was easier for them to manage because the subject did not involve much reading and formal, structured writing. In School G2, the International students were a quite separate group, with a special (English as a Second Language) teacher also in the classroom dealing with them on an individual basis on some occasions. At this school, these International students were the only students who were in any way uncooperative or argumentative towards the teacher and did not mix with the other students. At School C1 there were four International students. They were not a part of the class but spent time on the computers doing their own special work. Similarly, School G1 had a small contingent of International students independently working on the computers. While the International students were in the classrooms observed, they were not a part of the research sample and did not contribute to any of the data gathered. They had work to do, but they were mainly unsupervised. One classroom in School B1 also had a seriously disabled young man in a wheel chair, who had a Special Needs teacher dealing exclusively with him. All three schools where observation was undertaken had an ethnically diverse population, particularly School B1 which had a large number of Pacific Island students in the computing classroom.

Student Ability

The academic mix of students in the computer classrooms at year 12 and 13 was of interest. It was considered by most of the interviewees that many of the students were from the lower ability range, with few from the average or higher ability range. Among the reasons put forward for this was that Computing was not a Bursary subject, therefore students of average ability did not add to their study burden by taking a subject that would not contribute to their overall Bursary marks, and therefore University entry. On the other hand, a few students of higher ability, and with an interest in computing, would take it because they felt they could manage that additional burden, whereas students of lower ability would take it because they saw it as an enjoyable option with no formal external examination. For example, Mr Adamson at school B1 explained that:

> People (take computing) who know they are not going to do well in maths or science and more academic subjects ...and it has a certain component of fun in there ... they know there's no homework either and they like it anyway so we tend to get, to a certain extent, we tend to get the cast offs.

Fran, a student from School G2 felt that:

> It is known as, kind of dumb people kind of take it kind of thing. At first I was told to take it because it is easy. But more people who find school hard seem to take it especially in the 5th and 6th forms.

However Mr Smith from School C1 felt that the mix of students electing to take computing was wide-ranging and that while there was definitely a selection of lower-academic students, there were also a number of the top students. He said that in any year he could look at the top people in the computing classes and they would be the top students in the school. Nevertheless, two of the students from this school made comments referring to lower ability students opting to take computing because it was seen as an easy option. This is particularly interesting, because while there appeared to be a general consensus that students of lower academic standing tended to take computing classes, there was also a perception, by both students and teachers who were interviewed, that the reason why girls at School C1 tended not to take the two classes under observation was because they may have thought it was too hard for them. For example, Ms Cornell felt that they might view it as being "too hard", while Mary, a student, made comments about it being "such a high level we are doing there".

Mr Smith made some particularly interesting remarks about the girls who took computing, saying:

> They tend to be quite bright and again we are talking awful generalisations. The sort of people like Janet – she's the sort of girl

> who would quite happily sit there in a roomful of boys if she wanted to do a subject. And she doesn't seem to be worried about the types of language or abuse that she got.

He went on to say that Janet would be typical of the sort of girl who would come in on her own at lunch time to use the computers, and that from his perception she was quite unusual. He also said that while he considered a wide range of students took computing at School C1, there did tend to be the "stereotypical, loner type, nerd" attending and that it was probably easier for these types to take computing than a subject like social studies.

Socialisation

Student Behaviour

Student behaviour varied dramatically between the schools. This could have been related to the individual teacher's reactions to certain types of behaviour, or to the ethos of the school itself. The language at School C1 included a lot of swearing, there appeared to be little or no respect for other students or the equipment, and this behaviour seemed to be accepted by everyone in the classroom. Further, the students who were interviewed did not appear to find this a problem. Trevor said:

> There's a few f…s and s…s when the programs don't work or if someone dies in a game. I guess in the afternoon everyone is sort of withering off and being really tired as well and the language gets snotty.

Janet, who was a very smart and capable student, simply said:

> The language doesn't bother me because I know a lot of people who speak like that – it's quite normal with people my age which I find quite interesting.

And Nancy, from the same school, merely thought that even "5-year olds use that sort of language now".

In discussions with Mr Smith about the language he said that he did not think the girls minded. However, the bad language did appear to be more specifically related to the playing of games (which Mr Smith allowed in the class, and only the boys indulged in this activity). Trevor made some interesting comments about this:

> People sort of get excited and guys get pretty prideful. If they die it damages their pride. You know, everything you do you have got a little bit of pride and of course you think you are good at something and [if] someone's better you get pissed off.

Apart from the bad language which was so noticeable in the classroom at School C1, there were also other behaviours which were different. The noise level was high, the students were continually calling out to each other and the teacher, and on one occasion a student purposely kicked a chair over as he left the room. On the first day of observation there was a certain amount of showing off and one female student spent the whole of the class sitting on the knee of a male student. Mr Smith said this had never happened previously and throughout the rest of the observation she never spoke to that student again. Students arrived in the classroom throughout the class and offered excuses like "the bus was late" and were not reprimanded in any way.

The girls who were interviewed did not find the noise level a problem with Nancy saying, "You get used to it".

In comparison, the classrooms in School B1 were highly controlled so far as student behaviour was concerned. The moment the noise level rose Mr Adamson would quietly say "too much noise" and it would stop. On one occasion when a student opened the door and stood in the doorway waving to get his attention, he made him go back outside, knock on the door and ask to speak. While there was a bit of bad language, it was always quiet, and never used so that Mr Adamson could hear it.

The ethnic diversity in the classes at School B1 was high, and there were many Samoan boys. These boys often broke into song and in one particular class you could almost always hear one or other student singing quietly. They were also very proud of the achievements of their peers, and on numerous occasions insisted on showing the researcher how fast one of their friends could type, or a picture they had created on the computer of a chainsaw killing, fighting or bombing that they thought particularly well done.

While at School C1 the researcher's presence initially changed the behaviour of the class, the teachers in the other two schools said there was no change. At School G2, Ms Watson said that the presence of the researcher had not changed the student behaviour, whereas often when other outsiders came in their behaviour was so bad that it was embarrassing.

One of the noticeably different aspects of School B1 was the peer pride and the singing in the classroom. At School G2 the most noticeable difference was the cooperation and helpfulness, and also the way in which the girls touched each other, not in a sexual fashion, but at the end of class they would walk out with their arms around each other, or just lean against each other. In the class they would often put their arms around each other as they looked at the screen and discussed what might be a better choice or option.

E-mail and Games

However, while the observations may have shown friendliness and cooperation, Ms Watson from School G2 and Ms Cornell from School C1 both emphasised the fact that female students could be "vicious", and often used e-mails to spread malicious rumours about peers and staff. Therefore these applications had to be monitored very carefully. Ms Watson said:

> We try and keep it for educational purposes only because it is such an issue. The girls hot-mail each other and there is such awful anonymous stuff. Girls can be really vicious – bullying tactics – spreading rumours, adding to it and passing it on.

At School C1, both teachers observed that the girls used the library extensively at lunchtime to utilise the multi-media, internet and e-mail. It is interesting that they went to the library rather than to the computer labs where the boys tended to gather, although only the library computers had multi-media software.

Both female and male students used e-mail, but only one female student, from School G1, said she would play games if she had the time. On the other hand all of the boys who were interviewed loved playing games, and continually referred to them as "exciting". In the observations it was evident how much they enjoyed the games and they would make comparisons with other games, talk about liking the expressions on the characters' faces, and comment with evident enjoyment when they blew something up. At School C1 Ms Cornell said:

> For instance when you walk into the English classroom you don't have them say, Can we have a games period today, Miss? Whereas that's the first question you have almost every day. Can we have games today?

She also commented that at lunch-time in the computer labs:

> The boys swarm in there, they are playing games, there's a language, there's a whole masculine sort of thing and you have to be one of that group, you have to be a groupie almost to occupy one of those labs where it's a heavy male scene – I mean if you can get past the smell and the language you are doing quite well. And I don't think any right minded girl would want to.

All the girls from School C1 commented on the boys' game playing, and Mary encapsulates their comments in the following:

> Like you wouldn't see playing cards in an English class or a science class but Mr Smith is really relaxed about that. Those boys are just interested in games and guns and shooting.

Observation of Mr Smith's classes, as mentioned earlier, showed that the boys continually played games throughout his classes.

At School B1 the situation was different because Mr Adamson did not allow games to be played in class except for one period per week. However, these students had a learning-to-type program on the network called Mavis Beacon which had typing games built in, and as Mr Adamson said "the students just love it". He commented that while he thought their attraction for it was as a games substitute, their typing skills had become excellent with the top student achieving 77 words per minute in less than a year. He also noted that previously keyboarding and typing was not done at a boys school but that it was "suddenly very sexy" at School B1. Both Schools C1 and B1 allowed the students to play games during lunch hours and after school. One student from School B1 who was interviewed, Jack, said he spent most of his weekends playing games on the Internet, while another from the boys' school, Richard, said he was not interested in the Computer Club. Schools C1 and B1 both ran a Computer Club where the students could play games. In both cases this was monitored by a senior student, and was available at lunch times and after school.

In comparison, most of the girls at Schools C1 and G2 were not interested in playing games at all, and only used the computer room at lunch times to complete assignments and school tasks. They made comments such as "I have got better things to do with my time", and, "My brother can sit on the computer for 12 hours straight. I couldn't do that".

Machine Fascination

Particularly apparent at School C1 was the fascination that the boys had for the machine itself. Mr Smith talked about the fact that the boys hunt for things to do on the computer. He said that even in the years when the school had banned games the boys would be in the computer room in their spare time looking for anything interesting to play with, find out about and touch. They were there because the machine was there and they thought it would be fun to find out what it would do. One of the ramifications of this, according to Mr Smith, was that:

> [The boys] get to know what happens when they go wrong. Later on they have a lot more of that kind of knowledge about using a computer, a lot more experience just using the computer.

While he commented on the boys seeming to like "interacting with the computers a lot", Ms Cornell perceived it slightly differently, commenting, "they almost want to be attached to it [the computer] they can't cope if they are not actually attached".

At School B1, while all the boys who were interviewed enjoyed computing, one student, Jack, was rather more ebullient, saying, "I just have always liked it ever since I first used a computer. I don't know what exactly, but I love using the computer." This student was also very enthusiastic about computer games.

This section has described the context in which computing takes place, provided a description of the people involved and their behaviour in the classroom, and examined some of their attitudes towards computing. It becomes evident through reading this section that the individual teacher, and perhaps the ethos of the school, impacts on the behaviour of the students.

The next section focuses on analysing the qualitative data gathered which relates specifically to the scales of the CUCEI. Here, the individual scales were used as the themes, and sub-themes were identified within each scale.

Personalisation

This scale describes the extent to which the individual student has the opportunity to interact with the teacher and the concern displayed by the teacher for the student's personal welfare. According to Moos this is a relationship dimension of an environment and in the following analysis focuses on the involvement, affiliation and teacher support elements as described by Moos (1965). The themes which evolved out of examination of the transcripts were friendliness, helpfulness and support from the teacher.

Friendliness

It was obvious from the observations that all the teachers treated the students in a friendly manner. In School C1 in particular, the classroom had a very relaxed atmosphere; in fact at times it seemed too relaxed with the boys being quite cheeky and very noisy. All the students who were interviewed perceived their computing teachers, both past and present, as being friendly. Students used words such as "really nice" and "really good" to describe their teachers, and often perceived the computer classes as being "fun" because of their teachers. There was a general feeling expressed that they had more freedom within the computing classroom, and that the computer teachers were more relaxed, friendly and easy going. This was supported by the observations. One student's comments from School B1, Jack, encapsulated the general feeling of friendliness of the teachers by saying:

> The classes are pretty cool, pretty good. We are good for our teacher. Mr Adamson's really nice. I like him. Our teachers, they are always friendly.

However all three of the girls interviewed from school C1, while perceiving Mr Smith as being friendly and liking him, were slightly critical of the bond which appeared to exist between him and the boys in the computing classroom. Janet describes that feeling, and almost disassociates herself from that teacher/student relationship:

> Like with those boys they all seem to be real good friends and they all know each other and Mr Smith knows them really well and it's kind of a community thing.

Janet's comment is interesting because it highlights her isolation from the group of boys. Because there were so few girls in the classes at this school, they tended to sit apart from the boys, and not participate in a lot of the interactivity taking place between them. In the classroom where there was only one female student, this student began to sit beside the researcher after the first day of observation, and often directed comments to the researcher during the course of the class.

Helpfulness and Support

All students commented on the helpfulness of their teachers, although the students interviewed at School B1 all commented that they would ask somebody they knew first, and then ask the teacher if they couldn't find out on their own. They felt that teachers spent a lot of time explaining how to solve their problems, both individually and collectively. An example of the tone of the comments made is from Matt at School B1:

> If you need help you just need to ask and he will see you as soon as possible. If I ever get stuck he's always there to help me.

Mary from School C1 commented:

> If you don't understand it he explains it **really** well. He's really good.

Trevor from School C1 commented that:

> He pretty much caters for everyone's interests, like me and a couple of other guys who are really into designing graphics at the moment and he's sort of helping us out and stuff. He's good like that.

However, all the girls from School C1 were aware of differences caused by their being the minority group, and made slightly different comments from the boys, and from the girls at the single-sex school, such as the following from Nancy:

> I mean he's usually helping the boys because there are so few of us. ... But yeah if we need any help he'll come straight over and help us.

Innovation

The Innovation scale is concerned with the teaching methods used in the computer classroom. The questions focus on innovative and unusual activities which the teacher uses. The overall trend of student opinion regarding the Innovation scale was that among the daily tasks there was "a good variety of things to do" (Janet School C1). The major themes that evolved from analysis of the transcripts were those of problem solving, practicality and boredom.

Problem Solving

All students commented on the problem solving nature of the tasks that were assigned to them in the computing classroom. They enjoyed this approach to learning. For the most part students were given a problem or task to complete and they were expected to solve it on their own, or in consultation with other students, while the teacher would always help them if they had problems. Nancy from School C1 describes it as follows:

> A lot of the projects are quite hard. When you first get it you just think, "How the heck am I going to do this", and once you have got help and you have worked on it for a while you just think, "Wow, cool, this is good - how did I do it", and you are sort of satisfied and happy with the work that you did.

A number of students commented on the fun aspect of the exercises, as Christine from School G2 said:

> There are a lot of problem solving exercises which are so much fun. Most of the time we will be given something that is done, like spreadsheets where something's wrong and you have to go and find what's wrong. Very different from other subjects. You learn from other people's mistakes and things like that.

Practicality

This sub-theme included three elements: the actual act of doing, the perceived usefulness of the exercises, and the applicability to real life. It also highlighted subtle differences between the boys and girls. While both sexes seemed to enjoy the practical nature of the work, in that they were not just sitting and listening, but were actually doing something, this aspect seemed to appeal particularly to the boys. At

School C1 this appeared to be associated with the behaviour of the boys and their lack of attention, which meant the teacher had to repeat explanations. The girls, who had paid attention originally, then had to sit quietly through these repetitious lessons. The female students from School C1 referred to boredom several times, for example,

> Like when a lot of my friends dropped out in fourth form, they just found it boring. (Nancy).
> It gets boring quickly when, like our class doesn't listen very much. So you have to do the same topic and then the next lesson they say "I don't remember doing that" and so you have to do it again. (Janet)

When the boys found computing classes boring, it was more likely to be because they had already learnt to use a particular application. Mike from School B1, who is a fairly experienced user, comments:

> Sometimes they are pretty boring because I have done most of it. I know most of what we are doing now so it's boring.

Student Cohesion

The Student Cohesion scale is concerned with the degree to which students know, and make friends, with each other. Because most students have been at the same school since Year 9, and given that the computing classes are relatively small, it would be expected that they would know each other reasonably well. The only theme which was identified in this scale was Friendliness with Peers.

It is interesting that the three girls interviewed at School C1 all commented on the aspect of friendliness, in particular their lack of desire to be friendly with the boys in their classes and the extent to which the boys were friendly with each other. For example, Mary, a friendly, vivacious girl outside of the computer class, says:

> I don't know the people in my class really well. Over there [the computer room] I like to work by myself. I am pretty quiet over there because I have got no-one to talk to except Nancy, and she is usually listening to CDs. I do know the boys since 3rd form, but I don't really know them that well.

These girls also commented on the fact that the boys in their classes were all friends out of class (see Janet's comments under the Personalisation scale). Janet also commented as follows:

> There's two groups of boys and their friends and you can really see that. I know that it put me off [taking the computer class] a little bit, but my parents talked me into it and said it doesn't matter whether your friends are in that class or not.

Another aspect relating to the girls was that they tended to go to the computer room in their spare time as a group (there was always the exceptional girl who would go on her own). This had become evident at School C1 in the early 1990s, according to Mr Smith. The teachers could not understand why some days there would be no girls in the computer room at lunchtime, and on other days there would be a large group of them. When the girls were asked why this was happening the types of answers the teachers received, according to Mr Smith were, "Oh, yes, when we were deciding what to do at lunch time we decided to come in here and do this". The girls appeared to make a conscious decision to go in groups, whereas the boys would go individually.

Task Orientation

The items in this scale relate to the organisation of the class, how focused the students are on the related tasks, and how clearly the activities are planned and conveyed to the students. This scale relates to Moos' System Maintenance and System Change dimensions. The two themes which were identified in the analysis were those of work pressure, and order, organisation, and control.

Work Pressure

All three teachers gave very clear instructions regarding the tasks which were set for the students, although at School C1 the boys often did not listen because they were involved with games. It was noticeable in Mr Smith's classes that there was very little pressure to complete tasks. Students were permitted to do what they wanted, and if tasks were not completed Mr Smith did not appear to be concerned. However, most students did complete the required tasks. Nancy describes it thus:

> Mr Smith will say here's your project, this is what you do for the next two weeks. I think because in computers you get a lot of freedom and the girls you know they want to work whereas boys know that, we all know that, you are going to get away with a lot of things when you take computers. You know, "cruisy period", and there's not much the teachers can do to you if you don't do the work.

The reason why she felt that the teachers could not do anything about students who did not work, was because it was not a Bursary subject.

At School B1 the boys all worked fairly conscientiously. Mr Adamson highlighted the fact that he had no motivational problems, because the students enjoyed the subject. He made the boys do as much as possible in class, because he did not give them homework as only about 50% of these students had computers in their homes. He said:

> You see how I run the classes. It's all self-paced stuff, they know what they are doing, they come in, they log on and they are away.

The students at School G2 appeared very focused on their work. While there was chatter, it was very quiet and mainly confined to the work they were doing. When Ms Watson gave instructions the girls all stopped working on their computers and paid attention.

Order, Organisation and Control

As mentioned earlier, the classrooms were all run in quite different ways. Mr Smith from School C1 was very relaxed about order. He commented that the large number of boys compared to girls in the classroom did change the atmosphere and that "the language gets significantly worse and swearing goes up, and they abuse each other. If there are one or two girls in the room they get abused as much as boys do". While he was aware of this, he seldom attempted to stop this behaviour, and it did not appear to concern the girls, although their interviews confirmed they were aware of it.

In contrast, Mr Adamson controlled his classes very tightly. For example, when he was preparing the students for a test he made them turn away from the computers and face him. He forced them to interact with him by asking them questions. Once the class had commenced students could not enter or leave the room without seeking his permission. While he was very quietly spoken, the students treated him with respect and always did what they were told.

In comparison, at School G2 Ms Watson did not appear to need to control the students. She was very clear about instructions. For example, on one occasion the students were designing a Sports Award Certificate, the best one of which was to be used for the end of year presentations. She began the class by reminding them of certain aspects they needed to consider, continued by allowing them to choose which sport they would prefer to cover, and informed them that when the assignment was completed they would discuss the pros and cons of each design, and decide as a group which was the best one to use.

Cooperation

This scale refers to the degree to which students cooperate with each other, share their books and resources, and work together on projects. The significant sub-themes which were identified here were Helping, and Collaboration and Group Work. It was evident from the observations that the computer classroom lent itself to students helping each other and working collaboratively. Perhaps one reason for this was the inability of the teacher to deal with all the individual problems occurring in the classroom at the same time. Ms Watson (School G2) highlights this when she states that:

> With 20 students working on computers it is hard to spend a lot of individual time with them. At any point in any lesson at least 10 students could want me, so I encourage them to be independent learners, and to help each other and work with each other.

Helping

Most of the students who were interviewed said that they liked helping other students and also getting help from them. Mary (from School C1) and Jack (from School B1) were the exceptions, in that they said they preferred to work on their own. In fact, the boys at School B1 all commented that they would ask the person sitting next to them, or a friend, before calling on Mr Adamson. In one of the classes in this school there was one student who was considerably more computer literate than any of the other students, and he spent a lot of time helping out other students. He was very patient with them when he was explaining something, and this was particularly noticeable when with one student who sometimes called on him three or four times to work on the same problem.

Jane, from School G2, said that one of the reasons why she enjoyed computing so much was because:

> There is always people there that help and even if it is not the teacher because she's busy there is always somebody else who can help. I like helping people.

Collaboration and Group Work

At the single-sex girls' school, the students were participating in a national internet development challenge which involved working in groups of three. The groups had been required to select a topic they had already studied, or were currently studying in class, and present it on the internet. This required building a Web site of up to 10 pages, in a way that would reinforce their own learning and help other students to learn about the same topic. Once the Web site was built it was to be uploaded live so that the judges could view it. Prizes worth more than $50,000 were available to be won. Because they were sharing the same files these students would begin each class by discussing whether anyone in their group had made changes. They would then discuss such things as whether they all agreed on the colour, size or shape of the buttons they planned on using. All the groups worked together in a very collaborative manner, and even although they were working in groups, individuals would still move around to help other groups.

There was no evidence of any such collaboration or group work at the other two schools, and in fact Ms Cornell (School C1) did not believe that group work was possible in the computer classroom due to the nature of the subject. She said that:

> It's actually quite difficult to do group work. Everyone is producing individual work. You may not understand how to do a particular thing and you might turn to your mate and ask them because the teacher might be busy, but you are not working together on one assignment.

Individualisation

This scale relates to the way in which students are permitted to work in the classrooms, and how much control the students have over their choice of activities, and the speed at which they do it. It relates to Moos (1965) System Maintenance and System Change dimension which assesses the extent to which the environment is orderly and clear in its expectations. Two themes, Self-paced Learning, and Choice of Activity, evolved from analysis of the transcripts.

The nature of the computer classroom demands that many of the activities are individual because students have to interact with the machine. However, there appeared overall to be a good balance between students' ability to make their own decisions as to the work they undertook, the pace at which they undertook it, and the way in which they worked cooperatively which each other.

Self-paced Learning

All the students who were interviewed agreed that they were able to work at their own speed to a much greater degree than in other subjects. The teachers also felt that one of the advantages of teaching in the computer room was that students were able to pace their own work within the framework of the curriculum. Some of the comments that were made by students referred to their being reliant on themselves to "just do it". They appeared to enjoy the fact that there was much less talking by the teacher compared to other classes, like English and History, and they appeared to have the perception that they had more freedom in the computer classroom. Mary, from School C1, puts it succinctly when she says:

> Computers you just go off and do it yourself. Like they say here's a task, go off and work on it. And my teachers just expect me to do it.

All of the interviewed students said that they liked this aspect of learning computing, with Mike from B1 saying he preferred to work on his own, but also liked working with his peers, and the girls in the group interview from School G2 agreeing that they were expected to work things out themselves, one of them commenting that "You are working on your own, so you are not going to talk to anyone else". One rather quaint comment from Mike at School B1 was that he could work at his own pace and that "is good because you can talk to yourself, and not any restrictions".

One of the comments made in the group interview at School G2 was "We have fun there, and you can kind of do what you want". This comment was particularly interesting in light of a finding reported in the literature review (boys have fun, girls just work) and also because of the perception at this school that computers were for the less academically minded students. They particularly enjoyed the fact that no-one was talking at them all the time, and therefore they could work on their own and did not need to talk to anyone else. Jane, one of the students from School G2 who took part in an individual interview, said she enjoyed "trying to design things, work things out on my own. I usually like to work by myself". Yet this was a student who also enjoyed helping other students in the class.

The students all commented on their being given a problem and then going off and solving it on their own. Nancy (School C1) said:

> In computers you just go off and do it yourself. Like they say here's a task go off and work on it. If you need help then come and see me ... whereas in another class it's sort of, just listen to them talk and talk about a topic.

Trevor from the same school said:

> You are a lot more sort of shown what to do and left to do it by yourself whereas in other classes you are sort of guided. It means you are pretty much free and liberal and learn the way you feel best.

In particular, Mr Adamson at School B1 was committed to allowing the students to work at their own pace through their use of the step-by-step instruction book that students worked their way through. Mr Smith's approach (at School C1) was different in that he gave the students structured lessons at the beginning of a project, and then expected them to complete the project consulting either their peers or himself when they had difficulties. Ms Watson, at School G2, was quite clear about what tasks needed to be completed, but the students still felt that they were able to work at their own pace.

Choice of Activity

There were noticeable differences in how much control the teacher took over the decisions students could make regarding when and whether they did the assigned tasks. At School C1, Mr Smith did not compel any students to do the work, and there were a number of male students who did nothing other than play games, while other male students switched between the classroom tasks and playing games. All the boys in these classes played games at some point during the class. Mr Smith believed that the boys preferred to be left alone with the machine to find out by experimentation what possibilities it held.

The girls interviewed at this school felt that the teachers had expectations for them to work and do well, and they always chose to do the tasks required by Mr Smith. Nancy commented on the freedom to choose activities in this class, saying:

> I think because in computers you get a lot of freedom and the girls you know they want to work ... because we just go in, sit there listening to our music whatever doing our work while in other classes it would be take it off, you are not learning anything by listening to music. You can freely walk in and out of class. Basically there is just a lot more freedom.

Ms Cornell (School C1) frequently commented on both male and female students always wanting to do other things such as play games, or use e-mail. However, she said she did not permit this in her classes.

At the single-sex boys' school, Mr Adamson was very strict about students working on the appropriate classroom tasks. While they were able to work at their own speed, these students had no choice about what they could do in class, or when they did it. In comparison, at the single-sex girls school, the students did not appear to consider doing anything other than the tasks set out for them by Ms Watson.

Equity

While the Equity scale was one of the most important reasons for using the CUCEI, the observations and interviews extracted very little information in the context of the definition of Equity in the CUCEI, that is, the way in which it focused on how the student perceived the teacher treating the student in comparison to other students. However two sub-themes were able to be identified, namely, the Recognition of an Innate Bias, and the Demanding Nature of the Boys.

Recognition of bias

It appeared that equity issues were more evident in the mixed-sex school than in the single-sex schools. Ms Cornell (School C1) told a story about a bright, young, male student whom she advised to take a more technical elective run by Mr Smith because she thought it might appeal to him. The student did not like it and returned to the other elective because he preferred the design aspect. Her comment was:

> Now that's a young man saying I want to go – where Mr Smith would think that's a traditional woman's area.

While it was evident that Mr Smith was very aware of, and concerned about, the lack of female students taking computing, and had also been instrumental in generating initiatives designed to attract more female students, it appears that Ms Cornell perceived some innate bias into how Mr Smith viewed male and female students' preferences. This could be an underlying factor as to why he permitted games and bad language in his classes. It appeared that the girls in his classes were also aware of this innate bias judging from the comments made by Janet: "But he knows them quite well because most of them that's not the only computer class that they take" and, referring to the bad language, "A lot of my teachers wouldn't [tolerate the language] but I think the reason they do speak like that is because Mr Smith doesn't mind". Janet commented several times about Mr Smith being really good friends with the boys, and in his interview he referred to the fact that he took the fencing club at school. Mainly boys took fencing, and he said that many of them also took computing classes, and suggested that this was because they knew him from the fencing club. Mr Smith also expounded quite strong views about girls wanting to use the computer to achieve a purpose, and that they (the girls) "tend to want to work together".

Ms Watson (School G2) recited a story about one of her students which had disturbed her. She said:

> One student complained that she hardly got any help from me and had to go to others [students]. My perception was that I had helped her more than any other student in the class - so I called her back in and apologised, but I don't think that made her feel any better.

Notwithstanding this reflection and her concern about being seen to be fair, all the girls interviewed at this school felt that Ms Watson treated them all the same, and that they all received considerable encouragement and praise from her. This was also evident from the observations, where the field notes frequently refer to Ms Watson's positive comments to all students both individually and collectively.

Demanding Nature of Boys

The demanding nature of the boys was only an issue at the mixed-sex school (C1). It was commented on by Ms Cornell and the female students, but not by Mr Smith or any of the male students. Ms Cornell had previously taught at another co-educational school and she said it had exactly the same problems as School C1 in that the boys not only took over the computers at lunch-time and after school, but also took them over during class-time. They did this in several ways in her opinion. Not only were the boys physically overpowering but they would surround any girl who was using a computer and tell her which buttons to push. She said:

> If a girl happens to dare to sit down first she will have this group of boys around her telling her don't do that, you push that button, don't you know what you are doing, and so any right minded girl would get up and walk off, and of course the boys have won.

The second major aspect of this sub-theme, was the way in which both she and all of the girls interviewed at this school felt that the boys did not try and work out their problems when they came to a problem. Instead they would immediately yell out asking for help from the teacher, or to the class generally. Ms Cornell thought this was particularly noticeable with boys who were less confident, and in contrast she felt that the less confident girls would just give up. The brighter girls' first reaction was to retrace their steps and try and solve the problem for themselves, and then they would ask for help. She said that while this was a trait that was evident across the board, it tended to be highlighted in the computer classroom.

This difference was also evident at School G2, particularly in the class where the Internet project was being undertaken. One group was observed spending 20 minutes trying to display a puzzle satisfactorily in their Web site. They tried everything they could think of before asking Ms Watson for help, and when she could not, continued to work patiently until they were successful.

Summary

The data gathered from interviews and observations have been analysed and presented in this chapter. The analysis of the students' interviews indicated general satisfaction with their computer learning environment. They perceived their teachers as being helpful and pleasant. They all enjoyed the learning aspect, particularly the practical nature of the tasks and assessments, and the problem-solving approach adopted in the computer class room. One interesting point was that some students in the co-educational school perceived their classes as being at a high level, while at the single-sex schools (particularly School G2) it was perceived that "dumb" students tended to take computing. While class room management was approached differently by each of the teachers, all students appeared relatively happy with their individual environments. Classroom management was directly associated with the personality of the individual teacher and reflected their views on effective student learning.

The physical resources (software and hardware) were considered to be of a high standard by both teachers and students. It was noticeable that different configurations of the desks and seating could impact on the socialisation and interactions of all participants, in the case of the co-educational classes enabling the female students to physically separate themselves from the boys.

While it must be borne in mind that the observations were of one teacher's classes in each of the three schools, and that only one additional teacher from the co-educational school was interviewed, some interesting attitudes towards the use of the computer classrooms were revealed from the analysis. At the co-educational school it appeared that many of the students were allowed to use computer class time for recreational pursuits such as game playing and doing their own work. In two schools

International students used the computer class room as a mainly unsupervised aid to improve their English language skills.

There was an unsurprising homogeneity among all the boys (and their male teachers) relating to their attitude towards games and the machine itself. The main theme investigated throughout the interviews and observations was evidence of a computer culture which could be a deterrent to students' enrolling in computing classes. There was clear evidence of this in the mixed-sex school, in terms of the demanding nature of the boys, their bad language, aggressiveness and game playing all of which contributed to the isolation of the girls. It also highlights some of the differences in the activities undertaken by boys' and girls' in computer class room. On the other hand, in the single-sex schools the teacher's control over the class room activities was much more noticeable, leading to a more equitable environment for all students. The next chapter summarises the study, the approach taken, and the conclusions drawn. It then discusses the limitations of the study and concludes with recommendations for future research.

CHAPTER 6

SUMMARY, CONCLUSIONS AND IMPLICATIONS

Introduction

This study has investigated the learning environment of the computer classroom at the upper secondary school level. It has used both students' and teachers' perceptions, measured by survey and interview, as well as the observations of the researcher to construct an understanding of the computer classroom. This chapter begins with a summary of the study and continues by discussing the major findings which answer the three research questions. Recommendations are made for creating a learning environment which is equitable for both girls and boys. Limitations of the study are then reviewed, and suggestions for research to complement this study and further test the findings are made.

Summary of the Study

The research was set in the context of concern in the Western world regarding the lack of women involved in computing at all levels of the industry and education. The computer studies classroom is thought to have a culture which is unique to that particular environment (Schofield, 1995; Sproull, Zubrow, & Kiesler, 1986; Turkle, 1988). Hofstede (1980), a well-known cross-cultural researcher, defines culture as being the historically derived and selected ideas and patterns of values held by a group and to which they conform. A culture which is not appealing to girls, or not inclusive of girls, could therefore play a significant role as a deterrent to females enrolling in computer studies courses and their poor retention when they do enrol

(Margolis & Fisher, 2002). The suggestion that single-sex schools or classrooms may offer a solution to this problem has been put forward by a number of researchers, but no conclusive evidence has been forthcoming to demonstrate that girls do better in such an environment. This study focused on the perceptions of Level 12 and 13 students and their teachers in both mixed-sex and single-sex schools. Specifically the research investigated:

1) What are the characteristics of the computer studies classroom?
2) What perceptions of the computer studies classroom are held by Level 12 and 13 secondary school computing students?
    a) What are the differences (if any) between male and female students' perceptions of the computer studies classroom?
    b) What are the differences in perceptions of the computer studies classroom (if any) between students attending single-sex and mixed-sex schools?
3) How can the learning environment of the computer studies classroom be designed to be encouraging of both female and male students?

The study used a mixed-method design, involving the collection of both quantitative and qualitative data. The design was chosen to provide triangulation and complementarity in the data and so provide a richer picture of the computer learning environment. Quantitative data were gathered from students using the Actual and Preferred Versions of the CUCEI, and the qualitative data were gathered from observations in the classrooms and interviews with students and teachers.

The CUCEI was administered to 265 students from seven schools in the Central Wellington district; three co-educational schools, three single-sex girls' schools, and one single-sex boys' school. Because this instrument had not previously been administered in New Zealand secondary school classrooms, the results were first analysed to check the psychometric properties of the instrument. The results of principal components analysis suggested the omission of a number of poorly performing items prior to computing scores on the CUCEI subscales. Analysis of variance was then used to examine the differences between students' perceptions of their preferred and actual learning environment, and between male and female students in mixed-sex and single-sex schools.

Interviews and observations were carried out in three of the schools; one co-educational school (C1), one single-sex girls' school (G2) and one single-sex boys' school (B1). Four teachers (2 males and 2 females) and 15 students (5 males and 10 females) participated in interviews. The classes of three teachers (one teacher from each school) were each observed over a period of one to three weeks for between 10 and 14 hours. The analysis of these data involved the use of NUD*IST to help establish themes and sub-themes of the computer classroom culture. The first part of the analysis began by focusing on the context in which computing took place, the students, and the social interaction in the classroom. These major themes were then discussed in terms of the sub-themes. Under the context theme, the background of the teachers, their different teaching styles, and the physical resources provided by the schools were described. Under the students theme, the composition of the classes was described, and the different perceptions of the ability of the participating students was discussed. The social interaction theme identified and described the different behaviour of the students in each school, the difference between boys' and girls' attitudes towards e-mail and games, and the boys' fascination with the computer. The second part of the analysis related to the sub-themes associated with the seven scales of the CUCEI. Many of these sub-themes reflected the cultural aspects identified in the literature review.

The following section uses the findings from the research to provide answers to the three research questions. Research Question 1 is answered in terms of the context in which computing takes place and uses data gathered from interviews and observations. The second research question and its sub-questions were answered using the data gathered from the CUCEI to investigate the differences between the perceptions of male and female students from mixed- and single-sex schools. The answer to the third research question draws together findings from both the quantitative and qualitative data to describe what might be an equitable culture in the computer studies classroom and provide suggestions for making the culture more encouraging of both females and males.

Findings

Research Question 1: What are the characteristics of the computer studies classroom?

The Context of the Computer Studies Classroom

In this study the context was described in terms of the background of the teachers, their teaching styles and the physical resources.

Computing was a relatively new addition to the curriculum at the two single-sex schools whereas at the mixed-sex school it had been introduced by Mr Smith 20 years earlier. Then, the computing syllabus had emerged as a part of the mathematics curriculum and had a heavy focus on mathematics. However, for some years now the focus of the computer studies curriculum in New Zealand secondary schools has been on learning applications rather than understanding computer arithmetic and logic. Consequently, there was very little difference in the curriculum content currently offered at each of the schools.

The four teachers who were interviewed were drawn to computing from different academic and teaching backgrounds, although Mr Smith (School C1) and Mr Adamson (School B1) each had a science/mathematics degree and had taken basic programming courses as a part of their studies, which they had both continued to pursue as a recreational interest. Ms Cornell (School C1) and Ms Watson (School G2) had earlier experience as secretaries and both had later completed Arts degrees. They had taught themselves computing in order to teach their students. These backgrounds are consistent with that described in the literature as being typical of computer studies teachers (Schofield, 1995). Ms Cornell and Ms Watson both felt a need for a more in-depth knowledge about computers and computing, Ms Watson stating that she sometimes felt inadequate. Nevertheless, both of these women believed that they could play an important role in raising the level of girls' interest in computing by acting as role models. In fact Ms Cornell reported she had been employed explicitly for this purpose in the coeducational school.

The teaching styles of the three teachers whose classes were observed were quite different. Mr Smith from the mixed-sex school was very tolerant of students' behaviour, allowing the students to do virtually what they pleased. Although they appeared to do their work, the classes were very noisy and most of the boys spent considerable time playing games. In contrast, Mr Adamson at the single-sex boys' school was very strict. Students were expected to work quietly and when instructions were given he made them turn away from their computers and listen. At the single-sex girls' school the students were always quiet, polite and focused on their work, and always paid attention when Ms Wilson was giving instructions. Most notably, Ms Wilson was continually giving the students positive feedback about their work and encouraging the girls to help each other with problems. In the three schools, all the students who were interviewed thought their computing teachers, both past and present, were very friendly and more relaxed and easy going than teachers in other classes.

All the teachers acknowledged in interview that their style of teaching computing had changed over time from a formal, structured format to one that involved using a problem-solving approach and allowing students to work at their own pace. When interviewed, the students said they enjoyed this approach and found the exercises fun and useful. This was confirmed by the classroom observations and is divergent from other research which, although based mainly on computer science classes at University level, claims that this subject is often taught in a highly abstract manner (Grundy, 1996). All three teachers said they relied on students helping each other because the nature of the computer classroom meant they could not attend to individual student needs immediately. This, they felt, was a unique feature of the computer learning environment, because at any one time they could have a number of students requiring help for quite different problems, each needing them to sit down at the computer with the individual student. Nevertheless, all three teachers believed that the students learnt more from helping each other and the interaction that this required, than from relying on the teacher. It was evident from the observations and interviews that students at all schools enjoyed helping each other and working together.

The physical resources at all three schools were excellent, although the different ways in which the desks and computers were configured appeared to support different behaviour patterns. At School C1 the classroom layout meant the girls could physically isolate themselves from the boys, by sitting in a separate corner of the room with their backs to the rest of the class and ignoring the activities and loud conversations of the boys. This is very similar to the situation described in Schofield's (1995) research, although in her research the girls attempted unsuccessfully to be accepted by the boys. Interestingly, Ms Cornell from School C1 thought that the computer classrooms were a more unpleasant place to work in than other classrooms. She said that she and the other female computing teacher felt that these rooms were a very "masculine environment"; because the windows were never opened the rooms were stuffy and they were always untidy, with students' litter left behind.

Mr Smith and Mr Adamson both commented on the very strong support they received from their Principal and Boards, but Ms Watson felt that while she had good resources and support, computing was perceived as non-academic by both the Principal and the Head Teacher, and therefore of lower status than the more academic courses such as mathematics or history.

The Students

All of the observed classes had relatively small numbers of students. There was also considerable ethnic diversity. All interviewees (teachers and students) perceived computing at this level to be a subject that was taken mainly by students of lower academic ability, a point which is not raised in previous research. While Mr Smith felt the range of academic ability was wide, he did agree that many of the less able students chose to take computing because it was seen as an easy option. He added that there tended to be a number of young men who conformed to the stereotypical image of the computer nerd described in the literature, and who possibly found computing easier than a subject like social studies. Conversely, he perceived that many of the (admittedly few) girls who enrolled tended to be more academically able and confident in their abilities.

Another interesting factor was that in all the schools International students were placed in computing classes ostensibly to improve their English language skills. At School C1 these students were all males and while they had work set for them by the English language teachers they were mainly unsupervised and left to their own devices. Consequently, they spent their time playing games but did not interact with the other students. At the single-sex schools, these International students were also unsupervised and were mainly off-task, but again did not interact with their classmates.

In the mixed-sex school students had little pressure to complete tasks, and the boys' game-playing meant they did not listen to instructions, which then had to be repeated, sometimes several times. This irritated the girls. In the two single-sex schools students were aware of activities to be undertaken and the time frame in which they were to be completed. Order and control in these classrooms meant that students were in an environment which enabled them to concentrate on their tasks and communicate with each other and their teacher.

Social Interaction between Students and their Teachers

The ways in which students interacted with each other and the teacher varied considerably between the three schools. Bad language and noise were very noticeable features at the mixed-sex school. This appeared to be directly associated with the game playing which Mr Smith permitted in class time. The boys often yelled at each other and at the teacher, particularly when they were asking or offering help, and very often this would include some form of "smart" comments or bad language. Such disciplinary problems as these combine to make an atmosphere which seems to be unpleasant and not conducive to learning. However, neither he nor the female students found this disturbing, indicating perhaps that the girls as a minority group are accepting of the norms and values of the dominant group (Moos, 1979; Noddings, 1990). Nevertheless, in this school there appeared to be very little contact between the individual female students and the other students, male or female. They tended to position themselves so that they were physically isolated from the boys. Their comments suggested that they preferred not to have anything to do with them, and did not want to be friendly with them. Although he indicated in interview that he was sensitive to the girls' lack of participation in classroom interaction, Mr Smith took no steps to try to include them. He seemed to believe that they were able enough to look after themselves.

In comparison, at the single-sex boys' school, Mr Adamson never permitted the noise level to rise, the boys never used bad language in his hearing, and games were permitted in one class per week. During the games session, the classroom atmosphere was quite different in that the students became noisy and this was only time they were heard swearing. They also used a typing program called Mavis Beacon which had a games element to it and Mr Adamson felt that it was responsible for keyboarding being popular, and the high speeds which many of the boys had attained in a short period of time. Most of the boys displayed an interest in games and a fascination with the machine, with some saying they loved the computer since they first used it. This concurs with previous research by Margolis et al. (2000) at Carnegie Mellon University, where the males often talked about falling in love with computers. While Mr Smith perceived this fascination as boys wanting to find out how the machine worked, Ms Cornell believed they had a more emotional attachment to the computer, which again concurs with the findings of researchers such as Furger (1998), Margolis et al. (2000) and Turkle (1986).

During class time, girls at both types of school appeared focused and interested in their work, and tended to ask for help only after they had attempted seriously to solve the problem on their own. It was interesting to note that when the girls used the computer room in their spare time it was to complete assignments rather than play games, a characteristic exhibited by the girls in Schofield's (1995) study. However, they used the library extensively at lunchtimes because there they could access multi-media programs which they enjoyed. While both sexes used e-mail, it did pose a problem with the girls because some tended to use it for malicious purposes, and at the mixed-sex and single-sex girls' schools the use of e-mail had to be carefully monitored. This aspect of girls' behaviour has not been noted in previous research and this may be because easy access to e-mail is a relatively recent phenomenon.

The Characteristics of the Computer Studies Classroom

The observations and interviews revealed different characteristics of the computer studies classroom in the different types of school. However, only one teacher at each type of school was observed, and it must be recognised that the behavioural characteristics displayed by the students are likely to be a reflection of the individual styles of teaching and attitudes towards learning. Nevertheless, the backgrounds of the male and female teachers are typical of those identified in the literature and all teachers agreed they had changed their mode of teaching in the computer studies classroom from a more formal and structured format to a more problem-solving, self-paced approach as they became more experienced in the subject.

To summarise, the main characteristics which were evident in all three schools were the excellent resources available for students, and the way in which students helped each other, although in the mixed-sex school this was often tempered by a certain machismo attitude on the part of the boys.

Characteristics which were typical of the boys only were the change in attitude and atmosphere when they played games, and for many of them the excitement that was generated by the games and the fascination that the computer held for them. The male teachers also had a recreational, as well as a work, interest in computers and this is where they had gained their in-depth knowledge which led them to be more confident in their abilities than the female teachers.

In contrast, characteristics that applied to the girls at both schools were their focus on completing the tasks and their tendency to ask for help only when they had a real problem. The use of e-mail for malicious purposes was another characteristic applicable to girls at both schools, but not to the boys. Both female teachers hoped that they were acting as role models of women in computing for the female students. At the mixed-sex school, additional major characteristics relating to the girls were their isolation and their lack of interest in interacting with the boys in the computer studies classroom.

Research Question 2: What perceptions of the computer studies classroom are held by Level 12 and 13 secondary school computing students?

An overview of students' perceptions of the learning environment in their computer studies classroom is provided by comparing scale means for students responding to both the Actual and Preferred Versions of the CUCEI as displayed in Figure 4.1. Only the Student Cohesion scale had nearly similar results for the Actual and Preferred Versions for this scale, indicating that students are reasonably satisfied with this aspect of their learning environment (see Figure 4.1). On all other scales the means for the Preferred Version were around half a standard deviation or more higher than the means on the Actual Version (see Table 4.15) suggesting that students are less satisfied with the actual learning environment on the aspects measured by these scales. All these differences were statistically significant and the largest differences between the means were for the Innovation and Individualisation scales. On the whole, it seems that students experienced much less innovation in their lessons, and individualisation in their student-teacher interactions than they would like.

A major part of the study was to investigate the differences between male and female students in single-sex and mixed-sex schools. The scale means were graphed in Figures 4.2 and 4.3, suggesting some differences on some scales. These differences were examined more closely by computing the difference scores between the Preferred and Actual Versions of the CUCEI, and a MANOVA revealed some statistically significant differences (see Tables 4.20, 4.21 and 4.22). A summary of these differences is reported in Table 6.1 showing the effect sizes using eta^2 as a measure of the proportion of variance accounted for each effect that was statistically significant. Overall these effects were fairly weak, between 3% and 6%.

The qualitative findings, based on classroom observations and interviews with students in three schools, overall, suggested stronger differences between school types. Students in the single-sex schools seemed to be more satisfied with the academic tasks and social climate in their classrooms than students in the mixed-sex school. Here the differences between boys and girls were more pronounced. These differences are described in detail under Research Question 3.

Table 6.1

Effect Sizes (Eta^2) for Statistically Significant Differences for Sex and Type of School

Scale	Sex x Type of School	Sex	Type of School
Personalisation	-	0.060	0.041
Innovation	-	-	0.052
Student Cohesion	-	-	0.034
Task Orientation	-	0.032	0.036
Cooperation	-	-	-
Individualisation	0.032	0.041	-
Equity	-	0.024	-

Items on the Personalisation scale ask about how friendly and helpful the student perceives the teacher to be to them. As shown in Table 6.1 there were statistically significant differences between boys and girls, and between single-sex and mixed-sex schools (see also Figure 4.5). The girls in both types of school preferred a much greater level of personalisation than they perceived in their actual classroom environment. Students in the single-sex schools had smaller difference scores than students in the mixed-sex schools. In fact, the difference perceived by boys in the single-sex school was almost zero, indicating they were very satisfied with the level of personalisation.

The Innovation scale relates to variety in the teaching strategies used by the teacher and the type of activities the students are required to undertake. The results showed a statistically significant difference between single-sex and mixed-sex schools (see Figure 4.6 and Table 6.1). Both boys and (particularly) girls from the mixed-sex schools preferred a higher level of innovation than they actually perceived happening in their classroom. Students in single-sex schools had smaller difference scores, indicating that they were more satisfied with the actual variety of activities they experienced in their classrooms.

The Student Cohesion scale refers to how well students know each other, and how easily they make friends in the class. On this scale, as noted earlier, students' scores on the Actual and Preferred Versions were very similar. Nevertheless, the results showed a statistically significant difference between single-sex and mixed-sex schools (see Figure 4.7 and Table 6.1). For the boys the difference was very small.

The girls from the mixed-sex schools preferred a more cohesive learning environment than they perceived they had, but the girls from the single-sex schools did not.

Task Orientation in the classroom is about the level of organisation of class activities and the clarity of instructions. Statistically significant differences between boys and girls and between mixed- and single-sex schools were found (see Figure 4.8). Again, the girls from each type of school had larger difference scores than the boys, indicating they preferred greater task orientation than they perceived in the classroom. The difference for the boys from the single-sex school was almost zero.

The Cooperation scale refers to how the students work together and help each other. As noted above, students preferred to have higher levels of cooperation than they perceived to be evident in their classrooms. However, no statistically significant differences were found. Boys and girls in both types of schools responded similarly on this scale.

The Individualisation scale refers to how much control the student has over the choice of activity undertaken and the pace at which tasks are completed. This was the only scale to have a statistically significant interaction effect (see Figure 4.4). This was caused by the large difference between scores for boys and girls in the single-sex schools, and no difference between boys and girls in the mixed-sex school. Boys at the single-sex school had the smallest difference between the Preferred and Actual Versions of this scale indicating they were generally satisfied with the level of individualisation in their classroom. Their class was the only one to have a text book which enabled the boys to work at their own pace and this is a possible explanation for this result.

The Equity scale has questions asking about how each student perceives the teacher treats him or her compared to other students in the class. The results show statistically significant differences between boys and girls (see Figure 4.9). The girls in both types of school perceived that they received less attention from the teacher than did other students in the class. Again, the boys in the single-sex school were the ones whose preferred responses were closest to their actual responses.

Overall, there were two noteworthy findings. First, on all scales except Student Cohesion students had higher scores on the Preferred than the Actual Version of the CUCEI, indicating that all students would prefer a higher level of the features of the computer studies classroom learning environment measured by each of the other six scales. This was especially so for Innovation and Individualisation. Second, and although the differences were not always significant, the boys from the single-sex school perceived the actual environment to be closest to their preferred environment on all of these scales. In contrast, the girls from the mixed-sex schools displayed the greatest difference scores on all of the scales except Individualisation, where the mean difference score for girls from the single-sex schools was marginally greater. These latter findings are consistent with other research suggesting that girls may be disadvantaged in mixed-sex classrooms and that many students prefer single-sex classrooms (e.g. Crombie & Anderson, 1999; Grundy, 1996; Parker & Rennie, 2002; Rennie & Parker, 1997)

Research Question 3: How can the learning environment be designed to be encouraging of both female and male students?

The findings in terms of the first two research questions can be drawn together to provide a picture of the kind of computer studies classroom culture that is comfortable for both boys and girls. Essentially, the data suggest that the culture can be described along two broad dimensions. First, there is an interpersonal interaction dimension which describes the student-student and student-teacher interactions in the classroom. This dimension is similar to Moos' Relationship category and data from the CUCEI scales of Personalisation, Student Cohesion, Cooperation and Equity contribute to describing this dimension. The second learning dimension combines Moos' System Maintenance and System Change and Personal Development categories and is linked to the Innovation, Individualisation and Task Orientation scales of the CUCEI. The observations and interviews contribute information about both of these dimensions.

Interpersonal Interaction Dimension

Social Interaction

All students who were interviewed commented on the friendliness and helpfulness of their teachers, in some cases alluding to the fact that they were more relaxed in the computing classes than in other classes. In the two single-sex schools the students were observed to be very friendly and helpful towards each other. They were encouraged to help each other by their teachers. This was an aspect that was positively commented on in the interviews, yet the difference scores for the Personalisation scale showed that all students, except the boys from the single-sex school, preferred their environment to be even more friendly and helpful.

At the mixed-sex schools most of the boys knew each other well from outside activities and other computer classes which they had attended, which contributed to a strong boys' culture. Because so few girls attended the computing classes there was a tendency for the boys to dominate the classroom. Those girls who did attend did not attempt to be friendly with the boys, nor did they communicate with each other and therefore missed out on female companionship as well. Thus, they had very little social interaction in the computer classroom, and worked in isolation. This concurs with previous research (Schofield, 1995) as well as the results from the Student Cohesion scale where the girls in the mixed-sex schools showed a significant difference between their actual and preferred environment compared to their male classmates and students from the single-sex classes.

There were two other interesting aspects which may have impacted on the social interaction in the computer classrooms which were observed. First, there was a widely held perception of both staff and students that many of the students who enrolled in computing were of lower academic ability. However, those girls from the mixed-sex school who were interviewed perceived themselves as being academically more able than the majority of the boys. This perception of themselves as being more capable than the boys may have contributed to their unwillingness to socialise with them. Second, the fact that International students attended classes, but were not a part of the class and these students were therefore a separate and distinct group, may have had some negative impact on the ambience of the classroom. Further research would be needed to examine whether these two aspects do exert some influence on the learning environment.

Involvement and Support

It was clearly evident during the observations of the single-sex schools that the teachers encouraged qualities such as involvement and support through the structure of their classes. In one of the single-sex girls' classes the involvement took the form of working collaboratively on a project which was to be entered in a national competition. Members of each group were clearly involved with each other in their interactions and the time they spent discussing how to overcome problems and achieve their goals together. At the same time, they were aware of the work of other groups and offered advice and suggestions where appropriate. These students responded well to working in groups. While in the computer classroom students are required to interact on an individual basis with the machine, it was clearly illustrated here that group work was not only possible, but was a contributing factor in developing a cohesive and cooperative class. It was also a safe way of creating competitive activities where students could take risks without fear of individual failure. Group work enabled the teacher to foster positive attitudes of cooperation and belonging among members of the class.

In the single-sex boys' school the students were proud of the achievements of their peers, and they frequently moved around the classroom observing and commenting positively on other students' work. In comparison, while the boys in the mixed-sex school did help each other in their own way, they did not display any pride, and little interest, in the achievements of other students, and there was little interaction with, or between, the girls.

Working together collaboratively and cooperatively, and supporting and helping each other, increased student cohesion and this was illustrated in the results of the CUCEI, where the differences between the preferred and actual perceptions of the Student Cohesion and Cooperation scales were trivial for both boys and girls in the single-sex schools. In contrast, in the mixed-sex schools, the mean difference scores were trivial only for boys.

Learning Dimension

Discipline and Control

An equitable computer classroom is one where the environment is orderly, and where the teacher maintains control over activities. This was obvious in the single-sex boys' school where the students understood clearly the high expectations of their teacher regarding their behaviour and work habits. Despite this strong control, the CUCEI results indicate that on every scale these boys were the most satisfied with their actual environment. In contrast, it was apparent from the observations and interviews that there was a discipline problem at the mixed-sex school where students were able to do what they wanted, and the boys were not focused on their class work for much of the time. While at this school the lack of focus was usually because the boys were playing computer games, nevertheless the statistical results indicated both boys and girls in the mixed-sex schools preferred a higher level of Task Orientation.

Tasks and Assessments

All students interviewed in this study stated how they enjoyed the real life component and the problem-solving approach of the tasks they undertook in their computer classes, and frequently commented on this aspect of their class work. Nevertheless, the statistics for the Innovation scale suggest that students at all schools would prefer more variety in the type of assignments and work that they undertook, although this was less evident in the single-sex schools. This was in contrast to the researcher's observations where the tasks at all three schools appeared to be innovative and varied.

Apart from the boys from the single-sex boys' school, all students indicated a preference for a greater degree of individualisation. The use of a self-paced text book may have been the key to increased student satisfaction on this scale, as it allowed the boys to work at their own pace, and they did not have to rely on the teacher for all information. This meant they could repeat work if necessary, or go ahead of the rest of the group. The difference scores between perceived and actual environment were very large on the Individualisation scale for all except the boys from the single-sex school.

Physical Environment

The desks and computers in the classroom at the mixed-sex school where observations were undertaken were arranged in such a way that the girls could physically isolate themselves, allowing them to work on their own. While these girls said they were comfortable in this environment, there was no comparison between their situation and that of the girls at the single-sex school where the layout encouraged them to work together. As well, the room in the mixed-sex school was untidy and had a masculine feel about it, according to the female teachers, which also made it physically unappealing. This concurs with other researchers' observations and comments about the perceived masculine atmosphere of computer laboratories (Gurer & Camp, 2002).

Recommendations for Creating an Equitable Computer Learning Environment

The main purpose of the classroom is as a place to learn. Therefore the learning activities and the way in which the student undertakes them becomes an important aspect of the culture of the computing classroom. The computer classroom learning environment should be one which encourages learning and nurtures the intellectual growth of students. The following are some suggestions on how to achieve a computer classroom culture which is inclusive and beneficial to all students.

Providing Single-sex Classes

A major problem in the mixed-sex computer classrooms is the domination of the classroom by the boys as outlined by numerous researchers, for example Camp (1997), Grundy (1996) and Schofield (1995). It may be that the provision of single-sex classrooms in mixed-sex schools is one way of addressing a culture which is dominated by masculine values. There is some research to suggest that such a solution is good for both sexes because it enables teachers to address boys' and girls' issues separately (Gurer & Camp, 2002; Parker & Rennie, 2002). Particularly for the girls, this would provide female companionship and socialisation, and help eliminate the isolation which can occur in such situations.

Employing gender-neutral strategies

However, the provision of such classrooms does not guarantee an inclusive environment. In science classrooms at least there has been recent research suggesting that single-sex classrooms, accompanied by gender-inclusive strategies have proven successful in creating a more beneficial environment for each sex (Parker & Rennie, 2002). This would require teachers to undertake professional development relating to gender differences, for example, ensuring that they initiate interaction between them and the students, ensuring that the boys do not dominate the class time, and allocating equal time to the girls (Gurer & Camp, 2002). Such professional development would require willingness on the part of the teachers, and support from the schools.

Promoting computing as an interesting, gender-neutral subject should also focus on attracting students of all academic abilities, so that computing is not perceived as being for those who are less academically able.

Using group work

Interactive group-oriented work should be encouraged as a means of creating a cohesive and supportive classroom. Working collaboratively in groups enables students to discuss, explore, and investigate problems and discover solutions. While group-oriented work may need to be carefully managed to ensure that all students are participating, it can help encourage girls to become more confident in their computing abilities and to take risks they would not take in an individualised situation. Also, helping each other can give students a feeling of usefulness, that their knowledge is valued, and perhaps even an impression of recognition of their knowledge. Such feelings would contribute to their overall sense of self-efficacy, confidence and empowerment. Another benefit of group work is that it can act as a method of drawing into the class those students who may be on the social fringes, thus making the environment a more inclusive one. It can also act as a motivational factor, whereby members of the group encourage and motivate each other to complete tasks and extend their knowledge.

Maintaining a Harassment Free Environment

A harassment free environment can only occur in a class where standards of behaviour are such that there are few discipline problems, students are focused on their tasks and do not disrupt other students. The environment must be equitable in terms of participation and freedom from harassment, thus establishing a culture of care. It is essential that each student is given the opportunity to participate fully in all activities in the classroom, and this can not happen in a classroom that has discipline problems. This is particularly important where a mixed-sex classroom is dominated by a particular sex, be it male or female. Students must respect each other and their opinions and values, and one group must not be permitted to oppress another. This requires an element of trust whereby students know that they are in a safe environment that allows them to take risks and try new challenges without fear of failing or showing themselves to be inadequate.

Providing a suitable physical environment

Attention should be given to the design of the classroom and the placement of the machines as this can have significant implications for the social interactions which take place in classroom. Physically, it appears that the most suitable arrangement for the computing equipment is in groups of four because this is conducive to good communications and group work. However, this may not be possible or even suitable in all situations. What is essential is that consideration is given to what might be the most suitable desk arrangement to achieve a cohesive, cooperative and equitable environment.

A separate issue relating to the physical environment is the cleanliness and tidiness of the room. The state of the room is a reflection of the standards required by the teacher in that room, and when it is unclean and untidy then students are unlikely to take pride in the room, and have no sense of ownership of the room.

Providing Real-life Tasks and Appropriate Text Books

Tasks and assessments should be of a practical nature and have a real-life component, so that students can see the relevance and usefulness of the exercises to them. In a truly equitable classroom, teachers would focus on topics which are of interest to that particular group of students. For girls this may mean changing the nature of the tasks so that they can be approached from a more creative perspective. For the boys it may be creating tasks which hold their interest from a masculine perspective. However, it is important that tasks are not based entirely on gender, because girls should be encouraged to install software and set up computers as well as boys. Over recent years there are more games on the market which have been developed specifically for girls and their interests. By making these available and encouraging girls to use them, they may gain similar benefits from playing games as do the boys.

Appropriate text books and other resources should be provided to allow the student to work at his or her own speed without being reliant on the teacher for all instruction. When the student is completely dependent on the teacher for the necessary information to further progress then the teacher acts as a "gate-keeper" to the student's ability to learn. Further, students find it boring to wait for others to catch up.

Finally, teachers who follow Schon's (1995) epistemology of practice which is based on a close examination of what practitioners actually do, will reflect on the nature of their classroom and the successful implementation of student activities. Such reflection-in- and on-action will help the teacher to identify suitable and appropriate tasks, as well as methods of delivery, which can be adapted to the needs of individual groups, thus contributing to a change in the culture of computing.

While the preceding recommendations relate to classroom practice the following suggestions encompass a purview more related to school policy.

Encouraging Greater Female Participation

Attempts should be made to recruit more girls into computing and to ensure that computing is not seen as an unattractive option for them. This can involve a three-pronged initiative. First, innovative ways should be used to expose girl students to female computing experts. For example, since the data were gathered in this study School C1 has become involved in a Girl Power project in conjunction with the Women in Technology (WIT) organisation. Here, over a two-day period towards the end of the academic year, young, successful female members of WIT will go to the school and talk to Year 9 and 10 students about their jobs, their experiences in the work force and the opportunities which are available.

Second, hiring practices should focus on providing more female teachers who are qualified in computing, to act as role models so that girls can see female IT teachers participating and enjoying computing. The more women teachers are involved in computing, the more sex-normal it will become for girls, and help to dissipate the stereotypical "male nerd" image of computing. While more female teachers on their own will not change the culture, women do have a tendency to work more cooperatively and take a different perspective to computers and computing (Crump & Logan, 2000). Moreover, there is some research which suggests that girls (and boys) report more positive attitudes towards computing when taught by someone of the same sex (Corston & Colman, 1996) – another reason for the employment of more female computing teachers.

Third, the study has important implications for teachers of computing in secondary school. In the end, they are responsible for ensuring that the students have an appropriate learning environment and for the transmission and reinforcement of the culture. Therefore, professional development should be provided to ensure teachers are aware of gender-neutral strategies, and to provide support for them in the rapidly changing environment which is endemic to the subject of computing.

Limitations of the study

The major limitation to the research was the small number of schools and teachers who agreed to participate. The inclusion of more participants, particularly single-sex boys' schools, would have added strength to the results. Perhaps restricting the participants to the Wellington district was unnecessary and data from a wider decile range could have been captured by involving schools from outside the Wellington basin, thus eliminating any bias which may have occurred through the limited numbers of participants and school decile range.

Another limitation was the different types of schools. Parents send their children to single-sex schools for a variety of reasons often not associated with education, but as a reflection of the social relations and norms which they wish to see their children adopt. Therefore comparisons and judgements between mixed-sex schools and single-sex schools must be made with caution because other extraneous variables may confound the results.

A further limitation evolves from the many different types of computing classes. Level 12 and 13 computing classes in New Zealand schools offer a wide variety of topics, levels and even qualifications. In some schools students are offered Unit Standards, others the International Drivers Licence, and still others offer their own certificates. Within the Unit Standards there are at least two different subjects associated with computing – Information Management and Computer Studies – each with its own focus. Within that focus, the applications that are taught are many and varied. Such inconsistencies and differences make it difficult to compare between schools, and even classes within individual schools. This will become even more difficult as computing becomes a part of the technology matrix within the new qualification, the National Certificate of Educational Achievement (NCEA), which became a part of the national curriculum for the first time in 2002. Within this qualification, computing becomes a component in all the other technology subjects, as well as a subject in its own right.

While the use of the CUCEI highlighted significant and important differences it did pose some problems for analysis. Some questions, such as "Seating in this class is arranged in the same way each week", were not relevant in a situation where it is virtually impossible to change the seating arrangements on a regular basis. As well, the results from the principal components analyses suggested that posing questions in a negative manner, and using reverse scoring, may have been confusing to the student. Finally, the Personalisation scale did not perform well in terms of forming its own coherent factor, and it also had high correlations with some of the other scales. Using a modified form more closely aligned to the unique characteristics of the computer classroom may have strengthened the results.

Suggestions for Future Research

Increasingly, computers are being introduced as an integral part of all secondary education. It is therefore important to ensure that the unique characteristics which inhabit the mixed-sex computer classroom are identified and understood, so that equitable classroom environments prevail for all students. To this end, further research could include replication to test the generalisability of the present findings and new research in the context of recent curriculum change in New Zealand.

This research was necessarily limited by confining the study to Wellington schools and those schools agreeable to taking part. Replication of the study should involve more schools in other cities. While findings with regard to sex differences were consistent with other findings in the literature, the single-sex classroom computing culture needs much more research before findings can be regarded as secure.

New research could include the development of a new instrument which builds on this study's findings, including the classroom observations and interviews and thus focus more tightly on the unique cultural aspects of the computer classroom, and particularly on the different ways in which teachers present material to students in the computer classroom. Other research questions should ask about issues such as inherent beliefs about differences between boys' and girls' attitudes towards computers and computing, the methods of presenting material to students, the content of tasks and assessments and, in particular, the awareness and/or tolerance of disruptive behaviour in the classroom. The findings would test the validity of the recommendations made earlier for an environment which is encouraging for both girls and boys.

Since this study commenced and the data gathered there has been a change to the way in which the national curriculum is assessed. The National Certificates of Educational Achievement (NCEA) are standards-based qualifications that relate to a wide range of New Zealand curriculum-related educational outcomes. They have replaced the School Certificate, Sixth Form Certificate and University Bursaries. In the NCEA structure, Computer Studies has become an integral part of the technology matrix in New Zealand secondary schools. This matrix incorporates food technology and processing, information and communication, electronic, mechanical and biotechnologies and drawing graphics. Computers must now be used as a tool to aid in the development of communication, numeracy, information, problem-solving and other identified skills. Students will be required to draw on knowledge and skills developed in other areas of the curriculum throughout their technology education. In turn, technological activities will contribute to the development of learning in other areas by providing practical and authentic contexts in which the knowledge and skills can be used (Ministry of Education, 2000). Investigation of the impact that the NCEA has on students' and teachers' perceptions of both the computing undertaken as an integral part of each technology subject, and within the information and communication technology subject should be undertaken.

Perhaps the most critical area for future research concerns the adequacy of the training which computer teachers receive. As noted earlier, some computing teachers feel that their competencies are relatively low, as their teacher training was very often prior to the advent of computing as a school subject. Therefore with computing being required to be incorporated into a much wider spectrum of the curriculum, some research should be undertaken to identify the impact this has on teachers and the kinds of knowledge they need to teach computing effectively. Beginning in term 3, 2003, a professional development programme involving every secondary school in New Zealand will be activated to prepare teachers and schools for the NCEA. It is important that this programme is evaluated in terms of its effectiveness in enabling teachers to create an equitable culture in the computer classroom.

References

AAUW. (1992). *How schools shortchange girls. The AAUW Report.* New York: Marlowe & Company.

AAUW. (1999). *Gender Gaps. Where schools still fail our children.* New York: Marlowe & Company.

AAUW. (2000). *Tech-savvy: Educating girls in the new computer age.* New York: Marlowe & Company.

Alton-Lee, A., & Praat, A. (2001). *Questioning gender: Snapshots from explaining and addressing gender differences in the New Zealand compulsory school sector.* Wellington, New Zealand: Ministry of Education.

Anderson, G. J., Walberg, H. J., & Fraser, B. J. (1981). *Assessment of learning environments: Manual for the learning environment instrument (LEI) and the My Class Inventory (MCI)* (3rd ed.). Sydney, Australia: Macquarie University.

Andrews, G. (1997). CRA Taulbee surveys. *Computing Research News, 2,* 6-9.

Becker, J. (1995). Women's ways of knowing in mathematics. In P. K. G. Rogers (Ed.), *Equity in mathematics education: Influences of feminism and culture* (pp. 163-174). London: Falmer Press.

Bernstein, D. R. (1997, February). *Computing diversity and community: Fostering the computing culture.* Paper presented at the twenty-eighth SIGCSE Conference, San Jose, CA.

Bernstein, D. R. (1999, July). Java, Women and the Culture of Computing. *Proceedings of the 12th Annual Conference of the National Advisory Committee on Computing Qualifications: The new learning environment,* (pp. 21-28). Dunedin, New Zealand.

Booth, D. (1997). Evaluation of a change in teaching methods using the College and University Classroom Environment Inventory (CUCEI). *Teaching and Learning Forum 97.* Retrieved August 21, 2001, from Curtin University Web site: http://cea.curtin.edu.au/tlf/tlf1997/booth.html

Bowers, C. A. (1988). *The cultural dimensions of educational computing: Understanding the non-neutrality of technology.* New York: Teachers College Press, Columbia University.

Brown, J., Andreae, P., Biddle, R., & Tempero, E. (1997, February). Women in introductory computer science: Experience at Victoria University of Wellington. *Association for Computing Machinery SIGCSE Bulletin, Proceedings of the Twenty-Eighth SIGCSE Technical Symposium on Computer Science Education, 29,* 111-115.

Byrne, E. M. (1993). *Women and science: The snark syndrome.* London: Falmer Press.

Camp, T. (1997). The incredible shrinking pipeline. *Communications of the ACM, 40,* 103-110.

Campbell, D. T., & Fiske, D.W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56,* 81-105.

Chambers, S. M., & Clarke, V. A. (1990). Sex differences in computing participation: Concerns, extent, reasons and strategies. *Australian Journal of Education, 4,* 52-66.

Chavez, R. C. (1984). The use of high-inference measures to study classroom climates: A review. *Review of Educational Research, 54,* 237-261.

Clarke, J. A. (1995). Tertiary students' perceptions of their learning environments: A new procedure and some outcomes. *Higher Education Research and Development, 14,* 1-12.

Clarke, V. A. (1991). Creation of female-friendly computing environments. In L. J. Rennie, L. H. Parker, & G. M. Hildebrand (Eds.), *Action for equity: The second decade. Contributions to the sixth international GASAT conference* (Vol. 1, pp. 27-35). Perth, Western Australia: Key Centre for Teaching and Research.

Clarke, V. A. (1992). Strategies for involving girls in computer science. In C. D. Martin, & E. Murchie-Beyma (Eds.), *In search of gender free paradigms for computer science education* (pp. 70-76). Eugene, OR: International Society for Technology in Education.

Clarke, V. A. (1996). Sex differences in computing participation: Concerns, extent, reasons and strategies. *Australian Journal of Education, 34,* 52-66.

Clarke, V. A., & Chambers, S. M. (1989). Gender-based factors in computing enrolments and achievement: Evidence from a study of tertiary students. *Journal of Educational Computing Research, 5,* 409-429.

Corston, R., & Colman, A. (1996). Gender and social facilitation effects on computer competence and attitudes toward computers. *Journal of Educational Computing Research, 14,* 171-183.

Cottrell, J. (2000). *I'm a stranger here myself: A consideration of women in computing.* Retrieved August 2001, from http://www.mith2.umd.edu/WomensStudies/Computing/Articles+ResearchPapers/consideration-women-in-computing

Craig, A., Fisher, J., Scollary, A., & Singh, M. (1998). Closing the gap: Women education and information technology courses in Australia. *The Journal of Systems and Software, 40,* 7-11.

Crombie, G. (1999). Research on young women in computer science: Promoting high technology for girls. *Opening doors - Opportunities for tomorrow for young girls.* Retrieved July 2001, from http://cythera.ic.gc.ca/htos/allfemales

Crombie, G., & Armstrong, P. I. (1999). Perceptions of the high technology field of High School students enrolled in computer science. Retrieved July 2001, from http://cythera.ic.gc.ca/htos/hshightech/

Crump, B. J., & Logan, K. L. (2000). Women in an alien environment. *The New Zealand Journal of Applied Computing and Information Technology, 4*, 28-35.

Currie, D. (1993). *The construction of gender at UBC computing services.* Retrieved August 2000, from http:// www.herplace.org/compgend.html

De Landsheere, G. (1993). History of educational research. In M. Hammersley (Ed.), *Educational research* (pp. 3-15). London: Paul Chapman Publishing Ltd.

De Lisi, R. (2002). From marbles to instant messenger: Implications of Piaget's ideas about peer learning. *Theory into Practice, 41*, 5-13.

Denzin, N. K. (1988). Triangulation. In J. P. Keeves (Ed.), *Educational research, methodology, and measurement: An international handbook* (pp. 511-513). Oxford, United Kingdom: Pergamon Press.

Dunne, M. (1996). The power of numbers: Quantitative data and equal opportunities research. In L. Morley, & V.Walsh (Eds.), *Breaking boundaries: Women in higher education*. London: Taylor & Francis Ltd.

Durndell, A., Glissov, P., & Siann, G. (1995). Gender and computing: Persisting differences. *Educational Research, 37*, 219-227.

Edwards, P. N. (1994). From "impact" to social process: Computers in society and culture. In S. Jasanoff (Ed.), *Handbook of Science and Technology Studies*. Beverly Hills, CA: Sage Publications.

Ellett, C. D., Loup, K. S., & Chauvin, S. W. (1991). Development, validity and reliability of a new generation of assessments of effective teaching and learning: Future directions for the study of learning environments. *Journal of Classroom Interaction, 26*, 25-36.

Erickson, F. (1986). Qualitative methods in research on teaching. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 119-161). New York: Macmillan.

Ernest, P. (1995). The one and the many. In L. P. Steffe, & J. Gale (Eds.), *Constructivism in education* (pp. 459-486). Hillsdale, NJ: Lawrence Erlbaum.

Fisher, D. L., & Parkinson, C. (1988). Improving nursing education classroom environments. *Journal of Nursing Education, 37*, 232-236.

Fraser, B. J. (1989). Twenty years of classroom climate work: Progress and prospect.

Journal of Curriculum Studies, 21, 307-327.

Fraser, B. J. (1994). Research on classroom and school climate. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 495-541). New York: Macmillan.

Fraser, B. J., Giddings, G. J., & McRobbie, C. J. (1992). Assessment of the psychosocial environment of university science laboratory classrooms: A cross-national study. *Higher Education, 24*, 431-451.

Fraser, B. J., & Tobin, K. (1991). Combining qualitative and quantitative methods in classroom environment research. In B. J. Fraser, & H. J. Walberg (Eds.), *Educational environments evaluation, antecedents and consequences* (pp. 271-292). Oxford, United Kingdom: Pergamon Press.

Fraser, B. J., & Treagust, D. F. (1986). Validity and use of an instrument for assessing classroom psychosocial environment in higher education. *Higher Education, 15*, 37-57.

Fraser, B. J., Treagust, D. F., Williamson, J. C., & Tobin, K. G. (1987). Validation and application of the college and university classroom environment inventory (CUCEI). In B. J. Fraser (Ed.), *The study of learning environments* (pp. 17-30). Perth, Western Australia: Curtin University of Technology.

Frenkel, K. A. (1990). Women and computing. *Communications of the ACM, 33*, 34-47.

Furger, R. (1998). *Does Jane compute? Preserving our daughters' place in the cyber revolution*. New York: Warner Books.

Geertz, C. (1973). *The interpretation of cultures: Selected essays*. New York: Basic Books, Inc.

Gilligan, C. (1982). *In a different voice: Psychological theory and women's development* (2nd ed.). Cambridge, MA: Harvard University Press.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 11*, 255-274.

Grundy, F. (1996). *Women and computers*. Exeter, United Kingdom: Intellect Books.

Grundy, F. (2000, June). *Mathematics in computing: A help or hindrance for women?* Paper presented at Women, Work and Computerisation 2000 Conference, Vancouver.

Grundy, F. (2001, July). *A new conception of computing: Interactionism replaces objectivism.* Paper presented at *GASAT 10,* Copenhagen. Retrieved March 10, 2002, from Keele University Web site http://www.keele.ac.uk/depts/cs/staff/a.f.grundy/home/interact.htm

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park, CA: SAGE Publications, Inc.

Gurer, G., & Camp, T., (2002). *Investigating the incredible shrinking pipeline for women in computer science*. National Science Foundation. Retrieved July 27, 2003, from http://www.acm.org/women/pipeline-finalreport_ver_2.doc

Henderson, D. G., Fisher, D. L., & Fraser, B. J. (1998, April). *Learning environment and student attitudes in environmental science classrooms*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Diego, CA.

Hofstede, G. (1980). *Culture's consequences. International differences in work-related values*. New Delhi, India: Sage Publications.

Hofstede, G. (1994). *Uncommon sense about organisations: Cases, studies and field observations*. Thousand Oaks, California: Sage Publications.

Hofstede, G. (1997). *Cultures and organisations: Software of the mind*. New York: McGraw-Hill.

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviours, institutions, and organisations across nations*. Thousand Oaks, CA: Sage Publications.

Huff, C. W., & Cooper, J. (1987). Sex bias in educational software: The effect of designers' stereotypes on the software they design. *Journal of Applied Social Psychology, 6*, 519-532.

Jakobsdottir, S. (1996). *Elementary school computer culture: Gender and age differences in student reactions to computer use*. Synopsis of Ph.D. thesis. Retrieved July 10, 2001, from http://soljak.khi.is/thesisf/synopsis.htm

Jones, A. (2000). Gender matters in schooling in Aotearoa/New Zealand. In J. Marshall, E. Coxon, K. Jenkins, & A. Jones (Eds.), *Politics, policy, pedagogy: Education in Aotearoa/New Zealand*, (pp. 37-45). Palmerston North, New Zealand: The Dunmore Printing Company Ltd.

Kadijevich, D. (2000). Gender differences in computer attitude among ninth-grade students. *Journal of Educational Computing Research, 22*, 145-154.

Kelinson, J. W., & Tate, P. (2000). The 1998-2008 job outlook in brief. *Occupational Outlook Quarterly, Spring*, 2-39.

Kidder, T. (1982). *Soul of a new machine*. New York: Avon.

Kiesler, S., Sproull, L., & Eccles, J. S. (1985). Pool halls, chips, and war games: Women in the culture of computing. *Psychology of Women Quarterly, 9*, 451-462.

Klein, L. (1992). Female students' underachievement in computer science and mathematics: Reasons and recommendations. In C. D. Martin, & E. Murchie-Beyma (Eds.), *In search of gender free paradigms for computer science* *education* (pp. 47-56). Eugene, OR: International Society for Technology in Education.

Lamb, S. (1997). Gender differences in mathematics participation: An Australian perspective. *Educational Studies, 23*, 105-121.

Levy, S. (1984). *Hackers: Heroes of the Computer Revolution.* New York: Anchor Press/Doubleday.

Linn, M. C. (1985). Fostering equitable consequences from computer learning environments. *Sex Roles, 13*, 229-240.

Making science, maths sexy to girls. (2001, August 21). *The Evening Post*, p. 3.

Margolis, J., Fisher, A., & Miller, F. (2000). *Caring about connections: Gender and computing* . Retrieved August 21, 2001, from Carnegie Mellon University School of Computer Science Web site: http://www-2.cs.cmu.edu/~gendergap/papers/IEEE99.html

Margolis, J., Fisher, A., & Miller, F. (2001). *The anatomy of interest: Women in undergraduate Computer Science.* Retrieved September 10, 2001, from Carnegie Mellon University School of Computer Science Web site: http:www.cmu.edu/~gendergap/papers/anatomyWSQ99.html

Margolis, J., & Fisher, A. (2002). *Unlocking the clubhouse: Women in computing.* Cambridge, MA: The MIT Press.

Mark, J. (2001). *Beyond equal access: Gender equity in learning with computers* Retrieved September 13, 2001, from http://ww.enc.org/topics/equity/documents

Mathison, S. (1988). Why triangulate? *Educational Researcher, 17*, 13-17.

Millar, J., & Jagger, N. (2001). *Women in ITEC courses and careers.* London, United Kingdom: Department of Trade and Industry.

Millar, M. (1998). *Cracking the gender code: Who rules the wired world?* Toronto, Canada: Second Story Press.

Miller, L., Chaika, M., & Groppe, L. (1996). Girls' preferences in software design: Insights from a focus group. *Interpersonal Computing and Technology, 4*, 27-36.

Ministry of Education. (2000). *Technology in the New Zealand Curriculum.* Retrieved October 21, 2001, from http://www.minedu.govt.nz/web/downloadable

Ministry of Education. (2001). *Nationally recognised subjects taken by secondary students by year of schooling at 1 July 2001.* Retrieved October 15, 2001, from http://www.minedu.govt.nz/web/downloadable/dl6886_v1/subjects.xls

Ministry of Education. (2002). *How the decile is calculated.* Retrieved September 30,

2002, from
http://www.minedu.govt.nz/index.cfm?layout=document&documentid=7697&data=1

Moos, R. H. (1973). *Conceptualising educational environments*. Southeast Asia Development Advisory Group papers on problems of Southeast Asia. New York: The Asia Society-SEADAG.

Moos, R. H. (1979). *Evaluating educational environments*. London: Jossey-Bass Publishers.

Moos, R. H. (1980). Evaluating classroom learning environments. *Studies in Education Evaluation, 6*, 239-252.

Moos, R. H. (1991). Connections between school, work and family settings. In B. J. Fraser & H.J Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences* (pp. 29-53). Oxford, United Kingdom: Pergamon Press.

Moos, R. H., & Trickett, E. J. (1974). *Classroom environment scale manual*. Palo Alto, CA: Consulting Psychologists Press.

Moos, R. H. (1979). Educational climates. In H. J. Walberg (Ed.), *Educational environments and effects* (pp. 79-100). Berkely, CA: McCutchan Publishing Corporation.

Nair, C., & Fisher, D. (1999, August). *A learning environment study of tertiary classrooms*. Paper presented at the annual research forum of the Western Australian Institute for Educational Research, Perth, Western Australia.

Nair, C., & Fisher, D. (2000). Validation and application of a personalised form of a learning environment questionnaire for use in tertiary science classrooms. In D. Fisher, & J.H. Yang, (Eds.), *Proceedings of the second International Conference on Science, Mathematics and Technology Education: Improving classroom research through international cooperation, Taiwan,* (pp. 419-427). Perth, Western Australia: National Key Centre for School Science and Mathematics, Curtin University of Technology.

Nair, C. S., & Fisher, D. L. (2001). Learning environments and student attitudes to science at the senior secondary and tertiary levels. *Issues in Educational Research, 11*, 1-18.

Noddings, N. (1990). Constructivism in mathematics education. In R. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist views on the teaching and learning of mathematics* (pp. 7-29). Reston, VA: National Council of Teachers of Mathematics.

Nunnally, T. (1978). *Psychometric theory*. New York: McGraw-Hill.

Ogbu, J. U. (1978). *Minority education and caste: The American system in cross-cultural perspective*. London: Academic Press, Inc.

Parker, L. H., & Rennie L. J. (2002). Teachers' implementation of gender-inclusive instructional strategies in single-sex and mixed-sex science classrooms. *International Journal of Science Education, 24*, 881-897.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. (2nd ed.). Newbury Park, CA: Sage Publications, Inc.

Pearl, A., Pollack, M. E., Riskin, E., Thomas, B., Wolf, E., & Wu, A. (1990). Becoming a computer scientist: A report by the ACM committee on the status of women in computing science. *Communications of the ACM, 33*, 47-58.

PITAC. (1999). *Information technology for the twenty-first century initiative*. Retrieved September 8, 2001, from http://www.hpcc.gov/pubs/pitac/

Provenzo, E. F. (1991). *Video kids: Making sense of Nintendo*. Cambridge, MA: Harvard University Press.

Rasmussen, B., & Hapnes, T. (1991). Excluding women from the technologies of the future? A case study of the culture of computer science. *Futures, 23*, 1107-1119.

Rennie, L.J. (1998). Gender equity: Toward clarification and a research direction for science teacher education. *Journal of Research in Science Teaching, 35*, 951-961.

Rennie, L. J., & Parker, L. H. (1997). Students' and teachers' perceptions of single-sex and mixed-sex mathematics classes. *Mathematics Education Research Journal, 9*, 257-273.

Rentoul, A. J., & Fraser, B. J. (1979). Conceptualisation of enquiry-based or open classroom environments. *Journal of Curriculum Studies, 11*, 233-245.

Rokeach, M. (1972). *Beliefs, attitudes, and values: A theory of organization and change.* San Francisco,CA: Jossey-Bass.

Ryba, K., & Selby, L. (1995). *A study of tertiary level IT courses: How gender inclusive is the curriculum?* Wellington, New Zealand: Ministry of Education.

Sanders, J. S., & Stone, A. (1986). *The neuter computer: Computers for girls and boys.* New York: Neil-Schuman.

Schofield, J. W. (1993). Increasing the generalizability of qualitative research. In M. Hammersley (Ed.), *Educational Research: Current issues* (pp. 91-113). London: Paul Chapman Publishing Ltd.

Schofield, J. W. (1995). *Computers and classroom culture*. Cambridge, NY: Cambridge University Press.

Schon, D. A. (1995). *The reflective practitioner: How professionals think in action.* Aldershot, Hants, United Kingdom: Arena.

Shashaani, L. (1994). Gender-differences in computer experience and its influence on computer attitudes. *Journal of Educational Computing Research, 11*, 347-367.

Shmurak, C. B. (1988). *Voices of hope: Adolescent girls at single sex and coeducational schools*. New York: Peter Lang Publishing, Inc.

Silverman, S., & Pritchard, A. M. (1996). Building their future: Girls and technology education in Connecticut. *Journal of Technology Education, 7*, 1-13.

Spender, D. (1982). *Invisible women: The schooling scandal*. London: Writers and Readers.

Sproull, L., Kiesler, S., & Zubrow, D. (1987). Encountering an alien culture. In S. B. Kiesler & L. S. Sproull (Eds.), *Computing and change on campus* (pp. 173-194). Cambridge, NY: Cambridge University Press.

Sproull, L., Zubrow, D., & Kiesler, S. (1986). Cultural socialization to computing in college. *Computers in Human Behavior, 2*, 257-275.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage Publications, Inc.

Stuedahl, D., & Braa, K. (2000) *Where have all the women gone - from computer science?* Retrieved July 24, 2000, from http://www.ifi.uio.no/~systarb/Jenter.og.IT/iris.html

Taylor, P. C. (1996). Mythmaking and mythbreaking in the mathematics classroom. *Educational Studies in Mathematics, 31*, 151-173.

Taylor, P. C., Fraser, B. J., & Fisher, D. L. (1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research, 27*, 293-301.

Tobin, K. G. & Tippins, D. J. (1993). Constructivism as a referent for teaching and learning. In K. G. Tobin, & D. J. Tippins (Eds.), *The practice of constructivism in science education* (pp. 3-21). Hillsdale, NJ: Lawrence Erlbaum.

Toynbee, C. (1993). Reducing the drop-out rate. *Computing Research News, 5*, 2-20.

Trickett, E. J., & Moos, R. H. (1973). The social environment of Junior High and High School classrooms. *Journal of Educational Psychology, 65*, 93-102.

Turkle, S. (1988). *Computational reticence: Why women fear the intimate machine*. New York: Routledge and Kegan Paul.

UNCTAD Secretariat. (2002). *E-Commerce and Development Report 2002*. New York: United Nations.

Walberg, H. J. (1971). Models for optimizing and individualizing school learning. *Interchange, 2*, 15-27.

Walberg, H. J., & Anderson, G. J. (1968). Classroom climate and individual learning. *Journal of Educational Psychology, 59*, 414-419.

White, C., & Kinnick, K. N. (2000). One click forward and two clicks back: Portrayal of women using computers in television commercials. *Women's Studies in Communication, 23*, 392-412.

Williamson, J. C., Tobin, K. G., & Fraser, B. J. (1986, April). *Use of classroom and school environment scales in evaluating alternative high schools*. Paper presented at the annual meeting of American Educational Research Association, San Francisco, CA.

Woodfield, R. (2002). Woman and information systems development: not just a pretty (inter)face? *Information Technology & People, 15*, 119-138.

Wright, R. (1997). Women in computing: A cross-national analysis. In R. Lander & A. Adam (Eds.), *Women in computing* (pp. 72-83). Exeter, United Kingdom: Intellect Books.

Wubbels, T., Levy, J., & Brekelmans, B. (1997). Paying attention to relationships. *Educational Leadership,* 7, 82-85.

Wulf, W. A. (1998). Diversity in Engineering. *The Bridge, 28*, 1-7.

Yeaman, A. R. J. (1993). The mythical anxieties of computerization: A Barthesian analysis of a technological myth. In R. Muffoletto, & N. N. Knupfer (Eds.), *Computers in education: social, political, and historical perspectives* (pp. 105-128). Cresskill, NJ: Hampton Press.

Appendix 3A

Actual version

College & University Classroom Environment Inventory (CUCEI)

Personalised Form

Dear Participant

I am currently conducting research in Wellington schools for my doctorate on 6th form students taking computing classes. The purposes of this research project is to gain an understanding of students' perceptions of their computing learning environment, particularly in relation to what is known as the 'computing culture'.

If you agree to participate, please complete the questionnaire on the following pages. If you would like a summary of the findings or have further questions regarding the research please email me at K.A.Logan@massey.ac.nz or phone me on 04 801 2794 extension 6366 (work).

Thank you for your time.

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

Type of Class: (eg. Word Processing, Programming etc)

____

Do you intend going to University or Polytech when you finish school? Please circle: Yes/No
If Yes, what course would you like to take?

____

	Remember that you are describing your **actual** *classroom*	Almost Never	Seldom	Some-times	Often	Almost Always
1	The teacher considers my feelings.	1	2	3	4	5
2	The teacher is friendly and talks to me.	1	2	3	4	5
3	The teacher goes out of his/her way to help me.	1	2	3	4	5
4	The teacher helps me when I am having trouble with my work.	1	2	3	4	5
5	The teacher moves around the classroom to talk with me.	1	2	3	4	5
6	The teacher is interested in my problems.	1	2	3	4	5
7	The teacher 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 teacher uses new and different ways of teaching in this class.	1	2	3	4	5
10	The teacher 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 teacher 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 has to be done in this class.	1	2	3	4	5
23	I find getting a certain amount of work done is important in this 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 teacher decides what I will do in this class.	1	2	3	4	5
43	The teacher 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 teacher 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 teacher 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 3B

Preferred version

College & University Classroom Environment Inventory (CUCEI)

Personalised Form

Dear Participant

I am currently conducting research in Wellington schools for my doctorate on 6^{th} form students taking computing classes. The purposes of this research project is to gain an understanding of students' perceptions of their computing learning environment, particularly in relation to what is known as the 'computing culture'.

If you agree to participate, please complete the questionnaire on the following pages. If you would like a summary of the findings or have further questions regarding the research please email me at K.A.Logan@massey.ac.nz or phone me on 04 801 2794 extension 6366 (work).

Thank you for your time.

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

Type of Class: (eg. Word Processing, Programming etc)

____

Do you intend going to University or Polytech when you finish school? Please circle: Yes/No
If Yes, what course would you like to take?

____

	Remember that you are describing your **ideal** *classroom*	Almost never	Seldom	Some-times	Often	Almost always
1	The teacher would consider my feelings.	1	2	3	4	5
2	The teacher would be friendly and would talk to me.	1	2	3	4	5
3	The teacher would go out of his/her way to help me.	1	2	3	4	5
4	The teacher would help me when I am having trouble with my work	1	2	3	4	5
5	The teacher would move around the classroom to talk with me.	1	2	3	4	5
6	The teacher would be interested in my problems.	1	2	3	4	5
7	The teacher 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 teacher would use new and different ways of teaching in the class.	1	2	3	4	5
10	The teacher 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 teacher would often think of unusual activities	1	2	3	4	5
14	I 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
16	I would know most students in the class by their first name.	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

Please continue on next page

	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 pace.	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 teacher would decide what I would do in this class.	1	2	3	4	5
43	The teacher 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 teacher 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 teacher 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 3C

Questions for interviews with students

1. Why did you take computing as a 6^{th} form subject? Parents? Peers?
2. Do you intend to do Bursary? What subjects are you taking?
3. When did you first use a computer? Do you have one at home?
4. How do you find computer classes? What's good about them? What's bad about them?
5. What do you think about your computing teachers? Are they friendly and helpful?
6. How do you like solving problems in the computer classroom? Do you like to work on your own, rely on the teacher or work with other students?
7. Are computer classes different to other classes? Do you work differently in computer classes? Is there more noise? Do teachers treat you differently in computer classes?
8. Does your teacher explain instructions and answer your questions clearly?
9. Are the other students in your class helpful and friendly?
10. Do you like the tasks and assessments that you are given in class?
11. Some people say boys have an *easier* time learning computing. What do you think?
12. Some people say girls have an *easier* time learning computing. What do you think?
13. Why do you think there are so few girls taking 6^{th} and 7^{th} form certificate computing?
14. What classes do you like best?
15. Do you play computer games?
16. How often do you use e-mail?
17. Do you use chat rooms?
18. Does your school have a Games Club? Do you belong? Why/Why not? What do you like about it?

19. Do you think girls get the same amount of attention from the teachers in computer classrooms?

20. Do you prefer working with girls or boys?

21. Is there anything further you would like to add?

Appendix 3D

Questions for interviews with teachers

1. Can you give me a brief history of your teaching background?

2. How did you start teaching computing? How did you get into the area of computing?

3. What do you like/dislike about it?

4. Do students generally behave differently in computer classrooms to other classrooms?

5. Do you find that you teach, or have to teach, differently in computer classrooms?

6. Do you think that teachers have to approach the teaching of computing in a different fashion because of its interactivity - ie more of a problem solving approach? More group work?

7. Do you think boys and girls study differently, or learn differently in the computer classroom?

8. Is there a certain type of student that is inclined to take computing?

9. Why do you think there are so few girls taking 6^{th} and 7^{th} form certificate computing?

10. Do you believe a student needs to have good mathematics to be good at computing?

11. What do you think about students playing computer games?

Additional questions for those teachers who teach, or who have taught, computing to mixed-sex classes

12. What sort of activities have you noticed the girls doing on the computers that the boys don't do and vice versa?

13. Do you notice any difference in behaviour between boys and girls in the computer room?

14. Are the boys' attitudes towards computers different to the girls?

15. Do you find that you have to treat girls differently to boys in the computer classroom?

16. Do the different sexes mix well in the computer classroom, or do they tend to work in same sex groups?

17. What strategies (if any) do you have in place to encourage more female participation?

18. Is there anything further you would like to add?

Appendix 3E
Letter of Explanation

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 Wellington schools for my doctorate on 6th and 7th form students taking computing classes. The purposes of this research project is to gain an understanding of students' perceptions of their computing learning environment, particularly in relation to what is known as the 'computing culture'. This will be done through analysing a questionnaire, interviewing students and teachers as well as observation of classes.

The main objectives are to:

- Identify why female students are not choosing take computer studies as a career option.
- Highlight the extent to which female students' perceptions of the computer learning environment differ from male students'.
- Identify whether the 'computing culture' is evident in 6th and 7th form computing classes (Levels 12 and 13).
- Identify whether there are differences between perceptions of students at different types of school.
- Contribute to the broader theoretical literature on the lack of females in computing.

As a part of the gathering of information I would like to conduct interviews with teachers of 6th and 7th form computing classes, as well as observe some classes and interview some students. I can assure you that your feedback will remain confidential and data from the information gathering 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 Consent Form attached. If you would like a summary of the findings or have further questions regarding the research please email me at K.A.Logan@massey.ac.nz or phone me on 04 801 2794 extension 6366 (work).

Thank you for your time and help.

Keri Logan
Doctoral student
Curtin University
Perth, Australia

Appendix 3F

CONSENT FORM

CONSENT TO PARTICIPATE IN A RESEARCH PROJECT
CONFIDENTIAL

Title of Research Project:	Perceptions of the learning environment in Years 12 and 13 computing classrooms, and the effect of culture on that learning environment, in Wellington secondary schools.
Name of Researcher:	Keri Logan Doctoral Student Science Mathematics and Technology Education Centre Curtin University Perth, Australia

PARTICIPANT:
I have read the covering letter and understand it. I understand I have the opportunity to ask questions and that at my request I will receive feedback on the outcome of the research at its conclusion. I understand that the data 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 3G

Letter to schools

Dear

I am a Senior Lecturer at Massey University (previously Wellington Polytechnic) in the Department of Business Information. I am particularly interested in the lack of participation of women in the IT area, and in particular the lack of enrolments, and poor retention of females in tertiary courses relating to IT. As a result of this interest, myself and a colleague have been involved in research in this area over a number of years, and produced papers from differing perspectives on this issue. I am now preparing to do a PhD thesis, and would like to concentrate on the perceptions of Year 12 and 13 computing students and their teachers in the secondary schools in the Wellington area, and am writing to ask if your school would be willing to participate in such a study.

At the moment I am planning on using a statistical instrument developed and validated in Australia, which investigates the perceptions of students of their classroom learning environment. As well, I would like to interview students and their teachers, and if possible observe some classes. I realise that this would be an imposition on your school, and in particular the students and teachers involved.

Ethical considerations concerning the place and length of storage of data collected, and the confidentiality and anonymity of participants, will be in accordance with Massey University, and Curtin University requirements and will be extrapolated further if you are interested in participating in this research.

As this letter is a tentative enquiry to elicit your possible interest, I will follow it up with a phone call shortly, when we could possibly make a time for a more formal appointment for discussion. I hope that you will treat this request positively.

Yours faithfully

Keri Logan
Senior Lecturer

Appendix 4A

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

Scale Name and Items		n	% Responses 1[a]	2[b]	3[c]	4[d]	5[e]	Mean	*SD*
Personalisation									
A1	The teacher considers my feelings	256	16	23	79	94	44	3.50	1.07
A2	The teacher is friendly and talks to me	256	4	15	57	98	82	3.93	0.96
A3	The teacher goes out of his/her way to help me	256	13	17	82	82	60	3.63	1.07
A4	The teacher helps me when I am having trouble with my work	256	5	18	47	88	98	4.00	1.01
A5	The teacher moves around the classroom to talk with me	256	11	21	73	83	68	3.69	1.08
A6	The teacher is interested in my problems	256	33	44	72	76	31	3.11	1.21
A7	The teacher is unfriendly and inconsiderate towards me	255	6	6	48	44	151	4.29	1.00
Innovation									
A8	New ideas are seldom tried out in this class	255	10	28	107	67	43	3.41	1.02
A9	My teacher uses new and different ways of teaching in this class	256	27	42	122	55	10	2.92	.98
A10	The teacher thinks up innovative activities for me to do	256	25	52	95	62	22	3.02	1.09
A11	The teaching approaches used in this class are characterised by innovation and variety	254	17	29	94	71	43	3.37	1.10
A12	Seating in this class is arranged in the same way each week	256	95	44	43	31	43	2.54	1.50
A13	The teacher often thinks of unusual activities	256	53	71	84	30	18	2.57	1.15
A14	I seem to do the same type of activities in every class	256	26	45	84	64	37	3.16	1.18
Student Cohesion									
A15	My class is made up of individuals who don't know each other well	256	24	28	41	65	98	3.72	1.32
A16	I know most students in this class by their first names	256	5	15	33	49	154	4.30	1.03
A17	I make friends easily in this class	256	18	28	55	71	84	3.68	1.23
A18	I don't get much of a chance to know my classmates	256	11	24	50	64	107	3.91	1.17
A19	It takes me a long time to get to know everybody by his/her name in this class	255	11	22	40	66	116	4.00	1.16
A20	I have the chance to know my classmates well	256	24	39	61	57	75	3.47	1.31
A21	I am not very interested in getting to know other students in this class	255	12	33	61	43	106	3.78	1.25

Task Orientation									
A22	I know exactly what has to be done in the class	256	8	19	70	91	68	3.75	1.03
A23	I find getting a certain amount of work done is important in this class	256	11	30	63	90	62	3.63	1.10
A24	I often get sidetracked in this class instead of sticking to the point	256	36	48	105	46	21	2.88	1.12
A25	This class is always disorganised	256	8	28	55	73	92	3.83	1.13
A26	Class assignments are clear and I know what to do	256	17	21	67	88	63	3.62	1.14
A27	This class seldom starts on time	256	30	53	72	55	46	3.13	1.26
A28	Activities in this class are clearly and carefully planned	256	5	15	69	108	59	3.79	0.93
Cooperation									
A29	I cooperate with other students when doing assignment work	256	7	18	62	94	75	3.83	1.02
A30	I share my books and resources with other students when doing assignments	256	27	29	66	79	55	3.41	1.24
A31	I work with other students on projects in this class	256	27	36	76	70	47	3.29	1.22
A32	I learn from other students in this class	256	14	22	66	85	69	3.68	1.12
A33	I work with other students in this class	256	15	14	85	76	66	3.64	1.10
A34	I cooperate with other students on class activities	256	12	16	66	102	60	3.71	1.04
A35	Students work with me to achieve class goals	256	21	37	80	72	46	3.33	1.17
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	256	69	68	73	33	13	2.43	1.16
A37	I am generally allowed to work at my own pact in this class	256	20	19	70	77	70	3.62	1.19
A38	I have a say in how class time is spent	256	67	72	86	20	11	2.36	1.08
A39	I am allowed to choose activities and how I will work	256	47	75	79	38	17	2.62	1.14
A40	Teaching approaches in this class allow me to proceed at my own pace	255	14	29	94	75	43	3.41	1.07
A41	I have little opportunity to pursue my particular interests in this class	255	25	42	95	64	29	3.12	1.12
A42	My teacher decides what I will do in this class	255	68	83	66	30	8	2.32	1.09
Equity									
A43	The teacher gives as much attention to my questions as to other students' questions	256	6	24	63	75	88	3.84	1.07
A44	I get the same amount of help from the teacher as do other students	256	7	28	65	64	92	3.80	1.12
A45	I am treated the same as other students in this class	256	7	8	56	69	116	4.09	1.02
A46	I receive the same encouragement from the teacher as other students do	255	5	11	61	61	117	4.07	1.02
A47	I get the same opportunity to answer questions as other students	255	6	14	61	68	106	4.00	1.04
A48	My work receives as much praise as other students' work	256	6	23	55	76	96	3.91	1.08
A49	I have the same amount of say in this class as other students	241	7	12	49	67	106	4.05	1.05

Appendix 4B

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

	Scale Name and Items	n	% Responses 1[a]	2[b]	3[c]	4[d]	5[e]	Mean	*SD*
Personalisation									
P1	The teacher would consider my feelings	212	2	5	43	60	102	4.20	.91
P2	The teacher would be friendly and would talk to me	212	2	3	36	63	108	4.28	.86
P3	The teacher would go out of his/her way to help me	212	1	8	39	61	103	4.21	.91
P4	The teacher would help me when I am having trouble with my work	212	1	3	24	63	121	4.42	.78
P5	The teacher would move around the classroom to talk with me	212	3	4	49	73	83	4.08	.91
P6	The teacher would be interested in my problems	212	28	20	39	57	68	3.55	1.37
P7	The teacher would be unfriendly and inconsiderate towards me	211	8	14	13	21	155	4.43	1.11
Innovation									
P8	New ideas would be seldom tried out in this class	211	25	26	63	38	59	3.38	1.33
P9	My teacher would use new and different ways of teaching in this class	212	6	11	60	62	73	3087	1.04
P10	The teacher would think up innovative activities for me to do	212	10	16	49	67	70	3.81	1.12
P11	The teaching approaches used in this class would be characterised by innovation and variety	211	3	11	61	69	67	3.88	.97
P12	Seating in this class would be arranged in the same way each week	212	52	30	64	28	38	2.86	1.40
P13	The teacher would often think of unusual activities	212	27	33	65	37	50	3.24	1.32
P14	I would do the same type of activities in every class	211	74	51	53	25	8	2.25	1.17
Student Cohesion									
P15	My class would be made up of individuals who don't know each other well	191	13	14	38	38	88	3.91	1.25
P16	I would know most students in this class by their first names	211	6	5	22	52	126	4.36	.96
P17	I would make friends easily in this class	212	11	18	26	41	116	4.10	1.21
P18	I would not get much of a chance to know my classmates	212	15	17	32	40	108	3.99	1.27
P19	It would take me a long time to get to know everybody by his/her name in this class	212	22	23	41	32	94	3.72	1.39
P20	I would the chance to know my classmates well	212	13	13	41	43	102	3.98	1.22
P21*	I would not be very interested in getting to know other students in this class	212	32	20	37	26	97	3.64	1.50

Task Orientation									
P22	I would know exactly what had to be done in the class	211	5	5	35	61	105	4.21	.96
P23	Getting a certain amount of work done would be important in the class	211	12	8	45	78	68	3.68	1.09
P24*	I would often get sidetracked in this class instead of sticking to the point	211	11	26	68	57	49	3.51	1.13
P25*	This class would always disorganised	210	27	14	27	40	102	3.48	1.42
P26	Class assignments would be clear and I would know what to do	211	11	11	24	54	111	4.15	1.14
P27*	This class would seldom start on time	211	36	41	42	42	51	3.14	1.42
P28	Activities in the class would be clearly and carefully planned	211	4	7	35	68	97	4.17	.97
Cooperation									
P29	I would cooperate with other students in my class when doing assignment work	211	7	10	36	70	88	4.05	1.04
P30	I would share my books and resources with other students when doing assignments	211	12	19	41	47	92	3.89	1.22
P31	I would work with other students on projects in the class	211	8	12	49	49	93	3.98	1.12
P32	I would learn from other students in the class	211	5	16	41	59	90	4.01	1.07
P33	I would work with other students in the class	211	3	10	40	58	100	4.15	.98
P34	I would cooperate with other students in my class on class activities	211	3	8	39	60	101	4.18	.96
P35	Students would work with me to achieve class goals	211	9	21	37	64	80	3.88	1.15
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	210	72	50	57	16	15	2.30	1.22
P37	I would generally be allowed to work at my own pace in this class	210	3	6	52	61	88	4.07	.95
P38	I would have a say in how class time is spent	211	8	16	71	57	59	3.68	1.08
P39	I would be allowed to choose activities and how I would work	211	10	14	68	54	65	3.71	1.12
P40	Teaching approaches in this class would allow me to proceed at my own pace	210	13	10	52	69	66	3.79	1.13
P41	I would have little opportunity to pursue my particular interests in the class	210	14	27	62	46	61	3.54	1.22
P42	My teacher would decide what I would do in this class	211	38	46	78	30	19	2.74	1.18

Equity									
P43	The teacher would give as much attention to my questions as to other students' questions	210	0	2	34	52	122	4.40	.79
P44	I would get the same amount of help from the teacher as do other students	210	1	3	26	56	124	4.42	.80
P45	I would be treated the same as other students in this class	210	2	3	23	44	138	4.49	.82
P46	I would receive the same encouragement from the teacher as other students do	210	1	2	19	55	133	4.51	.74
P47	I would get the same opportunity to answer questions as other students' do	210	2	6	18	60	124	4.42	.82
P48	My work would receive as much praise as other students' work	210	1	5	21	57	126	4.44	.81
P49	I would have the same amount of say in this class as other students	189	3	3	22	49	112	4.40	.87

Appendix 4C

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	A1	0.34	0.05	0.01	0.61	0.07	0.17	0.06
	A2	0.48	-0.01	0.26	0.50	0.07	0.17	0.02
	A3	0.57	0.01	0.05	0.53	0.08	0.12	0.09
	A4	0.56	-0.00	0.16	0.44	0.09	0.26	0.07
	A5	0.36	0.06	0.24	0.57	0.11	0.24	0.06
	A6	0.19	0.02	0.29	0.38	0.22	0.27	0.10
	A7	0.26	0.15	0.54	0.20	0.24	0.15	-0.06
Innovation	A8	0.08	-0.06	0.03	-0.21	0.27	-0.00	0.53
	A9	0.14	0.04	0.24	0.62	0.15	0.09	-0.24
See this	A10	0.68	0.21	0.08	0.76	0.05	0.04	-0.16
	A11	0.24	0.30	-0.21	0.58	0.13	-0.17	-0.08
	A12	0.03	0.06	-0.21	-0.16	-0.05	-0.32	0.43
	A13	-0.16	0.22	-0.11	0.51	0.03	0.05	0.02
	A14	0.00	-0.01	0.00	0.25	0.20	-0.18	0.01
Student Cohesion	A15	0.12	-0.02	0.69	0.00	0.04	0.08	-0.19
	A16	0.08	0.26	0.57	-0.01	0.08	-0.14	-0.17
	A17	0.20	0.40	0.64	0.04	0.05	0.10	-0.04
	A18	0.13	0.12	0.61	0.12	-0.11	-0.08	0.36
	A19	0.09	0.07	0.65	0.01	0.14	-0.06	0.25
	A20	0.15	0.20	0.69	0.16	0.00	0.06	-0.21
	A21	0.03	0.32	0.54	-0.02	0.03	0.04	0.13
Task Orientation	A22	0.28	0.06	0.21	0.29	0.54	0.12	-0.12
	A23	0.12	0.05	-0.18	0.00	0.68	0.05	-0.15
	A24	0.05	0.01	-0.02	0.11	0.59	-0.03	0.10
	A25	0.18	-0.02	0.35	0.27	0.52	-0.13	0.11
	A26	0.22	0.01	0.27	0.04	0.60	0.01	-0.00
	A27	0.03	0.08	0.10	0.12	0.39	0.15	0.13
	A28	0.30	0.04	0.13	0.30	0.46	-0.19	-0.13
Cooperation	A29	0.08	0.68	0.26	-0.07	0.25	0.06	0.01
	A30	0.15	0.65	0.00	-0.01	-0.03	0.09	-0.17
	A31	0.03	0.77	0.06	0.13	-0.00	0.07	-0.01
	A32	-0.00	0.64	0.06	0.16	-0.02	0.08	0.17
	A33	0.08	0.80	0.04	0.18	0.04	0.01	0.04
	A34	0.15	0.71	0.29	0.11	0.05	-0.04	-0.08
	A35	0.15	0.74	0.05	0.08	-0.01	0.02	-0.05
Individualisation	A36	-0.14	-0.02	-0.04	0.06	-0.13	-0.07	0.54
	A37	0.19	0.05	0.32	-0.00	0.05	0.54	0.05
	A38	0.05	0.15	-0.09	0.23	-0.04	0.68	-0.14
	A39	-0.05	0.14	-0.25	0.23	-0.03	0.61	-0.03
	A40	0.28	0.12	0.14	-0.09	0.05	0.56	0.21
	A41	0.06	-0.11	0.40	-0.00	0.26	0.32	-0.14
	A42	-0.28	-0.15	0.03	0.03	0.22	0.35	0.39
Equity	A43	0.78	0.04	0.05	0.20	0.09	0.11	-0.02
	A44	0.74	-0.02	0.11	0.14	0.05	-0.08	-0.07
	A45	0.71	0.10	0.20	-0.05	0.22	0.01	0.05
	A46	0.81	0.14	0.14	0.14	0.11	-0.05	0.00
	A47	0.76	0.12	0.20	0.01	0.11	0.00	-0.12
	A48	0.74	0.18	0.08	0.10	0.12	0.13	-0.06
	A49	0.72	0.26	0.00	0.00	0.21	0.08	-0.02

Appendix 4D

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	P1	0.11	0.11	0.18	0.65	0.10	0.08	0.15
	P2	0.27	0.22	0.24	0.70	0.03	0.04	0.12
	P3	0.19	0.33	0.20	0.60	0.17	0.12	0.09
	P4	0.19	0.32	0.16	0.71	0.04	0.02	0.16
	P5	0.19	0.26	0.40	0.52	0.21	0.05	0.02
	P6	0.11	0.14	0.62	0.29	0.04	-0.00	0.03
	P7	0.14	0.14	-0.09	0.34	-0.00	0.410.	0.46
Innovation	P8	-0.00	-0.00	0.28	0.01	0.12	0.46	0.27
	P9	0.23	0.14	0.56	0.27	0.37	0.15	0.06
	P10	0.21	0.09	0.60	0.13	0.42	0.21	-0.05
	P11	0.18	0.07	0.63	0.12	0.36	0.22	-0.03
	P12	0.08	-0.00	-0.11	0.05	0.04	-0.12	0.36
	P13	0.10	-0.05	0.64	0.14	0.31	0.15	-0.12
	P14	-0.09	-0.10	-0.08	-0.14	-0.22	-0.03	-0.58
Student Cohesion	P15	0.05	0.12	0.32	0.08	-0.22	0.20	0.49
	P16	0.10	0.40	0.20	0.03	0.00	-0.07	0.34
	P17	0.30	0.18	0.62	0.08	-0.03	0.09	0.27
	P18	0.09	0.08	0.02	0.18	0.10	0.20	0.63
	P19	0.07	0.09	0.23	0.20	0.34	0.15	0.41
	P20	0.22	0.23	0.62	0.08	0.02	0.11	0.26
	P21	0.13	0.17	0.08	-0.04	-0.17	0.37	0.59
Task Orientation	P22	0.07	0.30	0.04	0.48	0.15	0.48	0.13
	P23	0.22	0.21	0.06	0.04	-0.24	0.41	-0.00
	P24	0.13	0.21	-0.13	0.09	0.32	0.53	0.14
	P25	-0.00	0.20	0.40	0.05	-0.15	0.59	0.16
	P26	0.16	0.21	0.11	0.26	0.13	0.55	0.12
	P27	-0.05	0.00	0.16	-0.00	0.00	0.58	-0.13
	P28	0.29	0.30	0.02	0.39	0.07	0.44	0.07
Cooperation	P29	0.77	0.24	0.12	0.20	0.02	0.07	0.16
	P30	0.77	0.12	0.01	0.17	0.02	0.09	-0.08
	P31	0.81	0.22	0.11	0.13	0.05	0.07	0.02
	P32	0.76	0.09	0.22	0.10	0.17	0.00	0.16
	P33	0.83	0.18	0.17	0.07	0.11	0.08	0.07
	P34	0.79	0.22	0.20	0.15	0.12	0.05	0.02
	P35	0.76	0.19	0.16	0.16	0.06	0.00	0.10
Individualisation	P36	-0.18	-0.27	0.04	-0.00	0.08	-0.03	0.37
	P37	0.14	0.26	0.05	0.25	0.47	0.23	-0.02
	P38	0.15	0.01	0.22	0.08	0.71	0.03	0.07
	P39	0.11	-0.00	0.17	0.10	0.80	-0.02	0.02
	P40	0.21	0.25	0.18	0.21	0.55	0.12	0.03
	P41	-0.02	0.11	0.08	-0.08	0.33	0.42	0.35
	P42	-0.13	-0.03	0.09	-0.05	0.49	-0.05	0.40
Equity	P43	0.13	0.56	0.20	0.31	0.14	0.34	-0.00
	P44	0.14	0.72	0.25	0.18	0.03	0.14	0.14
	P45	0.15	0.81	-0.00	0.10	-0.05	0.17	0.11
	P46	0.25	0.76	0.12	0.16	0.00	0.19	0.00
	P47	0.23	0.73	0.05	0.13	0.06	0.07	0.06
	P48	0.11	0.74	0.03	0.25	0.13	0.09	0.06
	P49	0.26	0.76	0.10	0.19	0.10	0.11	-0.04

Appendix 4E

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	P1	0.36	0.07	-0.05	0.51	0.00	0.09	0.44
	P2	0.50	-0.00	0.22	0.40	0.02	0.13	0.34
	P3	0.57	0.01	0.04	0.42	0.05	0.14	0.35
	P4	0.55	0.00	0.11	0.31	0.05	0.21	0.46
	P5	0.36	0.04	0.22	0.49	0.08	0.25	0.33
Innovation	P9	0.18	-0.01	0.27	0.66	0.20	0.11	-0.03
	P10	0.12	0.19	0.09	0.79	0.07	0.03	0.01
	P11	0.23	0.27	-0.17	0.60	0.19	-0.07	0.03
	P13	-0.15	0.18	-0.06	0.57	0.03	0.08	-0.02
Student Cohesion	P15	0.15	-0.06	0.69	0.02	0.06	0.07	-0.04
	P16	0.07	0.21	0.61	0.01	0.14	-0.08	-0.08
	P17	0.19	0.34	0.70	0.05	0.09	0.16	-0.00
	P18	0.12	0.07	0.64	0.06	-0.14	-0.08	0.21
	A19	0.06	0.03	0.65	-0.04	0.10	-0.05	0.31
	A20	0.17	0.13	0.73	0.21	0.06	0.11	-0.15
	A21	0.03	0.31	0.55	-0.06	0.01	0.02	0.10
Task Orientation	A22	0.28	0.06	0.20	0.00	0.55	0.15	0.05
	A23	0.10	0.05	-0.17	0.01	0.70	0.06	0.06
	A24	0.06	0.01	-0.03	0.11	0.55	-0.06	0.03
	A25	0.17	-0.02	0.31	0.18	0.48	-0.17	0.36
	A26	0.19	-0.02	0.29	0.04	0.62	0.06	0.09
	A27	0.00	0.11	0.04	0.00	0.29	0.03	0.57
	A28	0.28	-0.00	0.17	0.30	0.55	-0.07	0.00
Cooperation	A29	0.03	0.66	0.29	-0.08	0.27	0.11	0.12
	A30	0.17	0.66	0.02	0.01	0.00	0.10	-0.15
	A31	0.04	0.76	0.09	0.14	-0.00	0.08	0.01
	A32	-0.00	0.66	0.06	0.11	-0.10	0.03	0.27
	A33	0.07	0.81	0.06	0.16	0.00	-0.00	0.18
	A34	0.16	0.72	0.30	0.13	0.06	-0.07	0.00
	A35	0.16	0.73	0.10	0.13	0.01	0.07	-0.15
Individualisation	A37	0.15	0.04	0.29	-0.10	0.03	0.52	0.33
	A38	0.05	0.10	-0.02	0.30	-0.02	0.73	-0.12
	A39	-0.06	0.09	-0.19	0.26	-0.01	0.69	-0.06
	A40	0.21	0.08	0.15	-0.14	0.05	0.62	0.21
Equity	A43	0.78	0.05	0.04	0.13	0.09	0.12	0.14
	A44	0.77	-0.02	0.12	0.14	0.06	-0.08	-0.07
	A45	0.70	0.10	0.19	-0.07	0.21	-0.01	0.08
	A46	0.82	0.15	0.14	0.11	0.12	-0.06	0.05
	A47	0.79	0.12	0.20	0.00	0.14	0.00	-0.05
	A48	0.75	0.17	0.09	-0.09	0.15	0.15	-0.04
	A49	0.70	0.15	0.01	0.04	0.25	0.14	0.04

Appendix 4F

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

Scale	Item	I	II	III	IV	V	VI	VII
Personalisation	P1	0.19	0.11	0.15	0.66	0.13	0.12	0.06
	P2	0.28	0.22	0.21	0.74	0.13	0.00	0.04
	P3	0.19	0.32	0.17	0.60	0.11	0.20	0.10
	P4	0.18	0.33	0.10	0.70	0.18	0.10	-0.01
	P5	0.19	0.26	0.39	0.53	0.09	0.19	0.03
Innovation	P9	0.22	0.15	0.65	0.31	0.08	0.25	0.09
	P10	0.19	0.12	0.74	0.14	0.00	0.28	0.11
	P11	0.18	0.18	0.70	0.14	0.06	0.25	0.17
	P13	0.11	-0.00	0.74	0.15	-0.08	0.14	0.10
Student Cohesion	P15	0.06	0.09	0.15	0.11	0.64	-0.07	0.09
	P16	0.10	0.40	0.14	0.06	0.37	0.05	-0.21
	P17	0.29	0.17	0.52	0.08	0.49	0.01	-0.00
	P18	0.05	0.03	-0.08	0.20	0.60	0.24	0.09
	P19	0.05	0.04	-0.01	0.19	0.65	-0.10	0.03
	P20	0.21	0.23	0.51	0.06	0.48	0.12	0.00
	P21	0.11	0.14	-0.04	-0.04	0.79	0.01	0.27
Task Orientation	P22	0.03	0.30	0.09	0.43	0.23	0.28	0.39
	P23	0.24	0.19	-0.05	0.05	0.14	-0.14	0.50
	P24	0.10	0.22	-0.02	0.05	0.07	0.39	0.54
	P25	-0.01	0.21	0.37	0.05	0.35	-0.12	0.56
	P26	0.12	0.19	0.11	0.24	0.28	0.27	0.49
	P27	-0.06	0.01	0.23	-0.01	-0.17	-0.00	0.61
	P28	0.27	0.29	0.04	0.42	0.13	0.10	0.43
Cooperation	P29	0.76	0.24	0.08	0.20	0.20	0.09	0.04
	P30	0.78	0.11	0.00	0.17	-0.04	0.05	0.15
	P31	0.82	0.21	0.10	0.15	0.03	0.04	0.09
	P32	0.75	0.09	0.23	0.09	0.16	0.18	-0.03
	P33	0.82	0.17	0.17	0.08	0.11	0.14	0.06
	P34	0.79	022	0.21	0.16	0.05	0.11	0.04
	P35	0.76	0.19	0.16	0.15	0.12	0.08	0.00
Individualisation	P37	0.11	0.26	0.09	0.18	0.03	0.60	0.18
	P38	0.13	-0.00	0.26	0.06	0.03	0.75	-0.04
	P39	0.09	-0.02	0.26	0.08	-0.08	0.81	-0.06
	P40	0.20	0.25	0.23	0.19	0.01	0.57	0.07
Equity	P43	0.13	0.56	0.21	0.32	0.07	0.15	0.31
	P44	0.15	0.71	0.23	0.21	0.20	0.01	0.10
	P45	0.16	0.81	-0.04	0.11	0.14	-0.02	0.18
	P46	0.26	0.75	0.09	0.19	0.10	0.01	0.17
	P47	0.22	0.74	0.04	0.09	0.08	0.12	0.08
	P48	0.11	0.75	0.04	0.23	0.04	0.16	0.08
	P49	0.26	0.76	0.09	0.18	0.01	0.12	0.12

Appendix 4G

Loadings on Six Components of the Reduced Actual CUCEI without Personalisation (Varimax Rotation)

Scale	Item	I	II	III	IV	V	VI
Innovation	A9	0.20	-0.01	0.27	0.18	0.68	0.11
	A10	0.13	0.19	0.10	0.08	0.78	0.04
	A11	0.24	0.25	-0.15	0.19	0.61	-0.05
	A13	-0.12	0.16	-0.06	0.01	0.63	0.10
Student Cohesion	A15	0.14	-0.04	0.67	0.06	-0.01	0.06
	A16	0.08	0.21	0.60	0.11	0.00	-0.11
	A17	0.18	0.35	0.68	0.09	0.03	0.16
	A18	0.12	0.06	0.67	-0.07	0.07	-0.01
	A19	0.05	0.02	0.68	0.19	-0.04	0.00
	A20	0.18	0.13	0.71	0.02	0.21	0.10
	A21	0.02	0.30	0.56	0.06	-0.07	0.04
Task Orientation	A22	0.27	0.07	0.17	0.55	-0.02	0.11
	A23	0.11	0.05	-0.20	0.69	0.00	0.03
	A24	0.07	0.01	-0.05	0.54	0.10	-0.07
	A25	0.18	-0.03	0.33	0.57	0.18	-0.12
	A26	0.20	-0.03	0.27	0.62	0.04	0.05
	A27	0.00	0.09	0.09	0.45	0.01	0.13
	A28	0.30	-0.02	0.16	0.52	0.32	-0.08
Cooperation	A29	0.03	0.66	0.28	0.29	-0.09	0.10
	A30	0.17	0.67	0.00	-0.03	0.01	0.07
	A31	0.04	0.76	0.08	0.00	0.14	0.08
	A32	-0.02	0.67	0.08	-0.00	0.09	0.07
	A33	0.07	0.81	0.07	0.06	0.15	0.02
	A34	0.17	0.72	0.29	0.06	0.13	-0.08
	A35	0.17	0.74	0.08	-0.02	0.13	0.04
Individualisation	A37	0.12	0.06	0.30	0.14	-0.13	0.55
	A38	0.06	0.09	-0.04	-0.06	0.33	0.72
	A39	-0.06	0.08	-0.21	-0.04	0.27	0.68
	A40	0.20	0.07	0.16	0.10	-0.14	0.65
Equity	A43	0.77	0.05	0.05	0.13	0.11	0.14
	A44	0.79	-0.03	0.12	0.02	0.15	-0.06
	A45	0.72	0.07	0.21	0.21	-0.04	0.03
	A46	0.83	0.14	0.15	0.13	0.10	-0.04
	A47	0.79	0.11	0.19	0.12	0.00	0.01
	A48	0.77	0.15	0.09	0.12	0.10	0.17
	A49	0.71	0.24	0.01	0.25	-0.04	0.16

Appendix 4H

Loadings on Six Components of the Reduced Preferred CUCEI without Personalisation (Varimax Rotation)

Scale	Item	I	II	III	IV	V	VI
Innovation	P9	0.24	0.21	0.67	0.11	0.30	0.08
	P10	0.19	0.14	0.75	0.00	0.29	0.09
	P11	0.18	0.09	0.71	0.06	0.26	0.17
	P13	0.11	0.02	0.76	-0.08	0.16	0.11
Student Cohesion	P15	0.07	0.10	0.15	0.65	-0.06	0.09
	P16	0.10	0.40	0.13	0.36	0.05	-0.22
	P17	0.30	0.16	0.54	0.47	-0.00	-0.01
	P18	0.06	0.07	-0.06	0.62	0.27	0.08
	P19	0.07	0.08	0.01	0.67	-0.80	0.04
	P20	0.21	0.21	0.52	0.46	0.10	-0.00
	P21	0.10	0.11	-0.04	0.69	-0.01	0.25
Task Orientation	P22	0.05	0.40	0.12	0.28	0.36	0.40
	P23	0.24	0.18	-0.07	0.15	-0.14	0.51
	P24	0.10	0.21	-0.01	0.06	0.36	0.54
	P25	-0.01	0.21	0.38	0.35	-0.13	0.54
	P26	0.12	0.25	0.14	0.31	0.30	0.48
	P27	-0.06	0.00	0.22	-0.02	-0.03	0.61
	P28	0.29	0.37	0.07	0.18	0.19	0.44
Cooperation	P29	0.77	0.26	0.09	0.21	0.11	0.04
	P30	0.79	0.14	0.00	-0.02	0.07	0.16
	P31	0.83	0.23	0.11	0.05	0.06	0.10
	P32	0.76	0.10	0.23	0.16	0.18	-0.03
	P33	0.82	0.17	0.19	0.10	0.12	0.06
	P34	0.80	0.23	0.22	0.05	0.12	0.05
	P35	0.77	0.20	0.16	0.12	0.08	0.01
Individualisation	P37	0.12	0.29	0.11	0.04	0.61	0.17
	P38	0.14	-0.00	0.25	0.03	0.75	-0.05
	P39	0.10	-0.02	0.27	-0.08	0.80	-0.07
	P40	0.21	0.27	0.25	0.01	0.59	0.07
Equity	P43	0.14	0.62	0.22	0.11	0.20	0.30
	P44	0.16	0.74	0.24	0.22	0.04	0.08
	P45	0.16	0.82	-0.03	0.15	-0.02	0.15
	P46	0.27	0.77	0.10	0.12	0.02	0.16
	P47	0.23	0.73	0.04	0.08	0.09	0.06
	P48	0.13	0.77	0.06	0.04	0.15	0.09
	P49	0.27	0.77	0.10	0.02	0.13	0.11