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Why students leave their ICT degrees: A gender comparison

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Abstract

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Why Students Leave Their ICT Degrees: A Gender Comparison

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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 students give for leaving their ICT courses and examines gender differences in them. An online survey of early leavers from four Australian universities was conducted. The results show that, for many students, a combination of issues lead to their withdrawal. Whilst the gender imbalance was certainly noted, sexist behaviour from male staff or students was not rated highly as an issue in terms of the withdrawal of female students from their course. Females ex-students were however more likely to believe that they didn't have the expected background knowledge for the course, didn't understand the concepts, or didn't understand the meaning of terms used in the course. Recommendations are made to address issues that could be mitigated by university action.

Keywords

Gender; student attrition; student retention; ICT education

INTRODUCTION

The use of information and communication technology (ICT) now underpins the vast majority of work and business life in the developed world and this trend is also increasing in the developing world (ITU, 2010). As such, the role of ICT professionals is vital in maintaining our current lifestyles. It is surprising, therefore, to find a shortage of ICT professionals in most developed countries (Lewis et al., 2007). The Australian Computer Society, for example, identified a shortfall of 28,488 ICT staff for 2008, and projected a massive increase over the following decade (ACS, 2008). More recently there were 30,000 ICT positions unfilled in Germany (Telecompaper, 2010) and e-skills UK (2011) has predicted that over half a million new ICT professionals will be needed in the next 5 years.

There appear to be three main causes for this shortfall of ICT professionals:

1. the retirement of "baby boom" ICT professionals has reduced the available pool (Crisp et al., 2009).
2. a lack of students commencing ICT training, particularly ICT degrees (Cory et al., 2006; Lewis et al., 2007).
3. high levels of attrition from ICT training has compounded the problem (Bailey & Borooah, 2007; Marks, 2007).

The first of these causes seems inevitable. The second is a complex, long-term problem requiring a considerable shift in society's perceptions of ICT as a profession from one of "geeky guys" (Frieze, 2005) to one that garners respect. However, the third cause might be addressed if we understood the causes of attrition. This study explores gender differences in the reasons students give for leaving their ICT courses; an online survey was conducted to determine what factors in a student's personal life, or in their experience of attending university, influence their decision to leave their degree.

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" (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 exceptionally 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 and Borooah, 2007) found a 28% attrition rate. In comparison, medicine had an attrition rate of less than 5%, and education roughly 14%.

Researchers agree that attrition from tertiary study is expensive and wasteful (Bailey & Borooah, 2007; Tinto, 1993). This has implications for the universities that teach ICT as they depend upon student numbers for funding (Hinton, 2007; Tinto, 1993) and for the students who, having withdrawn from their degree, incur significant costs from which they gain no benefit if they do not graduate.

Numerous studies have focused on the reasons for attrition from tertiary education around the world. Many focus on only one reason at a time, such as financial aid (Stater, 2009), boredom (Mann & Robinson, 2009) or students with dependent children (Marandet & Wainwright, 2009) while others have attempted to cover multiple reasons. Hovdhaugen (2009) 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 than student goals or motivation, while the latter explained the reasons for transfer. Bailey and Borooah (2007) studied the role of personal characteristics in attrition, confirming the importance of financial hardship.

Early models of attrition, such as Tinto (1975) and Bean (1980) proved useful, and have been extended by various authors to better predict and understand the phenomenon. Cabrera et al. (1993) combined Tinto's Student Integration Model and Bean's Student Attrition Model, confirming that commitment, and social and academic integration were important factors. They also confirmed the importance of external factors such as encouragement from friends and family on the student's commitment to the institution

In addition to multi-disciplinary studies of attrition, a number of studies have focussed on attrition in ICT degrees. While ICT faces many of the same issues as other disciplines, factors such as the low numbers of females enrolling, and reports of higher female attrition rates (Barker et al., 2009) differentiate it. There is evidence that these are linked, as an increase in the proportion of females has been shown to reduce attrition (Cohoon, 2001). Previous research has shown that, while female ICT students do not appear to differ from male students in terms of their ability to understand course material, they lack confidence in their ability to do so (Beyer et al., 2003; Cohoon, 2007) and they may also have had less previous ICT experience (Cohoon & Aspray, 2006).

The outcomes of these 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. While some factors, such as a student's personal life and financial pressures, are 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 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.

METHOD

Four Australian universities from different states were involved in the study. Students who had transferred from an ICT degree to an unrelated degree at the university, or who had left the university altogether, between 2005 and mid 2010 were identified. These students were 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 programs etc. (see Table 1). The third set explored the possible reasons why participants had withdrawn 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. 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 the teaching environment (see Table 3). Section 4 asked about life experiences such as chance events, health, finances, travel, etc. (see Table 4). The items in sections 2, 3 and 4 were presented as negative statements describing possible reasons for attrition (e.g. 'The classes were boring') and respondents were asked to rate their agreement with each statement on a 5-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'.

FINDINGS AND DISCUSSION

Participants

A total of 154 ex-ICT students (18.8% females and 81.2% males) completed the survey. The relatively small number of females is consistent with the numbers studying ICT at the universities involved (Department of Education Employment and Work Relations, 2011), and with the literature on female participation in tertiary ICT education in Western countries (Cory et al., 2006; Lewis, et al., 2007). The respondents' individual characteristics by gender are shown in Table 1.

Table 1: Individual characteristics of respondents by gender

Student Characteristics	Females	% Female	Males	% Male	Total
Gender	29	100.0	125	100.0	154
Age: Under 18	7	24.1	18	14.4	
Age: 18	10	34.5	29	23.2	
Age: 19	1	3.4	8	6.4	
Age Range: 20 to 25	5	17.2	35	28.0	
Age Range: 26 to 35	2	6.9	19	15.2	
Age Range: 36 to 45	3	10.3	14	11.2	
Age Range: 46 to 55	1	3.4	1	0.8	153
Full-time	20	69.0	93	74.4	
Part-time	9	31.0	31	24.8	153
Domestic	26	89.7	100	73.6	
International	0	0.0	10	7.4	136
Degree First Choice: Yes	16	61.5	88	96.7	
Degree First Choice: No	10	38.5	6	5.0	120
ICT First Degree: Yes	18	69.2	84	96.6	
ICT First Degree: No	8	30.8	3	3.4	113
Attended Orientation: Yes	19	73.1	81	58.7	
Attended Orientation: No	9	31.0	29	21.0	138
Attended Functions: Yes	4	16.7	39	34.2	
Attended Functions: No	20	83.3	75	65.8	138
Enrolled Degree: CS	5	17.9	41	39.4	
Enrolled Degree: EE	0	0.0	4	3.8	
Enrolled Degree: IT	18	64.3	40	38.5	
Enrolled Degree: IS	4	14.3	14	13.5	
Enrolled Degree: SE	1	3.6	3	2.9	
Enrolled Degree: CE	0	0.0	2	1.9	132
Hours Worked p/w: 0-10hrs	9	36.0	38	34.2	
Hours Worked p/w: 10-20hrs	7	28.0	26	23.4	
Hours Worked p/w: 20-30hrs	4	16.0	16	14.4	
Hours Worked p/w: 30-40hrs	3	12.0	17	15.3	
Hours Worked p/w: 40+hrs	2	8.0	14	12.6	136
Marital Status: Single	18	64.3	80	74.1	
Marital Status: Partner no Child(ren)	4	14.3	16	14.8	
Marital Status: Single with Child(ren)	1	3.6	1	0.9	
Marital Status: Partner with Child(ren)	5	17.9	11	10.2	136
Dropped Course: Personal Reasons	3	10.3	37	29.8	
Dropped Course: Something about the Course	4	13.8	25	20.2	
Dropped Course: Both Personal and Course	22	75.9	62	50.0	153

The majority of the participants had studied full time (female 69%, male 74%) while many had been working over 20 hours per week (female 36%, male 42.3%) and caring for dependent children (female 21.5%, male 11.1%). Many participants had enrolled directly from school (female 58.6%, male 37.6%). The larger number of young females may partially explain their attrition as they may have lacked sufficient maturity to undertake an ICT degree. However, 43% of

male leavers were between the ages of 20 and 35 when they enrolled, so lack of maturity should not have been an issue for them. Another interesting difference was that 96.7% of male leavers, but 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 but curious that so many males left the degree of their choice. Another striking difference was that for almost all male ex-students it was the first attempt at university study (96.6%) but only for 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. Most of the female students who left their degree had been enrolled in IT (64.3%) while the majority of males had been enrolled in either Computer Science (39.4%) or IT (38.5%).

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 respondents (female 75.9%, 50% male) indicated that a combination of personal and course issues had influenced them. 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.*

> *"Two Reasons. A) Dad died. B) Course wasnt what i expected when i enrolled" Male, 24, CompSci.*

Personal reasons alone were the cause for almost 30% of males but only 10% of females. For example:

> *"I had to work more to pay rent/bills which negatively impacted my study. Centrelink allowances are too low to live on and (in my case at least) were cut off if I elected to do part time study" Male, 21, CompSci.*

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

For 13.8% of female and 20.2% of male participants the main reason was due to the course alone. 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.*

> *"The course content material was paced relatively quickly, and i wasnt able to pick up the programming languages fast enough, i lost interest in the course as the programming languages changed frequently ..." Male, 19 CompSci/GamesTech.*

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 reasons for attrition that relate to the university environment.

Table 2: Reasons for attrition associated with the university environment (SD = Strongly Disagree to SA = Strongly Agree)

University Experience Reasons	N	SD %	D %	N %	A %	SA %
Distractions prevented me from concentrating on my studies	153	13.7	26.1	19.6	32.7	17.8
Organising a suitable timetable, with no clashes, was hard	152	20.4	34.9	17.1	18.4	9.2
I couldn't get help when I needed it	150	19.3	37.3	16.7	18.0	8.7
The University staff were not friendly	151	25.2	35.8	21.9	11.9	5.3
The University facilities were not adequate	152	23.7	43.4	18.4	10.5	3.9
There were no opportunities to socialise	151	19.9	39.7	27.2	9.3	4.0
Attending evening classes posed a security risk	152	38.8	38.2	19.1	3.3	0.7

The most frequent response was that there were too many distractions preventing them from concentrating on their studies (40.5% overall, females 24.1%). Other notable reasons included the challenge of organising a timetable with no clashes (27.6% overall, females 13.8%) and getting help when needed (26.7% overall, females 31%). The difficulties some students experienced in obtaining help are illustrated by the following quote:

> *"….specifically asked admin staff, or teaching staff for help and was turned away on every occasion, or told to look at a website, neither of which provided the slightest bit of help…" Male, 18, IT.*

The issue of least concern was the possible security risk associated with attending evening classes (4% overall, females 10.3%) so this was more of an issue for female students, but at 10.3% it was still only a minor factor. Although security concerns are mentioned in the literature as a reason for attrition (Marginson et al., 2010) it does not appear to have been a major factor in this study.

The next set of reasons for attrition was associated with 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 (42.4% overall, females 41.4%). Many also found the pace of teaching too fast (32.2% overall, females 41.4%). As one of the participants put it:

> *"It was uninteresting and not exciting. I felt like I was just memorising information, not using critical thinking, not *really* learning" Male, 19, IT.*

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

Course Experience Reasons	N	SD %	D %	N %	A %	SA %
Teaching						
The classes were boring	151	9.9	27.8	19.9	25.8	16.6
The pace of teaching was too fast	152	17.1	33.6	17.1	20.4	11.8
The teachers didn't explain the exercises	151	13.9	38.4	19.2	19.9	8.6
I wasn't encouraged to do well by the teachers	151	15.2	34.4	27.8	16.6	6.0
The teaching methods were harsh and confrontational	152	20.4	43.4	24.3	10.5	1.3
The teachers were not prepared	152	18.4	51.3	20.4	5.9	3.9
The teachers' knowledge was out of date	152	15.1	44.1	25.0	11.8	3.9
Course						
The course didn't have a workplace focus	151	9.9	27.2	25.8	25.8	11.3
The course lacked practical applications	151	12.6	39.1	17.2	19.9	11.3
The course didn't have a business focus	152	14.5	26.3	28.3	21.7	9.2
The course was too theoretical	152	13.8	34.9	22.4	22.4	6.6
The course was poorly structured	149	12.8	34.9	25.5	15.4	11.4
There were too many assignments	147	13.6	36.7	27.9	18.4	3.4
The focus was on individual activities rather than groups	149	18.1	32.2	30.2	13.4	6.0
The course was too mathematical	151	15.9	46.4	19.2	12.6	6.0
Teaching and learning environment						
Academic environment did not suit my learning style	152	13.2	32.9	18.4	23.7	11.8
I didn't feel I fitted in or belonged	147	18.4	27.9	17.7	24.5	11.6
The teaching environment was not welcoming	152	15.1	38.2	21.1	17.1	8.6
I was in the minority in my classes	146	24.7	32.2	17.8	16.4	8.9
The course was too competitive	151	17.9	40.4	28.5	11.9	1.3
Preparedness and other student issues						
The course didn't meet my expectations	148	8.8	20.9	16.9	30.4	23.0
I didn't enjoy attending classes	146	12.3	18.5	19.9	32.9	16.4
I didn't understand the concepts	152	17.1	33.6	15.8	24.3	9.2
My results were not as high as I expected	149	12.1	29.5	28.9	22.1	7.4
I didn't make friends with classmates	145	15.2	33.8	24.1	17.9	9.0
I didn't understand the meaning of the terms used in the course	149	18.8	40.3	18.1	20.1	2.7
I didn't have the expected background knowledge	148	23.6	35.1	16.2	15.5	9.5
I felt it was unacceptable to be smart	147	36.7	44.2	14.3	4.8	0.0

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, other frequent course experience reasons were: the balance between application and theory; lack of workplace focus (37.1% overall, females 34.5%); lack of practical applications (31.2% overall, females 34.5%) and lack of business focus (20.9% overall, females 34.5%); course was too theoretical (29.0% overall, females 27.6%). ICT courses in Australia have the lowest proportion of students doing 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 felt that the teaching environment did not suit their learning style (35.5% overall, females 34.5%), or was not welcoming (25.7% overall, females 24.1%) and 36.1% felt that they did not belong (females 44.8%). Barker et al.'s (2009) study of predictors of intention to persist in computer science found that when students perceive the workload to be too heavy they are less likely to pursue the major. While this influenced some students (21.8% overall, females 17.2%) it was not the major issue.

Participants also noted reasons such as the course not meeting their expectations (53.4% overall, females 62.1%) and not enjoying classes (49.3% overall, females 55.2%). Some students felt that they did not understand the concepts (33.5% overall, females 55.1%), or terms used in the course (22.8% overall, females 41.4%) and believed that they did not have the expected background knowledge (26.9% overall, females 41.4%). 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.*

> *"You needed the Cisco CCNA in order to do one of the units." Male, 36, IT.*

Lacking the expected background has been identified in previous research as an important predictor of ICT attrition (Barker et al., 2009). This assumption of prior knowledge could be modified to prevent the exclusion of those who may have the talent for ICT without necessarily having dabbled in it for years. This expectation is built into the curriculum, to the detriment of those who do not fit the "geek" model.

The social aspect of study also received attention with many participants (26.9% overall, females 33.3%) agreeing that they didn't make friends with classmates. For example:

> *"During the tutorials there was no chance or encouragement to socialise with other students." Male, 17, Games Software Design.*

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. Many participants felt that they had picked the wrong degree (43.7% overall, females 55.2%). This sentiment implies a lack of understanding of the ICT discipline by people choosing ICT as a career path.

Table 4: Reasons associated with students' and their lives (SD = Strongly Disagree to SA = Strongly Agree)

Life Experience Reasons	N	SD %	D %	N %	A%	SA %
I picked the wrong degree	144	18.1	17.4	20.8	20.8	22.9
Attending university was too expensive	142	23.9	21.8	16.9	21.1	16.6
There was conflict with my work commitments	143	26.6	23.1	14.0	21.0	15.4
My timetable didn't fit with my work commitments	144	22.2	25.0	19.4	17.4	16.0
Travelling to university was/is difficult because of distance	145	31.7	25.5	17.9	15.2	9.7
Travelling to university was/is difficult because of transport	145	30.3	29.0	17.2	14.5	9.0
I couldn't get financial aid	141	32.6	25.5	22.0	9.2	10.6
My timetable didn't fit with the transport timetable	143	30.8	29.4	25.2	9.8	4.9
My family didn't help me to study at home	144	37.5	25.7	23.6	9.7	3.5
Living at home was too difficult	145	33.1	31.0	26.9	6.2	2.8
I became very ill or was involved in a serious accident	145	47.6	24.8	19.3	4.8	3.4
Studying at university wasn't as important as socialising	144	34.0	37.5	20.8	6.3	1.4
Living away from home was too difficult	144	31.9	26.4	33.3	2.8	5.6
A family member died, was very ill or had a serious accident	144	50.7	25.0	17.4	4.2	2.8
I lost my job	143	48.3	25.2	21.0	3.5	2.1
I missed my family	144	34.7	32.6	27.8	3.5	1.4
I or my partner got pregnant.	144	52.1	20.1	23.6	2.8	1.4
Living in student accommodation was too difficult	142	26.8	21.1	47.9	3.5	0.7

Financial pressures are of concern to students in all disciplines, and a major predictor of attrition (Bennett, 2003; Cabrera et al., 1993). The cost of university education influenced many of the participants in this study. It was considered too expensive by over a third (37.3% overall, females 24.2%) and 19.8% agreed or strongly agreed that they couldn't get financial aid (females 13.8%). Conflicts with work commitments were also a common issue; 36.4% agreed that they experienced conflict with work commitments (females 20.7%), and 33.4% noted that their study timetable did not fit with their work commitments (females 17.2%). Various aspects of travel to university were also found to be problematic for many: distance was an issue for 24.9% (females 20.7%), and transport availability for 23.5% (females 20.7%). 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 as illustrated by the following quote:

> *"Finances were a big issue; Public transport from the southern highlands was almost nonexistant, thus I had to drive - petrol was costing me greatly. To make the money to get to uni, I had to spend all my 'spare' time working, which of course meant I had no time for uni. Stress of both money and failing classes compounded, making both problems even worse." Male, 18, IT.*

Few ex-students indicated that they had been affected by serious illness (8.2% overall, females 3.4%), death or illness in the family (7.0% overall, females 6.9%), loss of their job (5.6% overall, females 3.4%) or pregnancy of themselves or their partner (4.2% overall, females 6.9%).

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 29 female participants are reported in Table 5 below. Overall, gender issues did not appear to be more or less important to the female respondents. Whilst the gender imbalance was certainly noted (62.9% overall), 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. 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 levels of agreement with these issues were however not significantly different from those of the male ex-students (independent samples t-tests: t=1.27, p=0.206; t=1.71, p=0.089).

Table 5: Female responses to gender specific reasons for attrition (SD = Strongly Disagree to SA = Strongly Agree)

Gender Specific Reasons	N	SD %	D %	N %	A %	SA %
There were no or few females in the classes	27	11.1	3.7	22.2	48.1	14.8
The course content was male oriented	29	20.7	24.1	27.6	20.7	6.9
Students acted or spoke in a sexist manner	28	28.6	32.1	32.1	3.6	3.6
Male students wouldn't let me participate	27	25.9	40.7	29.6	3.7	0.0
Male staff didn't encourage me to participate	27	25.9	33.3	22.2	18.5	0.0
Male staff acted or spoke in a sexist manner	27	33.3	37.0	25.9	0.0	3.7

The general sentiment is encapsulated 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.*

Gender was however found to have a significant influence on students' agreement with several of the other possible reasons for leaving their ICT course, as shown in Table 6 (independent samples t-tests were in the comparisons).

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

Reasons	Females		Males		
	Mean	Std. dev.	Mean	Std. dev.	Sign.
Distractions prevented me from concentrating on my studies	2.48	1.06	3.06	1.22	0.021
I didn't understand the concepts	3.54	1.17	2.57	1.21	<0.001
I didn't have the expected background knowledge	3.00	1.30	2.41	1.24	0.026
I didn't understand the meaning of the terms used in the course	2.96	1.29	2.36	1.02	0.027
My results were not as high as I expected	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
I picked the wrong degree	3.63	1.36	3.02	1.41	0.043

Males were significantly more likely to believe that there were too many distractions preventing them from concentrating on their studies (t=-2.34, p=0.021). 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). The findings of this study are consistent with this previous research. Lack of confidence in a discipline that is perceived to be challenging is thought to contribute to low enrolment rates of females (Manis et al., 1989). It also appears to contribute to female attrition. Actions that increase confidence should be pursued, such as 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, here, 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 set-backs; and being more dependent on reassurance from other people. 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 it occurred in other disciplines, such as science and engineering.

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.

SUMMARY AND CONCLUSIONS

Student attrition from ICT degrees is of serious concern to the ICT industry around the world because of a growing shortfall of ICT professionals (ACS, 2008). The results that have been discussed above demonstrate the range of issues that can contribute to student attrition. It appears that individual students rarely withdraw from their studies for just one reason. Personal issues and university and course related issues combine to put pressure on students who may respond by ceasing their studies. 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, as illustrated by the following quotes:

> *"I found the attitude of the faculties, the structure of courses and resistance to reasonable student requests very deflating and negative" Male, 21, Comp Eng.*
>
> *"Not enough help from staff was offered." Female, 18, IT.*

In addition to the high rate of attrition from ICT degrees, women are under-represented in ICT degrees and those who do take up ICT suffer similar rates of attrition as men. This research has attempted to understand the causes of attrition from ICT courses and any gender differences that may exist.

Relatively few ex-students had experienced serious life events (e.g. a death or serious injury in the family, pregnancy etc.) that necessitated their withdrawal, and females were not more likely to consider withdrawing due to these issues. More common reasons for withdrawing were associated with the university environment, the teaching of their ICT course, and their inability to combine their studies with other commitments. When assessing the university environment many students reported difficulty in obtaining help when required. The transition from school to university is a challenging one, so providing more support during the initial enrolment process or when students need to change their enrolment to accommodate other life changes could reduce their likelihood of leaving. As female students are very much in the minority, and likely to feel isolated, this kind of support is likely to be very valuable. Similarly, students who need to support themselves financially often experience financial pressures and conflicts with work commitments and may need help balancing their study, work commitments and transportation issues.

The major course related issues contributing to withdrawal were teaching style and the focus of the ICT course. Many ex-students found classes boring, but also noted the pace of teaching was often too fast, and exercises were not explained well. Similar sentiments have been expressed by students who continue with their ICT course, with ICT courses being ranked as low in enriching educational experiences and higher order thinking (ACER, 2010). ICT teaching styles clearly require urgent consideration. One possible improvement is to use small group activities (Barker et al., 2009; Powell, 2008), which provide students with more active learning experiences, thus reducing boredom (Schweitzer & Brown, 2007). They also increase interaction with other students and faculty, thereby reducing feelings of disconnection from the teaching and learning environment, and making it easier for students to ask for support when they need it. These kinds of

activities are particularly useful for female students as they help ensure they feel they are active participants in the class and in their own learning.

The balance between application and theory was also of concern, and ICT courses were seen to lack a workplace focus and to lack practical application. This concern is also expressed by students who have successfully completed their course and are working in the ICT industry (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). Better integration of practical and workplace knowledge and skills can also be achieved through providing industry related projects or work placements. Team-based projects that address problems of companies, government departments etc. enable students to gain professional skills while ensuring that curriculum is aligned with industry needs. Work placements or internships also provide students with valuable experience and strengthen their sense that their ICT course is relevant. Increasing the focus on the workplace may help students to see where their ICT degree leads, thereby providing a greater incentive to work through issues that might be making students consider withdrawing.

Some students' decisions about withdrawal were influenced by a perception that they did not have the expected background knowledge. Female students are particularly likely to feel disadvantaged in this way. This issue can be successfully addressed by implementing alternate pathways, so that students without a strong background take an alternative unit in their first year that provides the opportunity to develop the skills and confidence to succeed (Powell, 2008). Other strategies that have had success in improving female student retention include ensuring a gender balance in faculty and providing mentoring (Cohoon, 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.

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.

ACS 2008, 'The ICT Skill Forecast Project. First Report: Quantifying Current and Forecast ICT Employment', http://www.acs.org.au/attachments/ICTSkillsForecastingReportExecSummaryAug08.pdf.

Bailey, M & Borooah, VK 2007, 'Staying the Course: An Econometric Analysis of the Characteristics Most Associated with Student Attrition Beyond the First Year of Higher Education', DELNI, Ulster, Ireland.

Barker, LJ, McDowell, C & Kalahar, K 2009, 'Exploring Factors that Influence Computer Science Introductory Course Students to Persist in the Major', *SIGCSE Bulletin*, vol.41, no.2, pp282-286.

Bean, JP 1980, 'Dropouts and Turnover: The Synthesis and Test of a Causal Model of Student Attrition', *Research in Higher Education*, vol.12, no.2, pp155-187.

Bennett, R 2003, 'Determinants of Undergraduate Student Drop Out Rates in a University Business Studies Department', *Journal of Further and Higher Education*, vol.27, no.2, pp123-141.

Beyer, S, Rynes, K, Perrault, J, Hay, K & Haller, S 2003, 'Gender Differences in Computer Science Students', *SIGCSE Bulletin*, vol.35, no.1, pp49-53.

Cabrera, AF, Nora, A & Castaneda, MB 1993, 'College Persistence: Structural Equations Modeling Test of an Integrated Model of Student Retention', *The Journal of Higher Education*, vol.64, no.2, pp123-139.

Cohoon, JM 2001, 'Toward Improving Female Retention in Computer Science', *Communications of the ACM*, vol.44, no.5, pp108-114.

Cohoon, JM 2007, 'Gendered Experiences of Computing Graduate Programs', *SIGCSE Bulletin,* vol.39, no.1, pp546-550.

Cohoon, JM & Aspray, W (eds) 2006, *Women and Information Technology: Research on Underrepresentation*, Massachusetts Institute of Technology Press, Cambridge, Mass.

Cory, SN, Parzinger, MJ & Reeves, TE 2006, 'Are High School Students Avoiding the Information Technology Profession Because of the Masculine Stereotype?', *Information Systems Education Journal*, vol.4, no.29, pp3-13.

Crisp, G, Nora, A & 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*, vol.46, no.4, pp924-942.

Department of Education Employment and Work Relations 2011, 'Students, Selected Higher Education Statistics', Department of Education Employment and Work Relations, Canberra.

e-skills UK 2011, *Technology Insights 2011: Key findings*, from http://www.e-skills.com/Research/Research-publications/Insights-Reports-and-videos/Technology-Insights-2011/Technology-Insights-2011-Key-findings/.

Frieze, C 2005, 'Diversifying the Images of Computer Science: Undergraduate Women take on the Challenge!', *SIGCSE Bulletin*, vol.37, no.1, pp397-400.

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*, vol.4, no.2, pp13-26.

Hovdhaugen, E 2009, 'Transfer and Dropout: Different Forms of Student Departure in Norway', *Studies in Higher Education*, vol.34, no.1, pp1-17.

ITU 2010, New ITU report Shows Global Uptake of ICTs Increasing, Prices Falling, from http://www.itu.int/newsroom/press_releases/2010/08.html.

Jagacinski, CM, Lebold, WK & Salvendy, G 1988, 'Gender Differences in Persistence in Computer-Related Fields', *Journal of Educational Computing Research*, vol.4, no.2, pp185-202.

Koppi, T, Edwards, SL, Sheard, J, Naghdy, F & Brookes, W 2010, 'The Case for ICT Work-Integrated Learning from Graduates in the Workplace', in *Proceedings of the Twelfth Australasian Conference on Computing Education (ACE '10)*, Brisbane, Australia., 18-22 January.

Lewis, S, Lang, C & McKay, J 2007, 'An Inconvenient Truth: The Invisibility of Women in ICT', *Australasian Journal of Information Systems*, vol.15, no.1, pp59-76.

Manis, J, Sloat, BF, Thomas, NG & Davis, CS 1989, *An Analysis of Factors Affecting Choices of Majors in Science, Mathematics and Engineering at the University of Michigan*, University of Michigan, Michigan.

Mann, S & 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*, vol.35, no.2, pp243-258.

Marandet, E & Wainwright, E 2009, 'Invisible Experiences: Understanding the Choices and Needs of University Students with Dependent Children', *British Educational Research Journal*, pp1-19.

Marginson, S, Nyland, C, Sawir, E & Forbes-Mewett, H 2010, *International Student Security*, Cambridge University Press, Melbourne.

Margolis, J & Fisher, A 2002, *Unlocking the Clubhouse: Women in Computing*, The MIT Press, Cambridge, Mass.

Marks, G 2007, 'Completing University: Characteristics and Outcomes of Completing and Non-completing Students', *Longitudinal Surveys of Australian Youth, Australian Council of Educational Research*, http://research.acer.edu.au/lsay_research/55.

Mukherjee, A 2000, 'Effective Use of In-class Mini Case Analysis for Discovery Learning in an Undergraduate MIS Course', *Journal of Computer Information Systems*, vol.40, no.3, pp15-23.

Powell, RM 2008, 'Improving the Persistence of First-Year Undergraduate Women in Computer Science', *SIGCSE Bulletin*, vol.40, no.1, pp518-522.

Schweitzer, D & Brown, W 2007, 'Interactive visualization for the active learning classroom', *SIGCSE Bulletin*, vol.39, no.1, pp208-217.

Seidman, A (ed.) 2005, *College Student Retention: Formula for Student Success*, Praeger, Westport, Connecticut.

Seymour, E & Hewitt, NM 1997, *Talking About Leaving: Why Undergraduates Leave the Sciences*, Westview Press, Boulder, Colorado.

Stater, M 2009, 'The Impact of Financial Aid on College GPA at Three Flagship Public Institutions', *American Educational Research Journal*, vol.46, no.3, pp782-815.

Strenta, AC, Elliott, R, Adair, R, Matier, M & Scott, J 1994, 'Choosing and Leaving Science in Highly Selective Institutions', *Research in Higher Education*, vol.35, no.5, pp513-547.

Telecompaper 2010, *Number of ICT workers in Germany at record levels* Retrieved 19 Oct, from http://www.telecompaper.com/news/number-of-ict-workers-in-germany-at-record-levels-bitkom.

Tinto, V 1975, 'Dropout from Higher Education: a Theoretical Synthesis of Recent Research', *Review of Educational Research*, vol.45, no.1, pp89-125.

Tinto, V 1993, *Leaving College: Rethinking the Causes and Cures of Student Attrition*, 2nd edn, University of Chicago Press, Chicago.

Weng, F, Cheong, F & Cheong, C 2010, 'Modelling IS Student Retention in Taiwan: Extending Tinto and Bean's Model with Self-Efficacy', *ITALICS*, vol.9, no.2.

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