Abstract
Female students are strongly under represented in courses offered by the School of Computing at Curtin University of Technology. Recruitment of female students becomes an issue not only under equity concerns, but because retention within the School is higher. This paper looks at a pilot study to construct a profile of a typical female Computing student at Curtin, both undergraduate and graduate, in particular with an indication of the timing of the decisions which led to their enrolment in these courses. Such a profile might allow the School of Computing to focus its PR and marketing to the appropriate groups/schools/ages.

Introduction
There has been much recent and ongoing discussion on the topic of the recruitment and retention of students from under represented groups in Science and Engineering courses.

Reports from universities around Australia presented at WIC’97\(^1\) indicate that Curtin University is of Technology less able to recruit females into computer science-type courses. Figures at numerous other universities hover around the 20% mark compared to Curtin’s 10 - 12%\(^2\).

However, based on School of Computing Annual Report statistics, student demographics\(^3\) suggest that while recruitment of females into School of Computing courses at Curtin University is poor, the retention rate is better. In addition, recruitment of females into graduate and post-graduate courses is higher than into undergraduate courses.

Background
The entrance requirements to undergraduate courses offered through the School of Computing at Curtin University include a good pass in Mathematics subjects. Calculus and Applicable Mathematics is the base requirement, but a good pass in just Applicable Mathematics may enable a student to enrol, with an additional mathematics component attached to the course.

There is no mathematics prerequisite to enrolling in graduate or post-graduate courses offered. Of course an implicit requirement exists for post-graduate courses in that an appropriate computing degree is a prerequisite.

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\(^1\)Women in Computing Workshop, Melbourne University July 1997.
\(^2\)Delegates were asked to collate student demographics - these were presented as a poster session during the Workshop.
\(^3\)See the appendix for a summary of these statistics, as presented at WIC’97.
Research into gender and mathematics (as, for example, that reported in Fennema 1996) suggests that even as recently as 1990, many females choose to limit their options at University by not studying mathematics during secondary school. The bottom line would seem to be that mathematics has not offered them a life they wish to lead (Fennema 1996 p 22), and that, even if it did, the embedding of mathematics learning in male contexts (Willis 1996 p 45), has negative influence on girls’ learning (Fennema 1996).

Even greater gender-typing would seem to exist when computing is brought into the equation, so that as early as Year 9 (14-15 years old), secondary students are associating computing, with mathematics, as belonging to a male domain - a contextual association is shown to exist between mathematics, physics and computing, so that a positive attitude towards the former two subjects relates to a positive attitude towards computer literacy, at least (Makrakis and Sawada 1996 p 228, 225).

The commonly held belief that computers are "built" from mathematical elements and concepts may also lead to the inference that a mathematical inclination is a necessity for working with computers (Makrakis and Sawada 1996 p 230). The entry requirements for School of Computing undergraduate courses at Curtin University do nothing to dispel this belief.

In terms of the outcomes of computing studies, research undertaken through Deakin University shows that the stereotype remains in force even after entry into Computer Science courses at University. Secondary students categorised computing careers as boring, menial and not sufficiently challenging, with the essential ingredient of "sitting in front of the computer all day" (Clarke and Teague 1996 p 243). Career prospects involved either programming/technical computing, or office work of the ilk of word processing.

University Computer Science students reinforced the stereotype of technical, male sex-typed and mathematical career paths, showed enormous preoccupation with programming as the dominant activity undertaken, and expressed a sense of isolation when developing programs (Clarke and Teague 1996 p 243). Note was made that there were few differences between female and male responses from the University students.

This stereotyping, distilled to that of a young, male hacker, and a female word processing operator, is further reinforced by parental attitude. A study of undergraduate college students found that males who believed their parents held a gender-typed view of computing had greater confidence and interest in computing than other male students. This view existed as a negative reinforcement in female students - where females believed their parents held the view of computing as a male domain, their confidence and interest was less than other female students. Both males and female students with parental encouragement showed greater self confidence, interest and awareness of the benefits of computing in their daily life (Shashaani 1997 p 44).

The parental view would seem to have even greater influence in the (what to) study-related decision making process, so that where success at a male gender-typed subject may be attributed to ability in a male, it is likely to be seen as an outcome of effort in the female, said to be debilitating to one’s self esteem and confidence (Shashaani 1997 p 47). The result of all these influences, coupled with females’ lack of perceived useful-
ness of computing (Clarke and Teague 1996 p 244), is that females are discouraged from entering computing fields at an early stage in their education. An additional factor is that the computing students see at secondary school has little commonality with tertiary level Computer Science courses. The suggestion has been made (Gale et al 1997 p 23) that, based on the secondary subjects offered, computing is seen as a ‘weak’ option. Females with strengths in the relevant subject areas prefer to target more ‘professional’ courses, such as medicine, law etc.

The Study

Purpose

Consideration of the literature, and discussions at such fora as WIC’97, would seem to indicate that co-ordinators of Computer Science courses should ask such questions as

- what type of female enrols in computer science-type courses
- when (especially when during secondary school) do female students choose/choose not to do computer science-type courses
- how well do students in secondary school understand what computer science is (eg, as opposed to computer literacy)
- what is the general perception of computing careers amongst females
- how aware are secondary school students of computer science-type courses

and, of course, a myriad of additional questions of this ilk.

As a first pass at obtaining answers to some of these questions, the purpose of this study, then, was to construct a profile of a typical female computer science student, both undergraduate and graduate, in particular with an indication of the study choices made, what influenced these choices and their timing.

This might allow the School of Computing to focus its PR and marketing to the appropriate groups/schools/ages, and allow the questions that need to target secondary students to be addressed. It is expected also to have some influence on the decisions that address the issue of making courses such as computing more attractive to females.

Method

A questionnaire was prepared and distributed to female students enrolled in core units (courses) in each of the years of the degree and graduate courses, and to post graduate students individually. Given the low representation of females in these courses, and the necessarily voluntary nature of their response, a large sample was not expected. However, it would seem most females chose to return the survey, although some of these could be considered minimalist in nature. Students enrolled in other degree programmes but enrolled in these units were also included.

A decision was made to structure the questionnaire in such a way that some cross matching could undertaken with a study that looks at student retention at Curtin (see the paper by M Burgum at this conference for insight into that study). This was not seen to be part of this work, but was based on a holistic approach to research on this subject.

While analysis of responses for the survey has not been completed, it is possible, at this stage, to commence compiling profiles for a set of virtual students. The profiles noted in this paper are compiled from responses from undergraduates in the BSc (Computer Science) or (GIS) and graduates enrolled in the GradDip (Computing) only.
The virtual undergraduate student

Our composite female undergraduate student exhibits the following traits:

• is fairly certain she has chosen the right course, and expects to complete it
• is not stressed about being a female student in the course - one student noted
  I have never had a problem associated with me being a female
  another said
  being in the minority has its advantages: you can get recognised early
• agrees that she belongs at Curtin and in the course
• is supported in her attendance at University and in the course by family and friends, but feels that faculty and staff of the University and School do not necessarily care about her personally
• is confident to (at least) some extent about her mathematics and computing skills, but more ambivalent about general skills such as writing ability, problem solving and study skills
• is happy to meet with faculty and staff outside a classroom situation, to socialise informally as well as to discuss course-related issues/problems, but is more likely to discuss course-related problems with another student
  male or female is essentially irrelevant
• is likely to have attended Government schooling, and
• decided to go to University during secondary school years 9-10, but chose to attend Curtin and enrol in this course later during secondary schooling, or after secondary school
• sees the course as quite useful for getting a really enjoyable job. One student noted
  many of the more common computing jobs seem less enjoyable. But the ones I
  would enjoy would be helped by the course
  and at least a great deal of use in getting a well paid job
• was not greatly influenced by, but did attend, University Open Days, Career Expos and the like
• lives with parents/relatives, and ranks her social life as making the great (if not the greatest) demands on her time during an average semester week
• is likely to be overseas born and/or not have English as her first language

The virtual graduate student

Our composite female graduate student exhibits the following traits:

• is likely to be less certain she has chosen the right course, but still expects to complete it
• is not stressed about being a female student in the course - one student noted
  being a mature aged female student cuts down the field of potential friends even more. However, this doesn’t bother me as it did as an undergraduate
• is very stressed about the amount of time required both for the course and for all the demands on her time, especially if studying full-time
• is more ambivalent about her sense of belonging, both at Curtin and in the course
• is supported in her attendance at University and in the course by family and feels that faculty and staff of the School are likely to care about her personally. One student commented

I have been reassured and greatly assisted by some Comp Sci staff - for which I am grateful

• is confident to (at least) some extent about her general skills such as writing ability, problem solving and study skills but more ambivalent about mathematics and computing skills
• is happy to meet with faculty and staff outside a classroom situation, to discuss course-related issues/problems, but is less likely to socialise informally with them. Academic staff are likely to be first choice for discussing course-related problems
• will have attended private, single sex secondary school, and
• decided to go to University during secondary school years 9-10
• is less sure that the course is useful for getting future employment, enjoyable, well paying or otherwise. A sentiment expressed in various ways was

I hope!

• lives with partner/children, and ranks family/household responsibilities as making both the greatest demands on her time and causing the most problems during an average semester week

In addition, our virtual graduate student is focused on the study side of being a student at Curtin, and is more likely to express concerns at the quality of the teaching she receives.

Caveat

Of course, it is accepted that many factors influence the responses made to a questionnaire such as that distributed as part of this study. Of primary importance is the captive nature of these students: at the time of distribution of the questionnaire (October/November 1997), they were still attending classes, still part of the student coterie of the School. How different are the profiles of first semester first year undergraduate and graduate students - those who have been recruited, but not yet retained - likely to be?

Given this caveat, the results of this survey are positive, and reflect the impression obtained through School of Computing student demographics that retention of students is less of a problem than recruitment.

Discussion

However, the issues of targeting recruitment efforts appropriately remains, in particular for undergraduate recruitment. While secondary school students confirm the impression that the decision to attend University is made early during secondary school (those who didn’t always know they would attend University, decided in years 9-10), what influences that decision, and the decision to enrol in the course, are unclear. Support from family and friends once the decision is made, is evident, as is the minimal influence of open days and school visits. This latter is supported
by the work of Gale (Gale et al 1997 p 22).

Students of the graduate course would appear to be less influenced by externals. As one student noted

I had given considerable thought to the choice of course and the choice of Uni. For me this represented a change of career, and the decision was not made lightly or without some research

While less sure about career options/paths available (maybe just a more realistic view of job prospects), graduate students indicate confidence in the class of skills seen as necessary by professional computing women:

- logical thinking and problem solving abilities
- communications skills, including listening, writing clearly and technically
- organisational and research skills (Clarke and Teague 1996 245).

Other skills highlighted by that study include creativity and ability to work as part of a team - skills often labelled as feminine.

Currently computer use is dominantly in the mathematics/science subjects of secondary school. Girls are already not doing these, so while exposure to computer use heightens the rating of their use (Shashaani 1997 p 38), female students lack that exposure. In addition, the dominance in secondary school of male computer co-ordinators and teachers diminishes the chances of improving the gender balance - there are just not enough female role models (Makrakis and Sawada 1996 p 230). Nancy Leveson, herself a noted role model in the field of computing states that white males benefit from the self-reinforcing concept that they 'belong'. On the other hand women and minorities have few role models of success, and often feel like outsiders (Leveson 1990 p 1). Yet women in computing are successful. Grades of female students in Shashaani’s studies show that, in spite of lack of confidence, the females performed "much better" in the course that the male students. Females are thus further hampered by the We can, I can’t paradox (Shashaani 1997 p 45,46). This is confirmed within the School of Computing. Given the low numbers of female students, prizes to females is disproportionally high.

Perhaps we need the female students that we have to go out and spread the word.

The professional women in Clarke and Teague’s study expressed their enjoyment of computing jobs for their variety, challenge, opportunity for working with others and for helping people (Clarke and Teague 1996 p 244). This fails to substantiate the stereotypes. However, what is significant is that there was a tendency for most of these women to enter computing after working in another career (Clarke and Teague 1996 p 244). Does this mean at a time when the factors that influence school leavers are no longer strong?

**Conclusion**

Obviously substantial analysis of the data collected by this survey is still required. It should be possible to gain a clearer picture of the factors that influe-
ence female student life within the School of Computing. In addition, many respondents have indicated interest in being included in a follow up interview. The problem remains, however, that this is a captive cohort of students. Future work may look at refining the questionnaire, and surveying first year students, preferably before the University-set withdrawal deadline. Follow up interviews with those students who, for whatever reasons, are not retained within the School would then provide information that should prove useful to recruitment efforts.

Outside the School, this study may add to the data being collected and evaluated on equity issues within the University.

However, this study was funded through the BEDES Project. All of these suggestions require support from the School, and funding.

References


Gale, Amy, Andreae, Peter, Biddle, Robert, Brown, Judy, and Tempero, Ewan (1997) *Computer Science retention and recruitment at VUW.* pp. 20-26 In WIC’97


Appendix

Student Intake - Course Statistics by Gender

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**PostGrad includes PostGradDip(CompSci), MSc(CompSci)-Thesis, MSc(CompSci)-Coursework**

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