



UNIVERSITY
OF WOLLONGONG
AUSTRALIA

University of Wollongong
Research Online

Faculty of Informatics - Papers (Archive)

Faculty of Engineering and Information Sciences

2012

Attrition from Australian ICT degrees - why women leave

Madeleine R. H Roberts

University of Wollongong, mrhr01@uowmail.edu.au

Tanya J. McGill

Murdoch University, T.McGikk@murdoch.edu.au

Peter N. Hyland

University of Wollongong, phyland@uow.edu.au

Publication Details

Roberts, M. R. H., McGill, T. J. & Hyland, P. N. (2012). Attrition from Australian ICT degrees - why women leave. Proceedings of the Fourteenth Australasian Computing Education Conference (ACE2012) (pp. 15-24). Melbourne: Australian Computer Society.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library:
research-pubs@uow.edu.au

Attrition from Australian ICT degrees - why women leave

Abstract

Student attrition is of particular concern in the field of ICT because the industry faces staffing shortfalls, generally and a noticeable lack of female employees. This paper explores the reasons female students give for leaving their ICT courses. An online survey of early leavers from four Australian universities was conducted. The results show that, for many students, it is a combination of issues that leads to their withdrawal. Contrary to expectations, few female ex-students had experienced serious life events that necessitated their withdrawal or indicated that negative behaviour or attitudes had contributed to their decision to leave. More commonly female participants cited reasons associated with their lack of expected background knowledge. Recommendations are made to address issues that could be mitigated by university action.

Keywords

australian, women, why, degrees, ict, attrition, leave

Disciplines

Physical Sciences and Mathematics

Publication Details

Roberts, M. R. H., McGill, T. J. & Hyland, P. N. (2012). Attrition from Australian ICT degrees - why women leave. Proceedings of the Fourteenth Australasian Computing Education Conference (ACE2012) (pp. 15-24). Melbourne: Australian Computer Society.

Attrition from Australian ICT Degrees – Why Women Leave

Madeleine R. H. Roberts

School of Information Systems and Technology
University of Wollongong, NSW

mrhr01@uowmail.edu.au

Tanya J. McGill

School of Information Technology
Murdoch University
Murdoch, WA

t.mcgill@murdoch.edu.au

Peter N. Hyland

School of Information Systems and Technology
University of Wollongong, NSW

phyland@uow.edu.au

Abstract

Student attrition is of particular concern in the field of ICT because the industry faces staffing shortfalls, generally and a noticeable lack of female employees. This paper explores the reasons female students give for leaving their ICT courses. An online survey of early leavers from four Australian universities was conducted. The results show that, for many female students, it is a combination of issues that leads to their withdrawal. Contrary to expectations, few female ex-students had experienced serious life events that necessitated their withdrawal or indicated that negative behaviour or attitudes had contributed to their decision to leave. More commonly female participants cited reasons associated with their lack of expected background knowledge and with issues related to the course. Recommendations are made to address issues that could be mitigated by university action.

Keywords: Gender; female; ICT education; student attrition; student retention.¹

1 Introduction

Student attrition is of particular concern in the field of ICT because the industry faces staffing shortfalls (ACS 2008, e-skills UK 2011). Women have long been under represented in ICT employment and in ICT courses (Logan & Crump 2007), and there has been little sign of improvement (Gras-Velazquez et al. 2009). For example, only 1,997 female students commenced an ICT bachelor degree in Australia in 2009 compared to 9,106 male students (DEEWR 2011a). Given the low number of females entering ICT courses, it is essential that those that do enroll successfully complete their studies. Figures

from DEEWR show that in Australia approximately 16% of commencing female students leave their ICT course per year (DEEWR 2011b). This paper explores the reasons female students give for leaving their ICT courses and makes recommendations to improve their retention.

Attrition is the central theme of this paper and there are numerous definitions of its meaning from Seidman's simple "diminution in numbers of students resulting from lower student retention" (Seidman 2005, p. 92) to Hinton's (2007) comprehensive identification of nine forms of attrition. In this study the term attrition is used to indicate the loss of students from ICT courses either because: they leave the institution altogether or because they transfer to another non-ICT course at the same institution. It is thus used at both the institutional level and the course level.

ICT courses have very high attrition rates. An Australian study (Marks 2007) identified ICT as having the highest attrition rate with approximately one third of students leaving. A similar UK study (Bailey & Borooah 2007) found a 28% attrition rate. In comparison, medicine had an attrition rate of less than 5%, and education roughly 14%. Attrition rates of female students from ICT courses appear to be consistent with those of males (DEEWR 2011). However given the low number of female students starting, the industry cannot afford to lose them, and universities should do all that they can to retain them.

Numerous studies have investigated the reasons for attrition from tertiary education around the world. Many of these have focused on only one reason at a time, such as financial aid (Stater 2009), the effect of boredom (Mann & Robinson 2009) or students with dependent children (Marandet & Wainwright 2009) while others have attempted to cover a spectrum of reasons. Hovdhaugen (2009), for example, focused on both personal characteristics (gender, age, social background and prior academic achievement) and student goals and motivation once enrolled. The study found that personal characteristics explained withdrawal more effectively than student goals or motivation, while the latter largely

Copyright © 2012, Australian Computer Society, Inc. This paper appeared at the Fourteenth Australasian Computing Education Conference (ACE2012), Melbourne, Australia, January-February 2012. Conferences in Research and Practice in Information Technology (CRPIT), Vol. 123. M. De Raadt and A. Carbone, Eds. Reproduction for academic, not-for-profit purposes permitted provided this text is included.

explained the reasons for transfer. Bennett (2003) and Bailey and Borooah (2007) also studied the role of personal characteristics in attrition and both studies confirmed the importance of financial hardship. Some authors (Hagedorn, 2005; Kramer, 2007; Nora et al., 2005; Price et al., 1992; Tinto, 1993) have chosen to examine and discuss students as a homogenous entity while others have recognised the differences in experiences for male and female students (Barrow et al., 2009; Charles & Bradley, 2006; Manis et al., 1989; Seymour & Hewitt, 1997) and the need to identify, more specifically, why their experiences are different and what effects that has upon their decision to stay or go. Early models such as those proposed by Tinto (1975) and Bean (1980) have proved useful in understanding attrition, and have been extended by various authors to better predict and understand the phenomenon. Cabrera et al. (1993) investigated whether Tinto's Student Integration Model and Bean's Student Attrition Model could be merged. As well as confirming relationships among the commitment, social and academic integration factors they also found support for the effect of external factors such as encouragement from friends and family on the student's commitment to the institution.

In addition to studies focussing on attrition across a range of disciplines, there have been a number of studies focussing on attrition in ICT degrees. Barker et al. (2009) investigated factors relating to the social experience in computer science by exploring the types of interactions students had with peers, teachers and staff, and found that positive student-student interaction could be enhanced through the use of collaborative learning experiences in the classroom. Prior experience in programming was found to be an important predictor of intention to continue in computer science, however, technical ability appeared to be less important than soft skills (Lewis et al. 2008).

Whilst ICT faces many of the same issues as other disciplines, factors such as the low numbers of female students enrolling, and reports of higher female attrition rates (Barker et al. 2009) differentiate it. There is some evidence that these are linked, as an increase in the proportion of females has been shown to reduce attrition (Cohoon 2001). This finding is unremarkable, however, when the culture of computing is considered. Margolis and Fisher (2002) amply demonstrate the existence of a "Clubhouse" in computing which will, without any intention on the part of the male members, exclude women on the basis of numerical superiority alone. Previous research has shown that, while female ICT students do not appear to differ from male students in terms of their academic ability to understand the material, they lack confidence in their ability to do so (Beyer et al. 2003) and they may also have had less previous ICT experience (Cohoon & Aspray 2006). This view of female "deficiency" (Henwood 2000) must, however, be challenged and questions must be asked about why the computing curriculum contains assumptions about previous knowledge and experience. It is also imperative to investigate the actual reasons for women's loss of confidence in their abilities, since "lack" and "loss" are very different descriptors: the former indicating no confidence while the latter indicates confidence that has

been eroded. Margolis and Fisher (2002) convincingly demonstrate the erosion of confidence experienced by female computer science students attending Carnegie Mellon's prestigious Computer Science School where their very presence is questioned by fellow students who boast of their abilities and achievements, resulting in female students' disillusionment and waning enthusiasm.

Other studies specific to attrition in ICT have explored whether technical skills and emotional intelligence contribute to students' "affinity" with their major (Lewis et al. 2008). The researchers defined technical skills as the ability to: solve problems through abstraction and decomposition; develop algorithms; programme; and test. Emotional intelligence was defined as the ability to: understand emotion; control and express emotion; and use emotion in finding solutions. The study found that females with technical skills and emotional intelligence were most likely to remain in their major and that incorporating more soft skills into the curriculum would not only benefit all students but also create graduates far better suited to the current requirements of industry which include the ability to contribute effectively in teamwork.

The outcomes of these many studies suggest that attrition is influenced by both the personal characteristics of students and the educational environment. Some factors apply across many disciplines, and some are more discipline specific. Some factors appear to be gender specific. While some factors, such as a student's personal life and financial pressures, may be beyond the control of the institution, others, such as collaborative learning experiences in the classroom, the amount of contact students have with faculty members, and the way in which student ability is defined, can be influenced by universities. This paper explores the reasons female students give for leaving their ICT courses, and in particular looks at the difference that gender may make in the reasons for attrition. It concludes with recommendations to institutions based on these reasons.

2 Method

The study reported in this paper was part of a broader project investigating attrition. Only those aspects of the project relating to the reasons female students leave their ICT courses are included in this paper. Four Australian universities from different states were involved in the study. Registrars at the four universities identified students who had either transferred from an ICT degree to an unrelated degree, or had left the university altogether, between 2005 and mid 2010. Degrees classified as ICT covered the full spectrum from information systems through to computer science and computer engineering. These 2,868 students were then contacted, requesting their participation in an online survey. Completion of the questionnaire was voluntary and all responses were anonymous.

The online survey comprised 3 main types of questions. The first set of questions captured demographic and background information such as age, gender, marital status, etc. (see Table 1). The second set asked about their early participation in the course, including original enrolment status, if they had attended orientation events, etc. (see Table 1). The third set explored the possible

reasons for participants' withdrawal from their ICT course. This set of questions was presented in four sections. Section 1 asked if their main reason for leaving their degree was due to personal reasons, or if it related to something about the course, or if it was a combination of these (see Table 1). Section 2 asked about experiences of the university itself (see Table 2). Section 3 asked about their course including items relating to academic preparedness, the way the course was taught and run, and aspects of the teaching environment (see Table 3). Section 4 asked about life experiences such as chance events, health, finances, etc. (see Table 4). The items in sections 2, 3 and 4 were presented as negative statements describing possible reasons for attrition (e.g. 'I lost my job') and respondents were asked to rate their agreement with each statement on a 5-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'.

3 Findings and Discussion

Approximately 10% of letters and emails to potential participants were unable to be delivered due to address changes. A total of 154 ex-ICT students (18.8% females and 81.2% males) completed the survey, giving a response rate of 6% for those students who were able to be contacted. The relatively small number of females (29) is consistent with the numbers studying ICT at the universities involved (DEEWR, 2011a), and with the literature on female participation in tertiary ICT education in Western countries (Cory et al. 2006, Lewis et al. 2007). The female respondents' individual characteristics are shown in Table 1 (note: all percentages are percentage of those females who responded to the question).

The majority of the female participants had studied full time (69%) and all were domestic students (100%) while more than a third had been working over 20 hours per week (36%) and caring for dependent children (21.5%). The female participants were predominantly school leavers (58.6%) and this may partially explain their attrition as they may have lacked sufficient maturity to undertake an ICT degree. However 37.8% of female ex-students were in the 20 and over age range when they enrolled, so maturity should not have been an issue. Interestingly only 61.5% of females had enrolled in ICT as their first choice. It is not unexpected that people might leave a non-preferred degree, which would in part explain the female attrition. Similarly it was the first attempt at university study for only 69.2% of females, meaning that a significant proportion of females had either attempted or already completed a previous degree, enrolled in an ICT degree and then left.

The majority of participants had attended orientation activities (73.1%), but only 16.7% had attended functions organised by their school. Many of the students who had not attended functions indicated that either none were organised, or that they were not aware of any. Most of the female students who left their degree had been enrolled in IT (64.3%) and were critical of the course content. Several students mentioned the emphasis on programming and the expectation of prior knowledge as contributors to their decision to abandon their ICT degree.

Student Characteristics	Females	% of females
Age: Under 18	7	24.1
Age: 18	10	34.5
Age: 19	1	3.4
Age Range: 20 to 25	5	17.2
Age Range: 26 to 35	2	6.9
Age Range: 36 to 45	3	10.3
Age Range: 46 to 55	1	3.4
Full-time	20	69.0
Part-time	9	31.0
Domestic	26	100.0
International	0	0.0
Degree First Choice: Yes	16	61.5
Degree First Choice: No	10	38.5
ICT First Degree: Yes	18	69.2
ICT First Degree: No	8	30.8
Attended Orientation: Yes	19	73.1
Attended Orientation: No	9	31.0
Attended Functions: Yes	4	16.7
Attended Functions: No	20	83.3
Enrolled Degree: CS	5	17.9
Enrolled Degree: EE	0	0.0
Enrolled Degree: IT	18	64.3
Enrolled Degree: IS	4	14.3
Enrolled Degree: SE	1	3.6
Enrolled Degree: CE	0	0.0
Hours Worked p/w: 0-10	9	36.0
Hours Worked p/w: 10-20	7	28.0
Hours Worked p/w: 20-30	4	16.0
Hours Worked p/w: 30-40	3	12.0
Hours Worked p/w: 40+	2	8.0
Marital Status: Single	18	64.3
Marital Status: Partner no Child(ren)	4	14.3
Marital Status: Single with Child(ren)	1	3.6
Marital Status: Partner with Child(ren)	5	17.9
Dropped Course: Personal Reasons	3	10.3
Dropped Course: The Course	4	13.8
Dropped Course: Both Personal and Course	22	75.9

Table 1: Individual characteristics of respondents by gender

3.1 Reasons for Attrition

Participants were initially asked if their **main** reason for leaving their degree was due to personal circumstances, due to the course itself, or a combination of both. The majority of female respondents (75.9%) indicated that both personal and course issues had influenced their decision. For example:

"Pressures of changes in workplace increasing work hours beyond what I could fit studies around. The tutors did not answer most of the technical questions I had regarding the course" Female, 26, InfoSys.

Personal reasons alone were the cause for only 10% of the female participants. For example:

"The lack of financial aid which caused great stress and led to illness" Female, 24, CompSci.

While 13.8% indicated that the main reason was course related. For example:

“Course content wasn't practical nor business focussed enough. Where content overlapped with real on the job experience, staff were inflexible and unwilling to award credit...” Female, 18 CompSci.

Participants were then asked to respond to a series of 5-point Likert scales which presented many common reasons for attrition. Table 2 below presents the responses to reasons for attrition that relate to the university experience. The most frequent response was that female students could not get help when they needed it (31.4%). Other reasons included there being too many distractions preventing them from concentrating on their studies (24.1%) and the challenge of organising a timetable with no clashes (20.6%).

University Experience Reasons	N.	SD %	D %	N %	A %	SA %
Lack of help when needed	29	13.9	41.4	10.3	24.1	10.3
Distractions stopped me concentrating on study	29	17.2	41.4	17.2	24.1	0.0
Difficulties organising a suitable timetable	29	24.1	41.4	13.8	17.2	3.4
No opportunities to socialise	29	17.2	31.0	37.9	13.8	0.0
University staff were not friendly	29	17.2	51.7	17.2	10.3	3.4
University facilities were inadequate	29	31.0	34.5	24.1	10.3	0.0
Evening classes posed a security risk	29	34.5	31.0	24.1	10.3	0.0

Table 2: Reasons for attrition: university experience (SD = Strongly Disagree to SA = Strongly Agree)

The issue of least concern was the possible security risk associated with attending evening classes. Although security concerns are mentioned in the literature as a reason for attrition (Marginson et al., 2010) at 10.3% it does not appear to have been a major factor for females in this study.

The next set of reasons for attrition was associated with the course experience and is shown in Table 3. The most frequent response to the reasons relating to the course experience was that classes were boring (51.7%) and many females also found the pace of teaching too fast (41.3%).

In a recent Australian survey of over 30,000 students, ICT students were found to have the lowest levels of academic challenge, higher order thinking and enriching educational experiences of all disciplines considered (ACER 2010). The results of the current study reflect a sense that much ICT teaching may be boring because of its focus on transferring content knowledge at a rapid rate rather than making use of constructivist approaches; this is contributing to attrition.

Consistent with perceptions that ICT teaching can be boring, female participants also frequently showed agreement with reasons relating to the balance between application and theory: lack of workplace focus (42.9%), lack of practical applications (39.3%) and lack of business focus (35.7%). Females also saw the courses as too theoretical (28.5%).

Course Experience Reasons	N.	SD %	D %	N %	A %	SA %
Teaching						
Classes were boring	29	10.3	17.2	20.7	31.0	20.7
Pace was too fast	29	13.8	24.1	20.7	24.1	17.2
Teachers didn't explain exercises	29	10.3	31.0	24.1	24.1	10.3
Not encouraged to do well by teachers	28	14.3	35.7	25.0	21.4	3.6
Teachers were not prepared	29	20.7	51.7	20.7	3.4	3.4
Teachers were out of date	29	13.8	55.2	27.6	3.4	0.0
Harsh, confrontational teaching methods	29	10.3	51.7	37.9	0.0	0.0
Course						
Course lacked workplace focus	28	7.1	17.9	32.1	28.6	14.3
Course lacked practical applications	28	3.6	39.3	17.9	25.0	14.3
Course too mathematical	28	17.9	25.0	21.4	25.0	10.7
Course lacked business focus	28	10.7	25.0	28.6	28.6	7.1
Course was too theoretical	28	10.7	32.1	28.6	21.4	7.1
Poorly structured course	28	10.7	28.6	35.7	21.4	3.6
Too many assignments	28	7.1	35.7	35.7	21.4	0.0
Focus on individual activities rather than groups	28	14.3	39.3	32.1	10.7	3.6
Teaching environment						
Didn't feel I fitted in	27	18.5	14.8	18.5	29.6	18.5
Environment didn't suit my learning style	29	17.2	37.9	6.9	24.1	13.8
Environment unwelcoming	29	15.1	38.2	21.1	17.1	8.6
Course was too competitive	28	17.9	32.1	39.3	7.1	3.6
Preparedness and other issues						
Course didn't meet my expectations	28	7.1	14.3	14.3	35.7	28.6
Didn't enjoy classes	27	11.1	7.4	22.2	44.4	14.8
Didn't understand concepts	28	7.1	10.7	25.0	35.7	21.4
Results were disappointing	28	3.6	28.6	17.9	35.7	14.3
Didn't understand terms used	28	14.3	28.6	14.3	32.1	10.7
Didn't have the expected background knowledge	28	17.9	17.9	21.4	32.1	10.7
Didn't make friends with classmates	26	11.5	23.1	26.9	30.8	7.7
I felt it was unacceptable to be smart	28	42.9	42.9	10.7	3.6	0.0

Table 3: Reasons for attrition: course experience (SD = Strongly Disagree to SA = Strongly Agree)

ICT courses in Australia have the lowest proportion of students undertaking internships (ACER 2010), and a study by Koppi et al. (2010) noted that ICT graduates in the workplace have recommended that students receive more industry related learning. Weng et al. (2010) also called for an increased focus on solving business

problems. The following quote reflects a common sentiment among students:

“Degree simply wasn't what I wanted. Realised after I started it. Although I love IT and always thought I'd study it, I decided a degree combined more with business would be more beneficial” Female, 18, IT.

Issues associated with the teaching and learning environment were also considered important: some females felt that the teaching environment did not suit their learning style (37.9%), or was not welcoming (25.7%) and 48.1% felt that they did not belong. Barker et al.'s (2009) study of predictors of intention to persist in computer science found that when students perceive the workload as being too heavy they are less likely to pursue the major. While this influenced some students (21.4%) it was not the major issue.

Almost two thirds of the female participants also noted reasons such as the course not meeting their expectations (64.3%) and not enjoying classes (59.2%). These sentiments are relatively general and could be associated with a variety of other more specific reasons discussed in this section.

More than half the female students felt that they did not understand the concepts (57.1%), and many felt they did not understand the terms used in the course (42.8%) or did not have the expected background knowledge (42.8%). For example:

“I didn't have the expected background knowledge; the courses were definitely geared towards those with more pre-existing knowledge.” Female, 18, IT.

Having the expected background for ICT studies has been identified in previous research as an important predictor of attrition (Barker et al. 2009).

As indicated earlier, assumptions of prior experience and ability could be modified to prevent the exclusion of those who may have an aptitude for ICT without having spent every waking minute of their teens using computers. This myopic focus on computing (Margolis & Fisher 2002) underpins certain expectations built into the curriculum which are detrimental to those who do not fit the geek stereotype. This issue is explored further below in relation to different types of students.

The social aspect of study also received attention with one third of females (38.5%) agreeing that they didn't make friends with classmates. This was also identified by Barker et al. (2009), who found that levels of student-to-student interaction were perceived as 'unfavourable' by the computer science students in their study, and they recommended that faculty focus on incorporating activities that support interaction. This issue can be addressed in both the nature of the course and in the teaching approaches used.

The responses to possible reasons for attrition that relate to the lives of the students are shown in Table 4 below. More than half of the female participants felt that they had picked the wrong degree (62.9%). This sentiment implies a lack of interest and engagement with the degree content, but could also be associated with a variety of other more specific reasons that are discussed in this section.

Life Experience Reasons	N	SD %	D %	N %	A %	SA %
Picked the wrong degree	27	11.1	11.1	14.8	29.6	33.3
Attending university was too expensive	27	22.2	29.6	22.2	14.8	11.1
Conflicts with my work commitments	26	30.8	34.6	11.5	15.4	7.7
Distance made travel to university difficult	27	25.9	33.3	18.5	14.8	7.4
Travel to university was difficult because of transport	27	25.9	33.3	18.5	11.1	11.1
Timetable didn't fit my work commitments	26	11.5	38.5	30.8	7.7	11.5
I couldn't get financial aid	27	25.9	37.0	22.0	0.0	14.8
My family didn't help me to study at home	27	29.6	33.3	22.2	14.8	0.0
My partner or I got pregnant.	27	44.4	18.5	29.6	3.7	3.7
University study wasn't as important as socialising	27	29.6	48.1	14.8	7.4	0.0
Death, serious illness or accident in the family	27	51.9	25.9	14.8	7.4	0.0
I missed my family	27	25.9	40.7	25.9	7.4	0.0
I lost my job	26	50.0	30.8	15.4	0.0	3.8
Serious illness or accident	27	37.0	33.3	25.9	0.0	3.7
Difficulties living at home	27	40.7	33.3	22.2	3.7	0.0
Living away from home was too difficult	27	18.5	25.9	51.9	3.7	0.0
My timetable didn't fit with the transport timetable	27	25.9	37.0	33.3	3.7	0.0
Difficulties living in student accommodation	27	18.5	25.9	55.6	0.0	0.0

Table 4: Reasons for attrition: students' lives (SD = Strongly Disagree to SA = Strongly Agree)

Financial pressures are of concern to students in all disciplines, and a major predictor of attrition (Bennett 2003, Cabrera et al. 1993). ICT students are no different in this respect. The cost of university education influenced many of the participants. It was considered too expensive by 25.9% of females while 14.8% agreed or strongly agreed that they couldn't get financial aid. Conflicts with work commitments were also a common issue; 23.1% of females agreed that they experienced conflict with work commitments, and 19.2% noted that their study timetable did not fit with their work commitments. Various aspects of travel to university were also found to be problematic for many: distance was an issue for 22.2% of females as was transport availability (22.2%). Factors such as these make it difficult for students to fully engage with their studies and are likely to work in combination with other issues to precipitate attrition

Few female ex-students indicated that they had been affected by serious illness (3.7%), death or illness in the family (7.4%), loss of their job (3.8%) or pregnancy (7.4%).

The results above demonstrate the range of issues that can contribute to female student attrition. It appears that individual students rarely withdraw from their studies for

just one reason. Personal, university and course related issues combine to put pressure on students which may lead to withdrawal. In some cases ex-students feel they have made the decision willingly, but in others they are very conscious of the lack of support received.

3.2 Statistically Significant Gender Differences

Several possible reasons for attrition relating specifically to gender issues were included in the survey. The levels of agreement of the female participants are reported in Table 5 below. Overall, gender issues did not appear to be relatively important to them. Whilst the gender imbalance was certainly noted (62.9% agreement), sexist behaviour from male staff or students was not rated highly as an issue in terms of their withdrawal from the course. For example, only one female participant agreed that male students or staff spoke in a sexist manner, or that male students did not let them participate.

Gender Specific Reasons	N	SD %	D %	N %	A %	SA %
No or few females in class	27	11.1	3.7	22.2	48.1	14.8
In minority in classes	27	18.5	14.8	14.8	48.1	3.7
Male-oriented course content	29	20.7	24.1	27.6	20.7	6.9
Students' sexist behaviour	28	28.6	32.1	32.1	3.6	3.6
Male students stopped me participating	27	25.9	40.7	29.6	3.7	0.0
Male staff not encouraging	27	25.9	33.3	22.2	18.5	0.0
Male staff's sexist behaviour	27	33.3	37.0	25.9	0.0	3.7

Table 5: Responses to gender specific (SD = Strongly Disagree to SA = Strongly Agree)

Some female participants (18.5%) felt that male staff did not encourage them to participate, and 27.6% believed that the course content was male oriented. The general sentiment is captured by the following comment:

“As a female it was quite daunting being a minority in the class but the male students and teachers were in no way deliberately sexist.” Female, 17, IT.

Independent samples t-tests were used to compare the responses of female ex-students to the responses of male ex-students obtained as part of the larger study. Gender was found to have a significant influence on students' agreement with some of the other possible reasons for leaving their ICT course as shown in Table 6.

Females were more likely to believe that they didn't have the expected background knowledge for the course (t=-2.25, p<0.026), didn't understand the concepts (t=-3.82, p<0.001), or didn't understand the meaning of terms used in the course (t=-2.30, p=0.027). Previous research has suggested that female students have no less ability to undertake ICT courses than male students (Beyer et al.,

2003), however, it has been found that female ICT students lack confidence in their ability to achieve their educational goals (Beyer et al. 2003).

Reasons	Females		Males		
	Mean	SD	Mean	SD	Sig.
Distractions stopped me concentrating on study	2.48	1.06	3.06	1.22	0.021
Didn't understand the concepts	3.54	1.17	2.57	1.21	<.001
Lacked the expected background	3.00	1.30	2.41	1.24	0.026
Didn't understand the terms used	2.96	1.29	2.36	1.02	0.027
My results were disappointing	3.29	1.15	2.73	1.10	0.018
I was in the minority in my classes	3.04	1.26	2.41	1.25	0.021
Picked the wrong degree	3.63	1.36	3.02	1.41	0.043

Table 6: Reasons with significantly different levels of agreement between females and males

The findings of this study are consistent with this previous research although it was suggested earlier that there are identifiable reasons for this loss of confidence which can be addressed. Lack of confidence in ability to undertake study in a discipline that is perceived to be challenging is thought to contribute to low enrolment rates of females (Manis et al. 1989), however, questions should be asked about why computing should be challenging and whether this is, again, male modelling of computing (Margolis & Fisher 2002) as a field in which women do not fit. It also appears to contribute to female attrition, preventing female students from accessing the benefits that can flow from an ICT career. Actions that increase confidence should be pursued. These might include mentoring (Cohoon 2001), early exposure to work integrated learning or rethinking the expectations imposed on students by the current design of computing courses whereby students who demonstrate prior knowledge take more complex courses in their first year while those with less knowledge and skills are brought up to the expected level at a less challenging pace (Margolis & Fisher 2002).

Female ex-students were also more likely to say that their results were not as high as they had expected (t=-2.40, p=0.018), and that they felt they had picked the wrong degree (t=-2.04, p=0.043). Previous research has shown that female students who leave ICT degrees tend to have higher grades than males students who do not leave (Strenta et al. 1994), yet they are more sensitive to perceptions that their grades are lower than those they received in high school (Jagacinski et al. 1988). The culture of computing must be highlighted, once more, to explain why this is the case. Seymour and Hewitt (1997, pp241-242) identified a “process of discouragement” which manifested itself in female students: doubting their abilities; having a reduced capacity to deal with setbacks; and being more dependent on reassurance from other people.

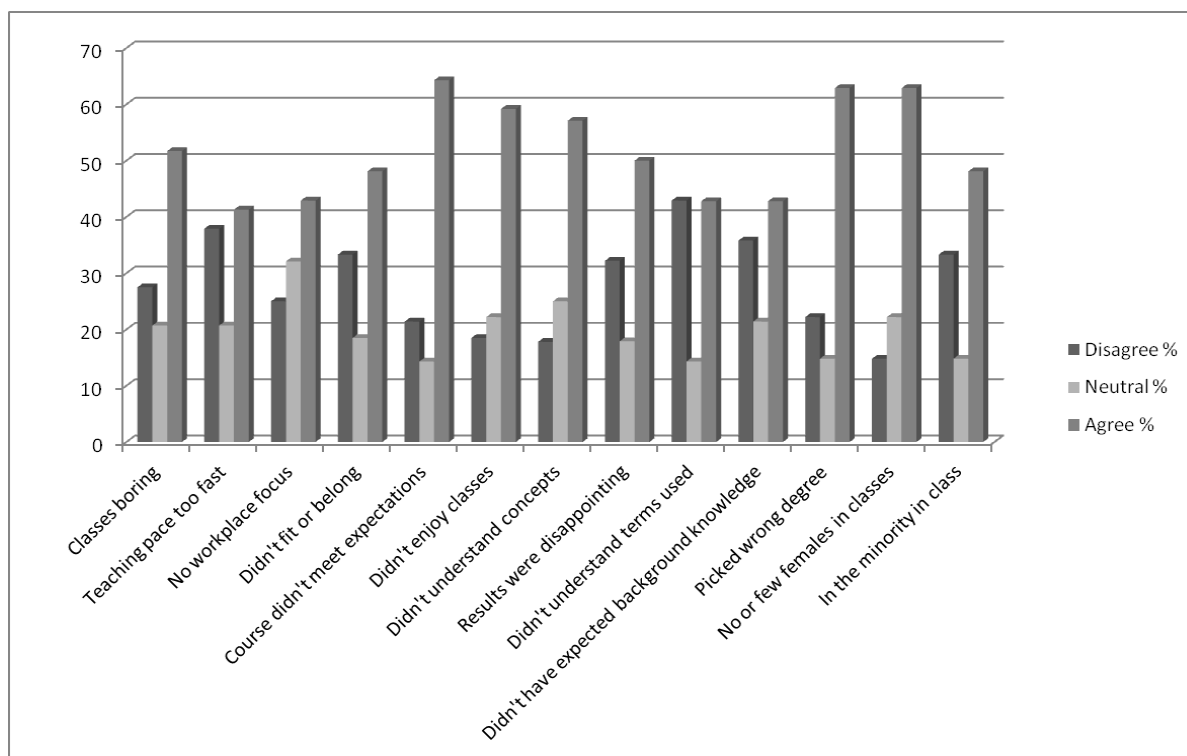


Figure 1: Dominant reasons for leaving ICT courses

Differential attrition of female students in this way is a major loss to the ICT profession, but it is not purely a gender issue, as Strenta et al. (1994) found that in other disciplines, such as science and engineering, where persistence was the same grades were the same.

Unexpectedly, there were no significant differences in response to most of the life issues: female students were not more likely to be affected by issues such as pregnancy or dealing with family illness.

4 Summary and Conclusions

The results presented in the sections above demonstrate the wide range of issues that can contribute to female student attrition. Figure 1 summarises those that were most frequently cited (25% or higher agreement).

Student attrition is an issue of serious concern to universities around the world. It is of particular concern to the field of ICT because of the shortfall of ICT professionals (ACS 2008) as it poses current and future risks for the ICT industry. Not only is there a lack of qualified people in sufficient numbers but, more significantly, there is a lack of qualified women able to contribute their ideas and assist in steering technological developments. This study has attempted to further understand the causes of female attrition from ICT courses by exploring the reasons female students from four Australian universities gave for leaving their ICT courses.

There are many factors that can contribute to the attrition of ICT students, and for many students it is a combination of issues that leads to their withdrawal. Some of the issues identified in this study are beyond the control of universities but many could be mitigated by universities taking appropriate action.

Contrary to commonly held beliefs about women as those most frequently affected by, and expected to manage, serious life events, only a relatively small number of female ex-students had experienced events such as death or serious injury in the family, pregnancy, or loss of their employment, that necessitated their withdrawal. They were also no more likely than males to consider withdrawing due to these issues. It was much more common for the participants to cite reasons associated with the university environment, the teaching of their ICT course, and their inability to combine their studies with other commitments. A theme in issues associated with the university environment was the difficulty in obtaining help when required. Providing greater levels of support during the initial enrolment process, and when students need to make changes to their enrolment to accommodate other challenges in their lives, would address a number of the factors that students have indicated influenced their decision to withdraw. As female students are very much in the minority, and likely to feel isolated, providing ongoing support could be very valuable in alleviating their feelings of not fitting in or belonging to their ICT course and, thereby, increasing their enjoyment of classes.

The course related issues that made a major contribution to female student withdrawal were related to the style of teaching and to the focus of the ICT course. Many female ex-students had found their classes boring, yet they also noted that the pace of teaching was often too fast, and exercises were not explained well. These sentiments have also been expressed by students who continue with their ICT course, resulting in ICT courses being ranked as having the lowest levels of enriching educational experiences and higher order thinking of all courses considered in a survey of over 30,000 students

(ACER 2010). The way in which ICT is taught clearly requires urgent consideration. Recommendations from the ICT education literature include increasing the use of small group class activities (Barker et al. 2009, Powell 2008). Small group activities provide students with opportunities to undertake more active learning, addressing the boredom issue (Schweitzer & Brown, 2007), but also to increase levels of interaction with other students and faculty. Increasing this interaction reduces the likelihood of students feeling disconnected from the teaching and learning environment, and makes it easier for them to ask for support when they need it. These kinds of activities are particularly useful as they help ensure female students feel they are active participants in the class and in their own learning.

In addition to the style of teaching, the balance between application and theory was also of concern. Courses were seen to lack a workplace or business focus and to lack practical application. This finding is not just applicable to students who withdraw; students who have successfully completed their course and obtained work in the ICT industry have also called for more industry related learning (Koppi et al. 2010). Increased use of case based teaching can tie ICT content to application, enabling students to understand the context in which their knowledge will be applied (Mukherjee 2000, Weng et al. 2010). Providing students with an understanding of the social context in which human beings can benefit from ICT may be one of the most important changes to teaching that can be made for all students (Rosser 1990). Better integration of practical and workplace knowledge and skills can also be achieved through providing forms of work integrated learning (e.g. industry related projects or work placements). Team based projects that address problems or opportunities provided by companies, government departments or community organisations enable students to gain professional skills while ensuring that curriculum is aligned with industry needs. Work placements (or internships) are another way to provide students with valuable experience and to strengthen their sense of the relevance of their ICT course. Addressing the perceived lack of workplace focus will lead to committed students who can see where their ICT degree is taking them, possibly providing a greater incentive to work through issues that might be making students consider withdrawing.

Many female students were influenced by a perception that they did not have the expected background knowledge and, as a result, did not understand the terms and concepts used in the course. Previous ICT experience has been found to be an important predictor of attrition (Barker et al. 2009). This issue can be successfully addressed by implementing alternate pathways, so that those students without a strong background take an alternative initial unit in their first year that provides the opportunity to develop the skills and confidence to be successful. This approach has been shown to be particularly valuable in addressing the attrition of female students, as they are more likely to believe that they do not have the necessary background (Powell 2008). Increasing their foundational knowledge would also lead to better results for female students. Gaining higher marks would increase the satisfaction female students

have with the course, encouraging them to believe they have chosen a suitable degree and motivating them to continue with their studies. Other strategies that have had success in improving female student retention include ensuring a gender balance in faculty and providing mentoring (Cohon 2001).

In order to gain further insight into the issues discussed above, it would be useful for future research to contrast these results with responses for ICT graduates. Some issues may not necessarily be institutional or course problems, but relate more to differing student perceptions. Approaches to changing these perceptions could then be explored.

5 Acknowledgements

This research was supported by an ALTC Priority Project grant. The following additional project team members contributed to the survey design: Tony Koppi, Philip Ogunbona and Fazel Naghdy (University of Wollongong); Jocelyn Armarego (Murdoch University); Chris Pilgrim (Swinburne University of Technology); and Paul Bailes (University of Queensland).

6 References

- ACER (2010): Doing more for students: enhancing engagement and outcomes. Australasian Student Engagement Report. http://ausse.acer.edu.au/images/docs/AUSSE_2009_Student_Engagement_Report.pdf. Accessed 6 Apr 2011.
- ACS (2008): The ICT skill forecast project. First report: quantifying current and forecast ICT employment. <http://www.acs.org.au/attachments/ICTSkillsForecastingReportExecSummaryAug08.pdf>. Accessed 1 Apr 2010.
- Bailey, M. and Borooah, V.K. (2007): Staying the course: an econometric analysis of the characteristics most associated with student attrition beyond the first year of higher education. Ulster, Ireland, DELNI.
- Barker, L.J., McDowell, C. and Kalahar, K. (2009): Exploring factors that influence computer science introductory course students to persist in the major. *SIGCSE Bulletin* **41**(2):282-286.
- Barrow, M., Reilly, B. and Woodfield, R. (2009): The determinants of undergraduate degree performance: how important is gender? *British Educational Research Journal* **35**(4):575-597.
- Bean, J.P. (1980): Dropouts and turnover: the synthesis and test of a causal model of student attrition. *Research in Higher Education* **12**(2):155-187.
- Beekhoven, S., De Jong, U. and Van Hout, H. (2002): Explaining academic progress via combining concepts of integration theory and rational choice theory. *Research in Higher Education* **43**(5):577-600.
- Bennett, R. (2003): Determinants of undergraduate student drop out rates in a university business studies department. *Journal of Further and Higher Education* **27**(2):123-141.
- Beyer, S., Rynes, K., Perrault, J., Hay, K. and Haller, S. (2003): Gender differences in computer science students. *SIGCSE Bulletin* **35**(1):49-53.

- Cabrera, A.F., Nora, A. and Castaneda, M.B. (1993): College persistence: structural equations modeling test of an integrated model of student retention. *The Journal of Higher Education* **64**(2):123-139.
- Charles, M. and Bradley, K. (2006): A matter of degrees: female underrepresentation in computer science cross-nationally. In J.M. Cohoon and W. Aspray *Women and information technology: research on under representation*. Cambridge, Massachusetts, MIT Press.
- Cohoon, J.M. (2001): Toward improving female retention in computer science. *Communications of the ACM* **44**(5):108-114.
- Cohoon, J.M. and Aspray, W. (eds) (2006): *Women and information technology: research on under-representation*. Cambridge, Massachusetts, MIT Press.
- Cory, S.N., Parzinger, M.J. and Reeves, T.E. (2006): Are high school students avoiding the information technology profession because of the masculine stereotype? *Information Systems Education Journal* **4**(29):3-13.
- Crisp, G., Nora, A. and Taggart, A. (2009): Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: an analysis of students attending a hispanic serving institution. *American Educational Research Journal* **46**(4):924-942.
- DEEWR (2011a): Students, selected higher education statistics. Canberra, DEEWR.
- DEEWR (2011b): Students, selected higher education statistics (No. RFI 10-324 Roberts).
- e-skills UK (2011), Technology insights 2011: key findings. <http://www.e-skills.com/Research/Research-publications/Insights-Reports-and-videos/Technology-Insights-2011/Technology-Insights-2011-Key-findings/>. Accessed 1 Apr 2011.
- Frieze, C. (2005): Diversifying the images of computer science: undergraduate women take on the challenge! *SIGCSE Bulletin* **37**(1):397-400.
- Gras-Velazquez, A., Joyce, A. and Debry, M. (2009): Women and ICT: Why are girls still not attracted to ICT studies and careers? from http://blog.eun.org/insightblog/upload/Women_and_IC_T_FINAL.pdf. Accessed 3 Apr 2011.
- Hagedorn, L.S. (2005): How to define retention: a new look at an old problem in A. Seidman *College student retention: formula for student success*. Westport, Connecticut, Praeger.
- Hinton, L. (2007): Causes of attrition in first year students in science foundation courses and recommendations for intervention. *Studies in Learning, Evaluation, Innovation and Development* **4**(2):13-26.
- Hovdhaugen, E. (2009): Transfer and dropout: different forms of student departure in Norway. *Studies in Higher Education* **34**(1):1-17.
- ITU (2010), New ITU report Shows Global Uptake of ICTs Increasing, Prices Falling. http://www.itu.int/newsroom/press_releases/2010/08.html. Accessed 3 Apr 2011.
- Jagacinski, C.M., Lebold, W.K. and Salvendy, G. (1988): Gender differences in persistence in computer-related fields. *Journal of Educational Computing Research* **4**(2):185-202.
- Koppi, T., Edwards, S.L., Sheard, J., Naghdy, F. and Brookes, W. (2010): The case for ICT work-integrated learning from graduates in the workplace. *Proc. Australasian Conference on Computing Education*, Brisbane, Australia.
- Kramer, G.L. (2007): Fostering student success in the campus community. San Francisco, Jossey-Bass.
- Lewis, S., Lang, C. and McKay, J. (2007): An inconvenient truth: the invisibility of women in ICT. *Australasian Journal of Information Systems* **15**(1):59-76.
- Lewis, T.L., Smith, W.J., Belanger, F. and Harrington, K.V. (2008): Are technical and soft skills required?: the use of structural equation modeling to examine factors leading to retention in the CS major. *Proc. International Workshop on Computing Education Research*, Sydney, Australia.
- Logan, K. and Crump, B. (2007): The value of mentoring in facilitating the retention and upward mobility of women in ICT. *Australasian Journal of Information Systems* **15**(1):41-58.
- Manis, J., Sloat, B.F., Thomas, N.G. and Davis, C.S. (1989): An analysis of factors affecting choices of majors in science, mathematics and engineering at the University of Michigan. Michigan, University of Michigan.
- Mann, S. and Robinson, A. (2009): Boredom in the lecture theatre: an investigation into the contributors, moderators and outcomes of boredom amongst university students. *British Educational Research Journal* **35**(2):243-258.
- Marandet, E. and Wainwright, E. (2010): Invisible experiences: understanding the choices and needs of university students with dependent children. *British Educational Research Journal* **36**(5):787-805.
- Marginson, S., Nyland, C., Sawir, E. and Forbes-Mewett, H. (2010): *International student security*, Melbourne, Cambridge University Press.
- Margolis, J. and Fisher, A. (2002): *Unlocking the clubhouse: women in computing*, Cambridge, Massachusetts, MIT Press.
- Marks, G. (2007): Completing university: characteristics and outcomes of completing and non-completing students. Australian Council of Educational Research. http://research.acer.edu.au/lsay_research/55. Accessed 30 Nov 2009.
- Mukherjee, A. (2000): Effective use of in-class mini case analysis for discovery learning in an undergraduate MIS course. *Journal of Computer Information Systems* **40**(3):15-23.
- Nora, A., Barlow, E. and Crisp, G. (2005): Student persistence and degree attainment beyond the first year: the need for research in A. Seidman *College student retention: formula for student success*. Westport, Connecticut, Praeger.

- Powell, R.M. (2008): Improving the persistence of first-year undergraduate women in computer science. *SIGCSE Bulletin* **40**(1):518-522.
- Price, D., Harte, J. and Cole, M. (1992): Student progression in higher education: a study of attrition at Northern Territory University. Canberra, Australian Government Publication Service.
- Rosser, S. (1990): *Female-friendly science: applying women's studies methods and theories to attract students*. New York, Pergamon Press.
- Schweitzer, D. and Brown, W. (2007): Interactive visualization for the active learning classroom. *SIGCSE Bulletin* **39**(1):208-217.
- Seidman, A. (ed.) (2005): *College student retention: formula for student success*. Westport, Connecticut, Praeger.
- Seymour, E. and Hewitt, N.M. (1997): *Talking about leaving: why undergraduates leave the sciences*. Boulder, Colorado, Westview Press.
- Stater, M. (2009): The impact of financial aid on college GPA at three flagship public institutions. *American Educational Research Journal* **46**(3):782-815.
- Strenta, A.C., Elliott, R., Adair, R., Matier, M. and Scott, J. (1994): Choosing and leaving science in highly selective institutions. *Research in Higher Education* **35**(5):513-547.
- Telecompaper (2010): Number of ICT workers in Germany at record levels. <http://www.telecompaper.com/news/number-of-ict-workers-in-germany-at-record-levels-bitkom>. Accessed 19 Oct 2010.
- Tinto, V. (1975): Dropout from higher education: a theoretical synthesis of recent research. *Review of Educational Research* **45**(1):89-125.
- Tinto, V. (1993): *Leaving college: rethinking the causes and cures of student attrition*. 2nd edn, Chicago, University of Chicago Press.
- Weng, F., Cheong, F. and Cheong, C. (2010): Modelling IS student retention in Taiwan: extending Tinto and Bean's model with self-efficacy. *ITALICS* **9**(2):97-108.