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Mission (im-)possible? Increasing the participation of female students in university computing courses

Iwona Miliszewska
Victoria University

Anne Venables
Victoria University

Grace Tan
Victoria University

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Iwona Miliszewska[1], Anne Venables[2] and Grace Tan[3]

School of Computer Science and Mathematics
Victoria University, Australia
Iwona.Miliszewska@vu.edu.au

Abstract

In 1990 the Australian Federal government set a target for a 40% enrolment rate of females in all non-traditional areas of study including computer science. In view of this target, the low enrolment of females in computer science at Victoria University is a persisting concern: enrolment rates have continued to decline from 30% in the early 1990s to less than 20% in recent years, despite significant attempts to arrest the decline by introducing annual student recruitment events such as school visits, career nights, and University Open Days. This suggested that the issue of encouraging females to study computing needed to focus more directly on factors deterring females from pursuing computing courses.

Misperceptions about the nature of computing studies have long been regarded as such a factor. Accordingly, last year a different initiative was launched. Focusing on girls from the neighbouring high schools, it aimed to dispel the misperceptions, and encourage girls to pursue computing studies, by demonstrating how interesting, easy, and female-friendly computing is at Victoria University. The girls were invited to spend a day in the shoes of a computing student at the University by participating in specially designed classroom activities, interacting with female university students, and lunching at the student cafeteria. While the event proved a winner on the day, it remains to be seen if it will translate into improved female enrolments in the future.

However, the effort involved in organising the event and the difficulties encountered in the process revealed the extent and complexity of the struggle for increased participation of females in computing studies. The following questions arose: Who is interested in pursuing the cause? Who is prepared to support it? What would it take to make a change? This paper reflects on these issues.

INTRODUCTION

The low enrolment and poor retention of female students in computing courses has been a well recognized problem, both in Australia and overseas; the already low female enrolment numbers are usually further decimated by high attrition rates. This situation has been often attributed to gender differences in interests, motivation, experience, personality characteristics, abilities, self-efficacy and socialisation. These differences, which put females at a disadvantage in computing courses, stem from a variety of factors both external and internal to the institution offering the course. External factors include the popular perception of the male dominated computing culture, its particularly masculine character and, often, a 'geek' image. The internal factors include environmental aspects such as inadequate pedagogical techniques, stereotypical attitudes of lecturers, tutors and fellow students, as well as lack of role models and proper institutional support (Fisher 2003; Miliszewska & Horwood 2002; Newmarch, Taylor-Steele & Cumpston 2000; Nielsen, von Hellens & Wong 2001).

In view of such a bleak picture, how possibly could females be attracted to study computing, and how could they be encouraged? It is a complex issue, on which tertiary institutions can have only a limited influence. For tertiary institutions, one way to encourage females to study computing is to focus more directly on internal factors – perceived or real – that deter females from pursuing

computing studies; the focus should be on internal factors, as they are the ones under the control of the institution. Once the deterring factors have been identified, they can and should be addressed. Then the improved learning environment for computing studies can be with confidence portrayed as female-friendly and promoted as such to prospective female students.

THE ISSUE OF FEMALE PARTICIPATION IN COMPUTING COURSES

Problems and Barriers
Throughout the world, considerable attention has focused on participation of women in the sciences, and more specifically their poor representation in information technology (IT) courses. In the United States it has been reported that although the science and technical university courses do attract female students, these are courses in bioengineering, chemistry, math, and biology, but not in the information or computing sciences (Eney & Hoyer 2005). In Canada, where 59% of undergraduate science students are female, 'only engineering, computer science and the physical science remain strongholds for men at the undergraduate level' (Intini 2006). In the UK, girls dominate in the health sciences and biological sciences, but their numbers are still low in computer science, mathematics, physical science, and engineering; these are all disciplines perceived to be 'male subjects' (UNESCO 2006, p. 14). Research has shown that one of the fundamental causes deterring women from studying IT is their misperception about the nature of computing studies and a lack of understanding of subsequent career prospects (Fisher 2003; Jepson & Perl 2002; Selby et al. 1997).

Hollywood and popular culture reinforce the stereotypical images of a computer scientist as the single-minded male hacking away at his computer in the isolation of his bedroom. Additionally, an IT career is portrayed as dull, lonely, and involving little human interaction (Newmarch et al. 2000; Wilson 2003). It has been shown that this 'nerdy' and 'geeky' anti-social image is so entrenched in society that it negatively colours the perception of young girls, their teachers, and parents (Cameron, Edwards, Grant & Kearns 1999; Selby et al. 1997). A large American study of 652 college-bound high school students found that one of the main reasons girls do not want to pursue IT studies was the negative media portrayal of computing as a nerdy discipline (Jepson & Perl 2002). A New Zealand study of high school students also found that computing was perceived as a 'technical, machine-oriented career' (Selby et al. 1997). In Australia, multiple studies reinforced the point that inaccurate perceptions, amongst high school students and the general community, act as a barrier for females who might otherwise consider studies in IT (Fisher 2003; MMV 2004; Teague 1997, 2002). In fact, as noted by Rodger & Walker, 'A major problem is that most girls do not know what computer science is!' (Rodger & Walker 1996, p. 373).

In Victoria, Australia, the state government commissioned a report into the attitudes of 17 to 19 years old high school students towards IT and university studies. Of the 217 students who planned to go onto university studies, 13% of males said they would study IT, but none of the female participants said they would study IT (MMV 2004). All students pointed to the limited choice of IT subjects at school, and the way in which those subjects were taught, as a deterrent from pursuing IT studies at university. Furthermore, students could not see the relevance of their school studies with respect to their future careers, and found it difficult to determine where IT qualifications would take them. This situation seemed further exacerbated for female students in that both teachers and parents tended to encourage them to pursue 'classical' female careers such as teaching and nursing (Teague 2002).

The studies cited above indicate not only the need for girls to be introduced to computing at an early age, but also for this introduction to be conducted in a well thought out and interesting manner. The importance of the 'enjoyment' factor cannot be understated. A Canadian study of girls aged between 8 to 14 attending an all-girls camp to promote science and technology found that, by far, the most important factor for young girls considering a career in science was that they enjoyed science rather than that they were good at it (ACTUA Report, 2004).

International research has shown that females, once enrolled in computing studies, are subject to an institutional environment that is somewhat 'male-oriented'. The computing learning environment

tends to magnify the negative impressions left by the external factors such as the popular perception of computing as a male dominated domain with a 'geeky' image, and creates new ones through negative classroom experiences. Several studies have reported that female students often feel intimidated in laboratories where they need to compete for computing resources and hence are hindered in acquiring the necessary practical skills (Newmarch et al. 2000; Selby et al. 1997). In addition, female students may receive differential treatment from their instructors; examples and problems selected to illustrate the subject content tend to be of interest predominantly to male students; and, whilst the lecturers tend to encourage the male students to solve problems, they tend to, often unknowingly, help solve the problems for the female students (Crump 2001). Furthermore, female students tend to be interested in a broader societal perspective of computing (Wilson 2003) and its application to other disciplines such as medicine or education for instance; yet current curricula of IT courses do not lend themselves to accommodating this type of interest. The negative classroom experiences described above tend to be even more difficult for female students to cope with if their number falls below the 'critical mass' of 33% of the student group (Crump 2001). All of these problems are further aggravated by the lack of female role models, inadequate institutional support, and poor career advice (Blank & Kumar 2002; Clayton & Lynch 2002; Cohoon 2001; Cohoon 2002; Lazowska 2002; Nielsen et al. 2001; Teague 2002).

Countermeasures

The lack of female students entering the IT training pipeline has become a global concern not only in geographical terms, but in the way it spans across sectors including governments, industry, universities, schools, professional bodies, and the community at large. Many of those sectors have acknowledged the problem, and have taken steps to counter it.

In Australia, the federal government has identified the shortage of female IT students as an issue requiring remedial action in the near future (Commonwealth of Australia, 2006). In Victoria, Australia's second largest provider of IT skills, the IT industry generates revenues of $A65.7 billion or 8.7 % of GDP. The state government continues to invest in possible countermeasures to steady the decline of skilled workers in the IT industry. One example of such a countermeasure was an awareness campaign aimed at high school girls and their parents, and focusing on fighting the negative gender-related stereotypes associated with IT (MMV 2004).

Companies, such as Google, have acknowledged the growing need to attract more women into the IT industry by providing scholarships to support females already enrolled in computing courses. Likewise, Motorola has set aside five $5,000 scholarships for females in IT courses from regional Australia. In addition, since 2002 the Australian Computer Society (ACS) has supported female students in gaining relevant industry experience; early recipients of this support (scholarship) included a single mother of four children in her final year of a Software Engineering degree, and another female enrolled in Computer Science studies at a regional university.

'Women in IT' associations have launched initiatives focusing on promoting the image of women in the computing industry. A recent well-publicised effort by 'Women in IT' founder, Sonja Bernhardt, and ThoughtWares, Australia, deployed glamour to promote women in IT and fight the stereotype that IT is a domain for geeks. They created and produced a glamorous 'Screen Goddess' IT calendar featuring photo shots of twenty different female IT professionals in spoof poses from famous Hollywood movies, like the shot from Dr No depicted in Figure 1.

Figure 1: Screen Goddess IT Calendar (Thoughtware Australia 2006; image reproduced by permission).

The calendar entries depicted women of five different nationalities and ranging in age from 25 to 60. By showcasing the glamorous side and the diversity of women in IT, the calendar aimed at smashing the popular 'geeky technologist' image of female IT professionals; it also aimed to attract the attention of community at large. Upon its release on August 11th, 2006, the calendar generated so much media interest that its website counted 3.5 million hits worldwide within the first 24 hours. It is planned that profits from the sale of the calendar will be used to support other initiatives to encourage young females to pursue IT studies and careers.

Another initiative organised by 'Women in IT' is the annual 'Go Girl, Go for IT' event. The free event aims to expand the career horizons of young girls aged 12 -17 by revealing the diverse opportunities in IT through an expo and 'tradeshow'. The interactive and entertaining expo allows girls to hear from and relate to young women who have carved out a career within Australia's IT industries; and, the IT career-focused 'tradeshow' encourages the girls to connect directly with exhibitor companies. The next 'Go Girl, Go for I.T. Careers Showcase – 2006' will be held in Melbourne in October 2006; an invitation has been extended in Victoria to the 50,000 female students currently attending secondary schools (VicICTforWomen 2006).

As attitudes of students towards IT are shaped in late primary and lower secondary years (Newmarch et al., 2000), it is no surprise that several successful US programs tackling poor perceptions of IT, targeted high school students. In their study of barriers to females' pursuit of IT studies Scragg & Smith concluded that 'the most effective solutions will be those that concentrate not on retention but on recruitment (including outreach to secondary schools)' (Scragg & Smith 1998, p. 82). Positive experiences and the confidence gained at outreach programs have been identified as an effective conduit for female student recruitment by both Rodger & Walker (1996), and Pollock et al. (2004); the effect of those programs seemed to be particularly positive when students were exposed to a broad set of hands-on experiences, and the programs were conducted by female staff members.

DISPELING MISPERCEPTIONS ABOUT THE NATURE OF COMPUTING STUDIES AT VICTORIA UNIVERSTIY

Poor participation and high attrition rates of females in computer science at Victoria University has been a persisting problem. Despite efforts to encourage participation and improve retention of females in the course (Miliszewska & Horwood 2000, 2002), the percentage of female enrolments has declined significantly in the recent years (from 31% in 1994 to 18% in 2004), and attrition rates, particularly after first year of study, soared to 40% in 2003. Since various initiatives undertaken over the years failed to impact on these disappointing trends, it was decided to try out a new three-phase 'myth-busting' approach. First, to investigate if, according to popular perception, gender bias exists in the computing course and if it contributes to female attrition rates; second, depending on the findings, to develop suitable interventions for the benefit of female students currently in the course; and third, to promote the 'new, improved' image of the course to prospective students.

Gender Bias in the Course – Target: All Students, Current and Future
In mid 2003 a study was conducted to investigate student perceptions of potential gender bias in the computing learning environment; of interest were environmental conditions within the control of the University including course curriculum, pedagogical techniques, access to computers in the classroom, class participation, and institutional support. Data on student perceptions was obtained through focus groups with students and a survey; computing students representing both genders and all year levels participated in the study.

The central topic of the focus groups was gender equity in the computing learning environment; the key question – 'Why do female students drop out of the course?' The comments made by students during focus groups centred around issues of gender balance of both students and teachers, course content, resource access and collaborative activities. The lack of gender balance in the student population was deemed inconsequential by all students; likewise, the gender of the lecturers did not matter, competence did. Both female and male students considered that they had equal access to computers in the computer laboratories and that there was no evidence of male dominance or 'bullying' in claiming available machines. Lack of self-confidence and lack of friendships were considered major factors contributing to females dropping out, as was the overall difficulty of the course, particularly programming subjects; lack of interest in the course from the beginning was also perceived as a contributing factor. Female students expressed the need for more support, especially of a social nature. They also perceived a need for students to be better prepared for the university experience. A detailed report on the findings from the focus groups can be found in Miliszewska, Horwood, Venables & Tan (2004).

Following the analysis of focus group findings, a survey was developed to seek confirmation of these findings from a wider cohort of computing students and discover other factors contributing to growing female attrition rates. The survey responses, reported in detail in Miliszewska, Barker, Henderson & Sztendur (2006), addressed the issues of transition to the course, satisfaction with the course, intention to drop out, gender, curriculum, and seeking help. The responses obtained from the survey confirmed that students, male and female alike, found no major gender-related problems in their learning environment. However, female students reiterated the need for female peers in the course by singling them out as the vital source of both academic and personal help. Transition to the course emerged as a possible factor contributing to high attrition rates of females in computing courses. Not only did the female students take considerably longer to settle into the course, but they also were most likely to drop out of the course during the first year of study.

The Computing Learning Environment can be Safe and Friendly – Target: Current Female Students
The analysis of student responses dispelled the myth that the computing learning environment at Victoria University is gender biased. However, it indicated that the first year, particularly the first semester, of the course was the 'make or break' period especially for female students. Not only was it an important period with respect to adjustment to the course but also it was a period most likely to influence most female students' decisions about quitting the course. It appeared also that the support of fellow female students was important in dissuading female students from quitting.

And, while the lack of female role models in the course was not identified as important, the preference for seeking help from female as opposed to male staff members seemed to suggest to the contrary. The findings of the study indicated that the retention of female students, particularly in the first year of the course, could be helped by greater personalisation of the learning environment, and improved socialisation within the course. Consequently, a range of formal and informal measures was introduced to realise those aims including: a 'welcome' meeting with all first year female students and female staff; follow-up meetings throughout the year; provision (by female staff members) of additional assistance regarding both academic and personal matters; clustering of female students in tutorial groups; and, formation of out-of-class study groups with a guaranteed access to computers. The increased personalisation of the learning environment seems to have helped arrest female attrition from the course; the reported attrition of female students in the year following the personalisation initiatives was reduced to zero from 40% in the previous year (University Course Analysis Report 2005). A detailed report on the personalisation initiative can be found in Miliszewska, Venables & Tan (2006).

Computing Studies can be Interesting and Attractive – Target: Prospective Female Students
Having completed the first two stages of the 'myth-busting' strategy, it was time for stage three. In stage one, the myth that gender bias exists in the computing learning environment at Victoria University was dispelled. In stage two, a range of countermeasures was introduced to address problems associated with female students' transition to the course (those transition problems were identified in stage one of the investigation as the 'make, or break' point for female students). Armed with a gender-neutral female friendly computing course, the next step was to promote it to prospective female students. The promotion included an event, titled GirlsOnly.Computing@VU, for Year 10 female students interested in possible future studies and careers in computing; the event was aimed at girls from the neighbouring high schools.

The event was hosted by members of an equity project team based in the School of Computer Science and Mathematics; it aimed to encourage female students to pursue computing studies by demonstrating how interesting, easy, and female-friendly computing is at Victoria University. Twenty-nine girls from four high schools – Gilmore College for Girls, Williamstown High School, Bayside Secondary College, and Heathdale Secondary College – participated in the event. The girls were greeted on arrival and accompanied to computing laboratories. As the event was held on a 'regular' day, the girls could observe the usual activities of university students working around them, which added to the girls' 'real' university experience.

The girls participated in three different computing activities. First – the 'Simpsons' – was an exercise in Web page programming. The girls were presented with a sample Web page full of characters from the 'Simpsons' cartoon series, and invited to modify the programming code of the page while, at the same time, observing the effects of the modifications in an Internet browser. There was no end to the excitement sparked by the power and ease of programming – seemingly little changes in the code resulting in the most extraordinary effects, for example an originally neutral background colour turning bright green, or a stationary Marg Simpson suddenly performing somersaults.

The second activity, 'Games', involved playing computer games: Olympic Snakes and Ladders, and Connect Four. Those were no ordinary games: they were developed by first year computing students as a programming assignment. The female participants enjoyed playing the games, and marvelled at their functionality and sophisticated graphics; a screen shot from the Olympic Snakes and Ladders game is presented in Figure 2. The girls found it hard to believe that computing students with only three months of programming experience under their belt could create such professional products. One of the participants commented 'I thought programming was difficult and boring, but this looks like fun; it cannot be that difficult if a first year student can do it.' – a sentiment shared by fellow participants.

Figure 2: Snakes and Ladders computer game.

The third activity, 'Fun with Faces', was an exercise in image processing – a combination of computing and mathematics. This exercise was particularly interesting for two reasons: firstly, participants worked with the images of their own faces, which they had first captured through digital cameras attached to their computers; and secondly, current female computing students assisted in conducting the activity. The image processing involved the use of digital masks to achieve sharpening and blurring of images, create prominent contours, superimpose several images and generate poster-like simplifications of original images. While the girls initially concentrated on removing blemishes and turning their images to glamour pictures, they concluded by transforming the retouched glamour pics into 'mug shots'.

The laboratory activities were broken up by a visit to the student cafeteria, and the eventful day finished with a short information session about computing courses. Finally, the girls were presented with special certificates of participation and invited to consider female-friendly computing studies at Victoria University. Since all of them reported enjoying a productive day, they may well accept the invitation.

DISCUSSION

The process of organising the GirlsOnly.Computing@VU event has revealed an important issue namely, an apparent lack of interest among high school staff in promoting IT studies and careers to high schools girls. Organisers of the event approached 28 schools from the neighbourhood through IT teachers and school principals; only four schools accepted the invitation. A similar lack of response from high schools has been experienced recently by the organisers of the national 'Go Girl, Go for IT' event to be held at the end of October 2006. Despite the offer of an exciting program, and a generous support from the business community with sponsorship from Coles Myer, Australia Post, Telstra, ACS, Multimedia Victoria, Google, Apple, HP and others, and despite the offer of giveaways, show bags, and even have some money to help schools with bus costs, there is a problem – there are not enough girls coming! In a desperate attempt to secure participants, the event organisers resorted to an email call for help from their friends and associates asking them to contact high schools and talk to the Careers teacher or IT teacher to make them aware of the event.

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The curriculum of high school IT subjects appears to be a problem too, particularly for girls. According to a recent Victorian study of high school students, 59% of girls and 50% of boys found IT subjects at school boring (Multimedia Victoria 2004). In addition to boredom, 22% of girls and 33% of boys were of the view that 'learning IT at school does nothing to equip one for a university place' (MMV 2004, p. 11). Sadly, this view is supported by the way in which the Australian Equivalent National Tertiary Entrance Rank (ENTER) scores are calculated at present. The ENTER score represents the aggregate result of a student's high school matriculation examinations; the score determines a student's eligibility to study a university course – the higher the score, the wider the choice of course options. Various high school subjects are regarded differently in the final calculation of the score – some are scaled up, others are scaled down. For example, an examination result of 30 (out of a maximum 50) in Specialist Mathematics is scaled up by 12 points to an aggregate score of 42; on the other hand, a result of 30 in Information Systems is scaled down to 27, and a result of 30 in Information Processing and Management is scaled down to 25 (VTAC 2006). Is it any wonder then that, aiming at maximum ENTER scores, students opt out of IT subjects in high school?

There is also the persistent image problem – computing as a discipline does not seem to attract high-school aged girls. In addition, computing lacks presence in the media favoured by this age group of girls. Lang & Hede (2004) analysed the most popular teenage girls magazines and found them void of pictures of girls using computers, or advertisements for computers; for the young female readers, who identify with the content of such publications, the absence of any mention of girls and computers perpetuates the message that computers are not a female 'thing'. This absence may well be an extension of the 'cultural maleness' inherently associated with computing. The 'cultural maleness' appears to be firmly embedded even in institutions that have long attempted to address the gender imbalance in IT. One recent example is the ACS's withdrawal of its support of the Screen Goddess IT Calendar; the initiative was deemed too 'racy' to be supported by a professional body – a decision made not by a score of outraged females, but rather by a male in charge (Hayes 2006).

Lastly, despite the wide acknowledgement of the problem of under-representation of females in IT, and the numerous efforts on the part of governments, universities, industry, and professional associations to address the problem, little seems to change. What appears to be missing is a well-planned coordination of the various initiatives, and cooperation between sectors. If, for instance, an event like Women in IT's 'Go Girl, Go for IT' was part of an orchestrated strategy aimed at attracting girls to IT, would high-schools not be aware of this event? Would they resist participating?

CONCLUSIONS

The under-representation of females in computing courses is a concern that has continued to defy all attempts to resolve it. With few exceptions, the negative trend has persisted. This might suggest that the issue needs to be addressed from a different perspective.

In this paper, several problems contributing to this negative trend have been identified. These problems include the myth and reality of IT education and careers, the traditionalism inherent in schools, institutions, media, and community at large, and the apparent lack of coordination and cooperation between the various entities trying to address the problems.

This paper suggested how universities could contribute to alleviate the problem of under-representation. The approach adopted at Victoria University for instance, aimed to dispel the misperceptions associated with IT, and attract high-school girls to pursue computing studies through an interactive hands-on event where the girls spent a day in the shoes of a computing student at the University; they participated in purposefully designed classroom activities, mingled with female university students, and even lunched at the student cafeteria.

On their part, universities alone can only have a limited influence on the future of females in IT. While they can ensure that their courses are interesting, free of gender bias, and accessible to

female students, they have limited influence on girls at the time when their perceptions, interests, opinions are formed. To this end, high-schools need to step in and do their share of encouraging. Universities need to channel their efforts into collaboration and facilitation, not only with high schools, but with other sectors as well. It appears that only an orchestrated effort can help achieve a gender balance in IT and redefine this difficult mission as 'impossible' but in Hollywood terms that is, possible after all.

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