EQUITY IN THE TERTIARY PROGRAMMING LEARNING ENVIRONMENT

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Research shows that the computing learning environment has not always been equitable for female students. In addition, it has been reported that the number of females enrolled in tertiary computing courses is low compared with males and retention is poor. In recent years New Zealand educational institutions have experienced an increased enrolment of 'new arrivals' - students of diverse nationalities, culture and educational backgrounds. The New Zealand government is encouraging the expansion of education 'exports' and yet little is known as how new arrival students, studying programming at tertiary institutions, perceive their learning environment.

This paper reports on research which examines how equity is perceived by these student subgroups. It is an outcome of a work-in-progress study, using a mixed-method design, that investigates first-year programming students' perceptions of their tertiary learning environment. Quantitative results showed that compared with New Zealand males and new arrival females, New Zealand females and new arrival males prefer a more equitable learning environment to the one that they actually experienced. However results from student interviews revealed differences amongst the student subgroups defined as gender and new arrivals indicating that there were areas of dissatisfaction not obvious from the quantitative data.

The focus of this work-in-progress paper is on the Equity component of the overall study and reports the results of quantitative and qualitative data. The concept of equity is one that concerns issues of justice and may at times demand inequality in order for some groups to have an even chance (Secada, 1989). Quantitative data was obtained from 125 sets of the Actual and Preferred forms of the College and University Classroom Environment Inventory (CUCEI) and qualitative data from 28 student interviews.

BACKGROUND

Equity issues for females studying computer science at the tertiary level, has been the focus of significant research in recent years (Bernstein, 1994; Grundy, 1996; Zuga, 1999). Areas of concern are the low participation and retention rates of females, sometimes attributed to prevailing teaching attitudes and practices which many women find are not conducive to their learning. Information technology and information systems courses have similar problems (McLennan, Young, Johnson, & Clemes, 1999; Ryba & Selby, 1995). Further confirmation of gender inequities was provided by the findings of in-depth interviews of 20 women working in the computing industry in Wellington, New Zealand. The women who had learned programming from tertiary institutions commented on the lack of women lecturers taking computing courses, the poor standard of lecturing, key concepts not being taught and assumptions made of their prior knowledge which they felt females, in particular, did not have. They also considered that lecturers were basing their teaching on the abilities and interests of the male students (Crump & Logan, 2000).
A related issue of significance relates to equity in the learning environment for the increasing numbers of international and immigrant students. Australia and New Zealand are among countries focusing marketing efforts on attracting international students (Burns, 1991) as they are proving to be making a significant, positive economic impact (Bartlett, 2001). Many institutions are experiencing an increase in students who have recently immigrated. For many of these students, being in New Zealand will be their first experience of living and studying in a foreign country with a culture, and often language, different from their own. They will very likely be a minority group (as will the females) and therefore the learning environment in the computing classroom will be experienced from a multi-cultural and crosscultural perspective.

An anthropological perspective that contextualises learning in a cultural milieu for science education has been posited by Cobern and Aikenhead (1998). They discuss literature on multicultural and crosscultural science education where students have "studied in non-Western countries or in indigenous societies, or with students who comprised minority groups within Western countries (i.e., groups under-represented in the professions of science and technology)" (p.40). Research of the experiences of these student groups has found that they have more problems and experience them to a more serious degree than students of the home country (Mullins, Quintrell, & Hancock, 1995)

These findings have relevance for students of programming who also study within a "cultural milieu"; in this case, the subculture of computing. The computing subculture is one that has been variously noted as strange, competitive, individualistic, idiosyncratic and alienating (Rasmussen & Hapnes, 1991). The subculture (Schofield, 1995; Schofield, 1995) has a powerful influence on both work and learning environments. The shared beliefs, values and norms to which the individual members of a group conform, or the way we do things may be overt or covert, written or unwritten, vocalised or invisible. They are, as (Taylor, 1996) says, extremely powerful. Females and new arrivals are minority groups and if they fall below a "critical mass" of 33 percent, will be more likely to experience a learning environment which is not as supportive as it is for the majority group (Byrne, 1993). New Zealand females and new arrivals will study within the computing subculture as minority groups with the new arrivals subgroup also facing adjustment to a new country. Each subgroup will be coping with their own "border crossings" (Cobern & Aikenhead, 1998) into the computing subculture.

Substantial research has been undertaken over many years into conditions and perceptions of classroom environment. The socio-psychological environment which is experienced by groups and subgroups can be very different (Moos, 1975) and has been found to be an important factor in learning (Diekhoff & Wigginton, 1988). Factors contributing to classroom environment include the atmosphere, tone, ethos or ambience of a classroom (Fraser, 1994), teacher-students and student-student relationships (Fisher & Fraser, 1991), as well as the equipment and activities within which students are engaged (Ellett, Loup, & Chauvin, 1991). It has been established that a positive educational environment is influential in student achievement and attitudes (Goh, 1994) with research over the last four decades focusing largely at the primary and secondary level. Little has been done at the tertiary level (Fisher, Henderson, & Fraser, 1995; Wubbels & Levy, 1997) and yet for students studying in these institutions, the environment is as important as for those in the earlier years of education.

The College and University Classroom Environment Inventory (CUCEI)

A survey questionnaire, the CUCEI, was used in my research to obtain quantitative data on how programming students perceive their learning environment. It was developed specifically for use with small classes of approximately 30 students in senior secondary and
tertiary education (Fraser, Treagust, & Dennis, 1986) and has recently been modified and personalised (Nair & Fisher, 2000). The form is designed with both a student and instructor version for assessing the actual and preferred environment. The actual version measures the participants' actual perceptions of their classroom learning environment whereas the preferred form measures the students' preferred perceptions of their learning environments. Both versions of the CUCEI have seven scales with a total of 49 items. The scales are Personalisation, Innovation, Student Cohesiveness, Task Orientation, Individualisation, Cooperation and Equity. Response alternatives have a five-point rating scale of Almost Never, Seldom, Sometimes, Often, Almost Always.

The research project

Informed by the relevant research on equity, the computing subculture and students studying in a foreign land, I am concerned that women and students coming to study in New Zealand from another country (defined as the category new arrivals) be not marginalised in their computing learning environments. The objectives of my study are to

- investigate students' perceptions of their programming learning environment
- investigate how the student subgroups defined by gender and as new arrivals perceive their programming learning environment
- contribute to the growing body of knowledge on students studying in an overseas country

The overall contribution this research will make is in understanding the tertiary laboratory and classroom programming learning environment. Evidence to date has indicated it has been a "chilly" environment for females (Bradley, 1998; Nightingale, 1995; Ryba & Selby, 1995b; Toynbee, 1993) but there is little known as to the perceptions of new arrivals. Results could inform administrators and teachers of how this subgroup perceive the programming learning environment and be useful in formulating courses that may ease the transition from their own culture to the new learning culture.

METHOD

Both quantitative and qualitative data were collected using the CUCEI and student interviews respectively. The CUCEI provides a means of broad-based measurement as well as forming the basis for questions of the semi-structured interviews of students and lecturers. The interviews provide detailed, "thick" description (Patton, 1990) of students' reflections about the learning environment offering more detailed insights into students' experiences. Adoption of the "interpretative and feminist approaches" where the importance of understanding the overall text of a conversation and more broadly, the importance of seeing meaning in context (Rubin & Rubin, 1995) permitted understanding of the students' experiences and views. I describe the data collection and analysis approaches in the following sections.

Sample Description

Students studying first year programming at three Wellington tertiary institutions were invited to participate in the study. The computing qualifications for which these students were studying varied from a one-year certificate, a two-year diploma to a three year degree.

A sample of 239 students completed the CUCEI forms but for the purpose of this paper a student sample of 125 provided paired data from the two forms of the CUCEI (Actual and Preferred). The Actual and Preferred forms were completed by students at different times.
resulting in a smaller sample responding to both instruments due to the high absenteeism rate.

A purposive sample (or judgment sample) (Frankfort-Nachmias & Nachmias, 1996) was selected, based on the categories of gender and new arrivals. The focus of analysis is on these subgroups. Of the 36 students selected, a final sample of 28 attended the interviews, which were held in the last semester of their first year of study. Table 1 below depicts the structure and numbers of interviewees.

Table 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Institute</th>
<th>Interviews</th>
<th>CUCEI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>New arrivals</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total new arrivals</td>
<td></td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>New Zealanders</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total New Zealanders</td>
<td></td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

The CUCEI

The CUCEI was administered over a period of four weeks in the latter part of the second semester. After being introduced to students by the lecturer, I briefly explained the purpose of my study, explained the format of the CUCEI and asked for their cooperation in responding to it. I waited whilst students filled in the form and occasionally provided clarification. The computer program SPSS was used for analysing the data and output provided the basis for the figures and tables of the next section of this report.

Interviews

The majority of the semi-structured group interviews were with two or three people at a venue at their institution. All participants agreed to the interview being audio-taped and
assurance was given that the transcriptions would be done by the researcher personally with pseudonyms used to preserve confidentiality.

Interview questions were mostly open-ended and developed around the factors contributing to classroom environment (described in the Introduction section). All participants were asked the same questions, in approximately the same order. They were not necessarily identical in phrasing but were in intent. My intention was to allow for "emergence" (Glaser, 1992) and permit flexibility for individual voices and "ways of knowing" (Belenky, Clinch, Goldberger, & Tarule, 1986) to be expressed and heard and yet to remain focused on the aspects of the learning environment covered by the CUCEI as mentioned above. The interviews lasted between 30 and 70 minutes.

Analysis

The transcripts from the interviews provided a full record of what each interviewee said. A more complete understanding of the true meanings and voices intended by the interviewees was enabled through analysing a complete and full record of the dialogue and conversation of the meetings. This increased the validity of constructs and inquiry results as well as providing new perspectives of frameworks.

The challenges of analysing a large volume of semi-structured and unstructured qualitative data was assisted through the use of the computer program, NUD*IST (Non-numerical Unstructured Data * Indexing Searching and Theorizing). As with many other computer programs, NUD*IST provides ease of data management, support and flexibility that would be more difficult with manual processes. The necessity for engagement in the qualitative analysis was not removed from my control but rather enhanced by the possibilities afforded through the program.

Before commencing coding of the transcripts I created an organisational hierarchical index tree structure of categories, subcategories, sub-subcategories, etc. The statistical data became a major category as did the scales of the CUCEI. However some questions and responses raised other issues and these became additional categories and sub-categories. When a new idea, event, interaction or incident which was distinct and palpable emerged, I considered it and created a name for that category, taking cognizance of the meaning I was attributing to the category. Sometimes the 'chunk' suited a subcategory or a sub-subcategory which related to and "dimensionalized" (Gahan & Hannibal, 1998) the category. The naming of a subcategory crystallises thinking. For instance the category Equity was further informed and a wider dimension of examination afforded by the subcategories of Age Difference, Racism, Minority, Stereotypes, Male Aptitude and Favouritism.

The Minority sub-category was further informed by the sub-sub-categories of Gender and New Arrivals.

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

RESULTS

Figure 1 below shows the mean profile for the Equity scale for both Actual and Preferred forms of the CUCEI. The total possible response score is 35 for the seven items. The new arrival males generally perceived Equity in their Actual environment less favourably than the
other subgroups and the mean score for their Preferred Equity environment was also lower. This is supported by comments made by the new arrival males which are discussed later. Results for the New Zealand males (Actual and Preferred environments) were very similar. New arrival females, had a lower mean score for their Preferred environment than their Actual, suggesting that on average, they are very satisfied with Equity.

*Figure 1. Mean profile for the Equity scale in the Actual and Preferred forms of the CUCEI for all student subgroups in programming tertiary classes*

The mean profiles for the seven statements for the Equity scale of the CUCEI for the student subgroups are shown below in Figures 2 and 3. The seven statements of the Actual form are:

Q.43 The instructor gives as much attention to my questions as to other students' questions.

Q.44 I get the same amount of help from the instructor as do other students.

Q.45 I am treated the same as other students in this class.

Q.46 I receive the same encouragement from the instructor as do other students.

Q.47 I get the same opportunity to answer questions as other students.

Q.48 My work receives as much praise as other students' work.
Q.49 I have the same amount of say in this class as other students.

Students circle the response alternatives 1-5 (Almost Never to Almost Always), with the mid-point being three. For the Preferred form, the content is the same but statements are phrased "I would prefer ..."

Figure 2 shows that the new arrival male students perceived their Actual Equity environment less favourably on every item than the other three groups, particularly in Q.44-49. Although they believed their lecturers gave as much attention to their questions as to other students’ questions (Q.43 mean 3.89), the mean for Q.48 (praise) was the lowest, 3.26. The mean scores for the other three subgroups are similar over all items. New arrival females were the most positive on all questions with the exception of Q.44. The New Zealand students reported experiencing their actual environment similarly. The relationships of the subgroups between questions are similar; for example, all groups have a lower mean score for question 44 and all groups have a higher mean score for question 45 (see comments re favouritism in the Interview section).

*Figure 2*. Mean profile for the seven questions in the Equity scale in the Actual form of the CUCEI for students in programming tertiary classes
Figure 3 below reports the mean profile for the seven Equity questions of the Preferred form of the CUCEI for all the four student subgroups. It can be seen that generally, New Zealand and new arrival females prefer a more equitable environment than males with New Zealand females having the highest preference on all questions compared with the other three subgroups. New arrival females do not have as high a preference for instructor encouragement (Q.46) as New Zealand females and New Zealand males. New arrival males, on average, had the lowest preferred mean scores for all but one question (Q.44).

Overall, the means are slightly higher for the Preferred environment compared with what students perceived they experienced in their Actual classrooms. The difference between the
Actual and Preferred means for New Zealand males is very small (ranging from -0.13 to 0.20, Table 2). Larger differences were reported for New Zealand females and new arrival males on Q.44 (0.48 and 0.58 respectively). This related to receiving the same amount of help from the instructor as other students. New arrival males also had the two highest means difference scores (Table 2) for questions relating to the instructor's response to their questions (Q.43) and the amount of say in the class Q.47).

*Figure 3*. Mean profile for the seven Equity questions in the Preferred form of the CUCEI for students in programming tertiary classes.
perceive their actual and preferred environments similarly with new arrival males showing
the largest differences for Q.44 and Q.48 (0.58). The spread in the standard deviations are
similar (.83 for NZ male and 'new arrival males, .8 for new arrival females) with a higher
spread for NZ females (.88).

Table 2

Means and Standard Deviations of Difference Scores for the Preferred and Actual Forms of
the Equity Scale Questions of the CUCEI for all Students in Programming Tertiary Classes

<table>
<thead>
<tr>
<th></th>
<th>Male New Zealand</th>
<th>Male New Arrival</th>
<th>Female New Zealand</th>
<th>Female New Arrival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
</tr>
<tr>
<td>Q.43</td>
<td>0.05</td>
<td>0.82</td>
<td>0.24</td>
<td>0.91</td>
</tr>
<tr>
<td>Q.44</td>
<td>-0.10</td>
<td>1.08</td>
<td>0.48</td>
<td>1.31</td>
</tr>
<tr>
<td>Q.45</td>
<td>-0.10</td>
<td>0.90</td>
<td>0.19</td>
<td>1.03</td>
</tr>
<tr>
<td>Q.46</td>
<td>0.05</td>
<td>1.13</td>
<td>0.33</td>
<td>1.20</td>
</tr>
<tr>
<td>Q.47</td>
<td>-0.13</td>
<td>0.81</td>
<td>0.16</td>
<td>1.15</td>
</tr>
<tr>
<td>Q.48</td>
<td>0.20</td>
<td>1.07</td>
<td>0.33</td>
<td>1.04</td>
</tr>
<tr>
<td>Q.49</td>
<td>-0.10</td>
<td>0.95</td>
<td>0.37</td>
<td>1.09</td>
</tr>
</tbody>
</table>
The very small difference between the Actual and Preferred means for the New Zealand male students was confirmed by the mostly positive comments in the interviews. Female New Zealanders and new arrival males had larger differences between Actual and Preferred forms for Q.44 which referred to the amount of help from the instructor. A better understanding was afforded by the interviews of the three women and two new arrival males from institute 3. Q.49 referring to the amount of say in the class showed the largest mean difference score of .67 for new arrival males. The interviews again enabled a better understanding of what was going on in the classroom for some of the members of this subgroup.

**Interviews**

Responses to interview questions were mostly congruent with the quantitative results with the majority of students agreeing their lecturers were helpful, encouraging and responsive to questions. However there were negative comments, the majority being made by the New Zealand females and new arrival males. Student responses are clustered around equity themes and the institution is identified by the number in parentheses.

*Male-oriented teaching and assumptions of prior knowledge*

Three New Zealand female students (from institute 3) were passionate in their angry descriptions of their learning environment. They believed the lecturer made unreasonable assumptions of their prior knowledge, he catered to male-oriented interests and was deficient in teaching skills, saying:

*He assumed; he assumed; he really had no idea where we were at ... we had no idea what they were for* (Patsy)

*The first VB [Visual Basic] project we had to do was massive, ABSOLUTELY MASSIVE [shouted] (Denise)*

*I think they have the wrong impression that people taking CBC [Certificate in Business Computing] know the basics of programming; we don't* (Ana)

*Because it was a male tutor everything seems to be male type things like how much fuel a car uses, soccer teams, rugby* (Patsy)

The one-hour interview with these three women was different in tone and emotion from all other interviews. They were angry that after nearly a year of study, they would not be able to write more than one or two lines of code, despite keen motivation and conscientious study. They criticised their lecturer's teaching style and skills, saying he "burbled on" and "kept repeating the same thing, using the same example". Students from the other two institutions did not comment on this aspect of equity.

*Classroom management - maturity, monopoly and favouritism*

Maturity was a significant positive factor for the older students but not always for the younger students. Clarissa, 1, a mature New Zealand female, when asked if she got a "fair go" said:
quite happy with it. The mature students are more likely to grab the tutor when he walks in the door so I think the young ones miss out quite a bit in our class; the mature ones would have a list of what they wanted and they'd be waiting and grab the lecturer.

Mani, 2, a younger, new arrival female, felt positive about her mature classmates, saying her minority status didn't affect me that much; most of the students are mixed cultures so I could fit into them especially original Kiwi people didn't care I was from another country. I found it very easy to talk to them because most of them were mature students so we could have a meaningful conversation without talking rubbish

whereas Ritu, 1, found most of the Kiwis [New Zealand students] "were very young kids with different interests".

A new arrival male, 2, (successful at programming) felt he got a fair go but thought this was because the lecturer tended to spend more time with the "good students". Other students noticed incidents of favouritism, saying:

- Really, individuals were favoured; the ones who had the gift of the gab ... some of us out here are really working hard for everything we get and I'm not taking anything away from those ones but things went wrong for them and suddenly they got that extra help (Rachel, 1, New Zealand female)

- There are a few students that had a good relationship with the teacher and they go to them because the teacher is ready to spend two hours really really helping them; sitting next to them, typing in the code; I saw it. (Ian, New Zealand male, 2)

- Teacher not very friendly; he stands at the back but he didn't help me; he talks to some Kiwi (Ken, new arrival male, 3)

- I feel the same; we give up (Wen, new arrival male, 3)

There were many positive comments about classroom management, with Sanuko, new arrival female, 2) observing:

- The tutor was so good because when you raised your hand he always acknowledged us and always divide some time and always make sure to go to everyone and so he always covered all the class

Institutional

Issues relating to policy and institutional support were commented on negatively by seven students. The three New Zealand women from institute 3, who had experienced a very negative environment believed their lecturer should have had more support in the way of teacher training and time allowance for preparing new course materials when the programming language was changed.

Three New Zealand males from institute 2 commented unfavourably on what they thought was an over-emphasis on programming in the first year, resulting in less time for networking
and data communications. Two new arrival males (institutions 1 and 3) and a New Zealand male, 2, believed that enrolment criteria is too low. Khalim (new arrival male, 1) said:

"management will not accept only good students; they take anyone so it's money; 1/3rd drop out, 1/3rd fail and 1/3rd pass"

Racism and minority status

Women were asked how they felt about being the minority gender in the classroom and the new arrivals were asked "Have people treated you differently because you are from another country?" Sometimes I probed more bluntly by asking "Have you experienced any racism?"

With the exception of the two young Chinese males (Ken, 3, and Wen, 3) they all reported positively to the minority question. Most of the new arrival sub group are mature students, joining classes where the majority of students (with the exception of one programme in one institution) are over 25 years of age. Some of them had studied abroad previously, some of the younger students had very positive attitudes, mostly experiencing supportive environments. Comments were:

Not a problem; my background I did Masters in Agriculture in Russia ... I'm used to it (Ritu, 1)

Very comfortable (Sanuko, 2)

Yes, it didn't affect my learning but I wonder why less ladies here (Ranjine, 2)

The positive attitude of students in this subgroup, being willing to participate in a new culture possibly contributed to these pleasing and surprising responses. Ming, 2, said:

It was easy because I also want to understand what makes their culture and sometime I find some chance to talk with them but if I don't then noone would talk.

All new arrivals with the exception of one female, said they had not experienced discrimination or racism. Two male new arrivals were surprised at the question with Khalim, 1, saying:

I'm from Egypt; I'm not a minority. We are the original.

When asked what he meant by this he explained that the Egyptian civilization was centuries older than New Zealand's and compared with his country's history, achievements and culture it didn't occur to him that New Zealanders might consider themselves superior to someone coming from that background.

Ritu, 1, had experienced "certain instances, certain looks; minor, but it didn't affect my learning". Perhaps because she was a mature student who had lived abroad before, she was better able to ignore the implied racism.

Another factor which possibly contributes to the low level of racism these students say they experienced is the location of the tertiary institutes. Wellington is New Zealand's capital city with a large multicultural population. It is possible that overseas students attending institutions in other cities in New Zealand would not find a similar situation.


**Language**

Language was a problem for some new arrival students studying in an English environment and also communicating with each other when working together in study groups. Lui (new arrival female, 1) came from China and found difficulty, saying:

*I have two Hong Kong classmates; problem was a problem of language*

The loneliness of arriving in a new country and coping with a strange culture, difficulty with the language, as well as the computing subculture was experienced by two young Chinese male students. They said:

*I have no kiwi friends (Ken, 3)*

Yeah but always just face to face with computer and you talk to someone and they say ok, you can just do yourself. Not really student help (Wen, 3)

**Course content**

The following negative comments relate to the lack of extension work, an objection to the "monkey see, monkey do" approach to teaching and a lecturer who "takes over the keyboard".

There's no programming on putting a button on - any child can do it ... what the hell it's like teaching babies; they didn't teach me; they give me a handout book if I put it aside I will not be able to do it again (Khalim, male new arrival, 1)

*I personally would have preferred a step further but it was good in terms of the scope of the course* (James male New Zealand, 1)

Disadvantage was it didn't cater for accelerated learning; the tutors were happy to assist with more advanced stuff when they were free (Mike, 3)

**Student attitude**

The NZ male students and new arrival females mostly viewed Equity favourably, believing it was up to the individual to be treated fairly. Henry said:

*depends on yourself actually. Some students pretty slack; they often want somebody else to do it for them. If I solve it I get more experience, they don't know anything.*

Mike, 3, thought it was "a case of self-help" and Brent, 2, said help was available for "those who ask". The seemingly independent attitude of many of the male students contrasted with some of the female students who appeared to require (and in some cases, expect) more teacher help.

**Collaborative work**

Khalim, an Egyptian engineer and a successful mature programming student, resented continually helping students, saying:
I'm a student still so I'm not so creative to do more than four ideas ... so I'm helping students who are struggling; I'm giving him my ideas so when they hand in the work it looks suspiciously similar ...

**Delivery Mode: Lectures, class discussion and computing laboratories**

Lectures were mostly viewed negatively by all subgroups. The length of time as well as number of lectures, lack of interactivity, irrelevance and a preference for practical laboratory work were cited as reasons for finding lectures "boring" (Mani, new arrival female, 2) and "absolutely pointless" (Patsy, New Zealand female, 3). New Zealand male and female new arrival students attending institute 2 that gave lectures only once a week for the first half of the first semester were more positive, saying:

> yes, we could ask questions (Ranjine, new arrival female, 2)

> The lectures/labs mix worked quite well; especially our class and that's why 80% of the people are still there (Peter, New Zealand male, 2)

Practical laboratory work which provided "experience", "made us think" and were returned with helpful feedback were appreciated.

> the more you practice, the more errors you got the more you understand (Henry, New Zealand male, 1).

> Being able to do something practical; achieve set goals for example in each class; actually learn something; add two numbers and have output on the screen and you feel as though you've actually achieved something (Mike, New Zealand male, 3)

> Tutorials were good because we could ask questions with good answers; ... the lecturer made us think in a logical way; it helped me a lot (Mani, new arrival female, 2)

Students were intolerant of a lot of talking via lectures, generally comparing them unfavourably with the practical laboratory work. Students were very clear that they needed to work through the exercises to be able to understand programming concepts.

**A controlled (with freedom) and structured environment**

The majority of students valued a learning environment where they knew what they had to do and how to go about things. They appreciated the informal laboratory environment with the freedom for self-directed and self-controlled learning. Positive comments were:

> There isn't any unreasonable control over things we do; in fact there haven't been a lot of restrictions placed on us at all; it's pretty good (Clarissa, New Zealand female, 1)

> We have a very big respect for the teacher; in a way it's good because it makes you very free but sometimes it's bad because the teachers can't say anything(Ranjine, new arrival female, 1)
Ruby [lecturer] would put at the beginning of the week on the board what was going to be covered; if we needed to know something we’d turn up on that day; otherwise it was working on our own stuff; I got my money's worth. ...it's a little closer to my style ... I'm more an independent learner than a group learner (Peter, New Zealand male, 2)

If I wanted to do something I went off and did it; there was no problem (James, New Zealand male, 2)

I'm not a typical student as I generally work at my own pace and pick up things faster than other students (Michael, New Zealand male, 3)

We know what we have to do and by when (Ian, male New Zealand, 2)

However some new arrival students were negative:

Most of the time depend on myself; noone to help me (Ming, 1)

I think he talking by himself; I didn't understand (Ken, 3)

You have to call them five or six times and then they come to you and just do it; you can't see what he is doing; it's not good (Wen, 3)

DISCUSSION

The results of this study, as measured by the CUCEI, indicate that the majority of students perceived the equity of their Actual and Preferred environments as similar with the mean scores for the seven items of the Equity scale generally indicating student satisfaction with their learning environment. Two subgroups, New Zealand males and new arrival females indicated that they mostly perceived equity favourably. However the interviews revealed differences amongst the student subgroups and raised issues not covered by the items of the Equity scale. These issues related to teaching approaches and assumptions of prior knowledge, maturity as a variable impacting on equity, the role of institutional support in teaching, lack of language skills for new arrival students, course content and delivery mode of lessons.

For some New Zealand females who preferred a higher level of Equity there were issues of concern. The three women from institution 3 were vehement about the teaching approach which caters to male interests and assumptions of prior knowledge. They also commented on the poor institutional support provided to their lecturer. They felt alienated and suffered a loss of confidence in their abilities, despite passing the programming courses. The loss of self confidence has been noted in studies which have investigated the low participation and poor retention rates of women studying computer science in many Western countries including America (Margolis, Fisher, & Miller, 2001; Seymour & Hewitt, 1997), New Zealand (Brown, 1994; Ryba & Selby, 1995), Britain (Grundy, 1996) and Australia (Chambers & Clarke, 1990). The three women may have experienced a more equitable learning environment if there had been a diversity of approaches to teaching programming and an acceptance of "the validity of multiple ways of knowing and thinking, an epistemological pluralism" (Turkle & Papert, 1990).

The new arrival males reported the least equitable experiences. Some students of this subgroup were very dissatisfied with aspects of their personal relationships with their teacher, shown by the results of both quantitative and qualitative data. The interviews helped explain the lowest mean scores recorded by this subgroup for Q.43 and 47. Another area of
concern revealed through the interviews was the cooperative and collaborative way of working. A collaborative learning environment is widely believed to enable students to co-construct more powerful understandings than they could alone but this view oversimplifies important issues concerning the social structure of groups, the goals of individuals in groups and the diverse nature of knowledge construction. Too great a dependency on group assignments and tasks may create an inequitable environment for the capable students. For Khalim, this approach proved irksome and he resented the reliance of fellow students (and his teacher) on his helpful assistance. This approach is not always satisfactory or appropriate for all students and, as well, "may not be the best mode of learning for all educational aims" (Linn & Burbules, 1993). These results should be of concern to both lecturers and administrators if New Zealand is to build a reputation of learning excellence for new arrival students.

The importance of relevant practical laboratory work was a theme for all subgroups. This contrasted with comments regarding the lectures which many of the students considered did not address their learning concerns. Lectures, which addressed immediate lab work, were appreciated. Lectures, which were delivered by institute 2 for only the first part of the course replaced in later months by increased tutorial and practical lab sessions, were very popular. Gallagher (2000), notes that when the usefulness of learning becomes more evident, students understand and are able to apply knowledge.

The differences which students bring to a programming class mean that it is important for the lecturer to provide equal learning opportunities for all students. An awareness of the time spent with individuals, the need to balance the demands of the more assertive students with the quieter, retiring students as well as teaching approaches which include the whole class are necessary to ensure no one group or individual dominates the lecturer's time. The interviews gave insights from the viewpoint of some mature-aged students who noted the ability of the older students to sometimes monopolise lecturers' and lab assistants' time to the detriment of the younger students who did not have the same confidence in approaching the teachers.

Tertiary programming courses have a student population of diverse ages, ethnicity, computing experience and expectations. The results reported in this paper suggest a need for greater personalisation and individualisation in order to provide an equitable learning environment for the different student subgroups. This is no easy task but a first step is an acceptance of the validity of multiple ways of knowing and thinking.

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