Why Don't More ICT Students Do PhDs?

Cally Guerin1*, Asangi Jayatilaka2, Paul Calder3, Alistair McCulloch4, Damith Ranasinghe2

1 School of Education / University of Adelaide, Adelaide, Australia
2 School of Computer Science / University of Adelaide, Adelaide, Australia
3 School of Computer Science, Engineering, and Mathematics / Flinders University, Adelaide, Australia
4 Research Education (Learning and Teaching Unit) / University of South Australia, Adelaide, Australia

* cally.guerin@adelaide.edu.au

Abstract

Compared to many other disciplines, ICT has relatively few students choosing to continue into doctoral studies. We have explored some of the perceived barriers to undertaking doctoral studies in ICT in three Australian universities. Current students were surveyed to establish their post-course intentions regarding employment and further study. Their reasons for not choosing to go onto research degrees were linked largely to concerns about the financial implications of such study and a limited understanding of what research in ICT involves. We recommend that ICT students be given accurate information about the costs involved, that students have authentic undergraduate experiences of research, and that smooth pathways be developed to allow students to return to doctoral studies after working in industry.

Keywords: Information and Communication Technology (ICT); doctoral education; motivations; barriers.

1 Introduction

Despite increasing focus on doctoral-level education and the doctoral graduates produced by higher education institutions, relatively few ICT bachelor graduates from Australian universities choose to undertake doctoral studies compared to most other STEM disciplines (Graduate Careers Australia 2013). This paper seeks to uncover and explore some of the barriers to doctoral studies in ICT, in order to better understand why this is a relatively unattractive option to many potentially suitable graduates when compared to the situation in other disciplines.

Previous research has identified five factors influencing decisions to embark on doctoral studies across all faculties: family and friends, intrinsic motivation, lecturer influence, research experience, and career progression (Guerin et al., 2014). In Engineering more specifically, the reasons for continuing into a PhD are based on a genuine interest in the topic, often inspired by positive undergraduate experiences of engaging with active research (Guerin and Ranasinghe 2010, Jiang and Loui 2012). Baytiyeh and Naja (2011) identify professional attitude, social attitude, financial attitude and subjective norm as factors influencing choices regarding PhD study for engineering graduates; Jiang and Loui (2012) add the sense of attachment to the university department as another important influence in this decision making. While a clearer picture about the motivations underpinning students’ decisions to undertake research degrees is starting to develop, very little has been published relating to the barriers to continuing study. Although Crede and Borrego (2011) comment briefly on barriers for Engineering students more generally, reliable information relating to ICT specifically appears to be virtually non-existent. As has been found when attempting to encourage greater participation in undergraduate education, understanding these barriers is important for policy makers and universities to develop appropriate strategies for reducing or removing them (Gorard 2006). A recent review of research into access to doctoral education reveals that there is little research into the barriers to students continuing to postgraduate degrees of any sort (McCulloch and Thomas 2013) and this current project, involving students at three Australian universities, goes some way towards addressing that knowledge gap through a specific focus on ICT.

2 Method

The current paper asks: what are the barriers for ICT students moving into study for a research degree? To the best of our knowledge, there is no relevant questionnaire readily available to conduct our investigation. Therefore, a questionnaire was designed to identify the level of interest in pursuing a research degree and the barriers/motivations relevant to those decisions amongst current undergraduate and Honours/Masters students.

2.1 The Questionnaire

The complete questionnaire contained three main sections. Section 1 contained four statements regarding students’ intentions after completing their current degree, that is, whether they intended to leave higher education or continue studying (in a different undergraduate degree, in a Masters by coursework degree, or in a research degree). Section 2 contained 13 statements regarding possible barriers to undertaking a research degree. The third section contained 17 statements regarding possible motivations for undertaking a research degree.

Respondents were asked to answer Section 1 and either Section 2 or 3. In each section, they were asked to respond to statements on a 7-point Likert scale with responses ranging from 1 (strongly disagree) to 7 (strongly agree). In addition to the closed questions, respondents were also invited to provide qualitative
comments at the end of each section. The focus of this paper is on responses to Section 2, which investigated the reasons students identified for not choosing to continue into research degrees.

2.2 Questionnaire Design
Since there is no existing research that focuses directly on the barriers for pursuing a research degree, we used related studies to develop a questionnaire. The main sources for this are Park et al. (2010), who have discussed barriers to undertaking research degrees in medical science. We also used the insights of Naturalistic Decision Making (NDM) (Klein, 2008), particularly in relation to the influence of “past experience” in decision making. Finally, the researchers' domain knowledge gained from extensive experience of the sector was used to inform the questionnaire design. In summary, the questionnaire items were based on five main themes: 1) Financial reasons (4 questions); 2) Attitude (2 questions); 3) Value for degree (2 questions); 4) Lack of awareness (3 questions); and 5) Past experience (2 questions). Participants were invited to indicate the strength of the influence of each element on a 7-point Likert scale, ranging from 1 (not at all) to 7 (a lot). Respondents were also invited to provide comments at the end of each section. Respondents were invited to answer Section 1 and either Section 2 or 3. Here we report on the reasons students identified for choosing not to continue into research degrees.

2.3 Survey Administration and Participants
The three universities involved in this study have different histories, and different strategic and research priorities. They represent three different types of universities: University One is a member of the Group of 8 (Go8) leading research-intensive universities; University Two is part of the Australian Technology Network (ATN) that focuses on the practical application of tertiary education; and University Three is an Innovative Research University (IRU), a collaboration that comprises research universities established more recently than the Go8 group.

Human Research Ethics approval was granted by each of the three universities and hard copies of the survey were handed out in ICT final year undergraduate and Honours/Masters classes. Altogether 172 responses were received. All the respondents answered Section 1 regarding intentions following graduation, and 136 respondents answered Section 2 regarding barriers to undertaking a research degree.

2.4 Overview of the Analysis
Two approaches have been taken to analysing the data gathered in the survey. Firstly, we conducted an overall analysis of the responses (regarding post-course intentions and barriers for pursuing a research degree) using descriptive statistics and then explored the reasons for those decisions in closer detail according to differences between university types (Go8, ATN and IRU). Secondly, an Exploratory Factor Analysis was undertaken to investigate the underlying structure of factors that are perceived by students to be potential barriers to continue studying in a research degree.

2.5 Preliminary Analysis: Descriptive Statistics
An initial evaluation of the dataset resulted in the elimination of seven respondents who had completed less than 75% of the questionnaire. For all other respondents, missing scale items were imputed by determining the mean for the items on the scale (an appropriate data replacement strategy when less than 5% of data is missing) (Tabachnick & Fidell, 2007). No outliers were found for Section 1; one outlier was detected and removed from Section 2. Descriptive statistics regarding demographic characteristics of all respondents, including details of gender, nationality, age, current university and levels of study, are presented in Table 1. We have

<table>
<thead>
<tr>
<th>University One</th>
<th>University Two</th>
<th>University Three</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-course intentions</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Barriers to doctoral study</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

Table 1: Descriptive statistics for respondents
interacted responses of 5, 6 and 7 as indicating broad agreement with the statement, whereas 1, 2 and 3 indicate broad disagreement.

The data satisfy the assumption of homoscedasticity, therefore t-tests could be carried out. In line with the central limit theorem, means of samples from a population with finite variance approach a normal distribution regardless of the distribution of the population. Provided the sample size is at least 30, we can assume that sample means are normally distributed. Given our smallest sample size for a t-test is 44, assumptions of normality are satisfied.

2.6 Exploratory Factor Analysis
Exploratory Factor Analysis (EFA) was used to investigate the underlying structure of factors that are perceived by current final year undergraduate and Honours/Masters students to be potential barriers to continue studying in a research degree. EFA is used to reduce a large number of variables into a smaller set of variables (also referred to as factors) and, as its name suggests, it is exploratory in nature and has the advantage of having no expectations of the number or the nature of the factors. Therefore, it is not expected that the themes identified in the questionnaire development stage would necessarily emerge as distinct factors in the EFA. Nevertheless, the results obtained through EFA enable identification of the most important factors for not continuing into a research degree.

3 Post-course intentions
Table 2 shows the respondents’ intentions following completion of their current undergraduate/Masters degree with most (78%) intending to leave the university system for employment after completion of their current degree. The most common response for this statement was 7 on the Likert scale. The statement “continue studying in a different undergraduate degree” received the lowest percentage for broad agreement (12%) with the most common response being 1 on the Likert scale. “Continue studying in a Masters coursework degree” (25%) and “continue studying in a research degree” (27%) received similar levels of broad agreement. However, these options were not interpreted by the respondents as being absolutely mutually exclusive, demonstrating the potentially fluid nature of post-graduation decision-making, with 13% of respondents being in broad agreement with both the possibility of pursuing a Masters by coursework degree and also the possibility of pursuing a research degree. This fluidity is also demonstrated by the fact that 17% of respondents were in broad agreement with both “I want to leave the university and get a job” and “Continue studying in a research degree”. Fluidity in intention (and thus decision-making) is something that comes through the results fairly consistently and has implications for both policy makers and university administrators.

Table 2 also shows that the majority of the students in all three institutions plan to leave the university and find a job after completing their current degree (S1). Interestingly, while 14% of students from both the Go8 and IRU universities broadly agreed to the possibility of continuing studying in a different undergraduate course (S2), just 4% of students from the ATN university indicated this intention. Although the responses here are from institutions with different emphases on research,
similar percentages of students intended to continue studying in a research degree (S4): University One (Go8) 27%, University Two (ATN) 24% and University Three (IRU) 33%. Not all have decided on their next step, though: 24% of students from University One, 16% from University Two and 10% from University Three remain uncertain about pursuing a research degree. While such uncertainty in ICT areas is considerably less than that found by Shaw et al. (2013) in a cross-institutional study of Honours students in all faculties (which stood at one third of students), this level of uncertainty supports the earlier contention that the decision-making process regarding research degrees is not static but fluid.
4 Barriers to doctoral study

The reasons for deciding not to continue studying in a research degree are shown in Table 3. The most common reason given was the desire to start earning money (S1) with 85% of respondents being in broad agreement with this statement, and most commonly representing this at 7 on the Likert scale. This was followed by being tired of studying and wanting a change (67% of respondents), which most commonly scored 6.

The least common response in this section was “I never thought about it” (21% in broad agreement), while two thirds (66%) were in broad disagreement with this statement. This suggests that many of the respondents have considered embarking on a research degree, but decided against it. Interestingly, 38% of respondents expressed broad agreement with the statement “I don’t really know what it would involve” and that 31% of respondents were in broad agreement with “I don’t know anything about research”. Perhaps students do not consider the possibility of undertaking research because of a lack of knowledge or understanding about what form that might take in ICT.

4.1 Effect of Institution

Comparing results between universities reveals some interesting patterns (Table 3). The most common barrier to pursuing a research degree for all institutions was overwhelmingly the desire (or need) to earn money, in line with the findings of Crede and Borrego (2011) that financial reasons pose a major barrier to postgraduate study in the US context. Some students (especially those from ATN University Two) also seem to believe that employers may not want people who are too highly qualified (S12). A higher percentage (65%) of the IRU University Three students were in broad agreement that they do not know what research would really involve compared to the students of Go8 University One (33%) and students of University Two (38%); in a possibly related finding, a higher proportion of University Three students thought their grades would not be high enough to allow them to pursue doctoral study. When added to those students at Universities Two and Three who report a lack of knowledge about research being a barrier, this may indicate that options for postgraduate study in ICT are not presented effectively at any of the three institutions studied here, regardless of the broader institution’s priorities regarding research. Furthermore, 80% of students at the ATN, 70% of the students at the IRU and 61% of students at the Go8 university were in broad agreement that they are tired of studying and want a change.

5 Factors influencing decisions not to pursue research degrees

In seeking to uncover the underlying structure of the barriers to undertaking a research degree, we conducted an Exploratory Factor Analysis. This involves a series of sequential steps (e.g., selection of the number of factors, selection of the factor rotation method) that also involve evaluating multiple options. This procedure is explained in detail in our previous work (Quérin et al., 2014).

Although sample size is important in factor analysis, there is no agreement as to the optimum or minimum number and a variety of opinions can be found in the literature. Hair et al. (1995) suggest that sample sizes should be 100 or greater. For Comrey and Lee (1992), 200 is seen as a fair sample size. However, MacCallum et al. (1999) take the view that such rules of thumb can be misleading, explaining that they often fail to take into account the complex dynamics of a factor analysis. As an example, when communalities are high (greater than .60) and each factor is defined by several items, appropriate minimum sample sizes can actually be relatively small (Henson, 2006). In our study, as presented in Table 4, most of the communality values are greater than 0.6. It is also worth noting that Sapsas and Zeller (2002) point out that even as few as 50 cases may be adequate for factor analysis.

The ratio of subject-to-variable is an important aspect to be considered before conducting an EFA. When total sample size increases, this ratio becomes less important; on the other hand, the subject-to-variable matters more when the sample size is relatively low (Osborne & Costello, 2004). Further, for a large sample size or large ratio, the results will be more reliable (Osborne & Costello, 2004). In our study, even though the sample size was 133, a significant case-to-variable ratio of approximately 10:1 was present, allowing us to make strong claims from the data.

The correlation matrix was inspected for correlations in excess of 0.3. The literature warns that, if no correlation exceeds this, the applicability of factor analysis should be reconsidered (Tabachnick & Fidell, 2007). The Kaiser-Meyer-Olkin measure of sampling adequacy tests whether the partial correlations among variables are small and this was 0.65, above the recommended value of 0.6 (Hair et al., 2009). Bartlett’s test of Sphericity tests whether the correlation matrix is an identity matrix, hence can be used to determine whether the factor model is appropriate. This value was significant (p<0.05) (c^2 = 443.1, df=78, Sig.=0.000), indicating the possibility of using factor analysis with the data.

For the 13 items used in the questionnaire, a Principal Component Analysis (PCA) was conducted. To determine the number of factors to retain, we used Parallel Analysis (PA). In recent research, PA is often recommended as the best method to assess the number of factors (Lance, 2006; O’Connor, 2000; Velicer et al., 2000). PA takes into account sampling error and retains factors when actual eigenvalues surpass random ordered eigenvalues. Parallel Analysis indicated that four factors should be retained. Initially, the four factors accounted for approximately 61% of the total variance; this is in line with the heuristic recommended by Hair et al. (2009), which states more than 50% of the variance should be explained by the retained factors.

Factor rotation maximises high item loadings and minimises low item loadings, therefore producing a more interpretable and simplified solution. As suggested by Tabachnick and Fiddell (2007), we undertook an oblique rotation first and inspected the correlation of factors. Since no correlation exceeds the threshold of 0.32,
Following an exploratory factor analysis, factor scores may be computed and used in subsequent analyses. A factor score is a numerical value that is meant to indicate a person’s relative spacing or standing on a latent factor. Therefore, factor scores were computed for every participant based on Bartlett factor coefficients. The Bartlett method is considered to be a redefined method of computing factor scores. Redefined methods aim to maximize validity by producing factor scores that are highly correlated with a given factor and also attempt to maintain the existing relationships between factors. In order to identify whether there are any significant differences among the four factors and to identify the most important factor, repeated measures ANOVA (Analysis of Variance) was carried out.

Basically, ANOVA provides a statistical test to determine if the means of several groups are equal or not. This can be seen as a generalization of the t-test for more than two groups. The reason for carrying out a repeated measures ANOVA test as opposed to multiple t-tests is as follows. Every time one conducts a t-test there is chance of making a type I error that corresponds to the confidence interval. Therefore, when more hypothesis tests are carried out, there can be more risk of making a Type I error and the power of the test can be significantly reduced. However, the ANOVA test controls these errors and the Type I error remains at 5%.

Repeated measures of ANOVA indicated significant differences among the four factor scores (F(3,396)=39.41, p<0.05). The ‘Change orientation’ was shown as the most important for the participants (mean=5.7). This was followed by the ‘Perception of research’ factor (mean=4.3), ‘Financial Factor’ (mean=4.1) and the ‘Career Orientation Factor’ (mean=3.6). However, repeated measures of ANOVA do not indicate where these differences occur exactly. Therefore, we conducted a post hoc test using the Bonferroni technique which indicated significance (p<0.05) differences between ‘Change Orientation’ and all other factors.

6 Discussion and Conclusions

The results reveal interesting variations and similarities across the university groups considered in this study. The large majority of students surveyed across the three universities intended to leave the university system and find a job on completing their current undergraduate or Masters degree. Their readiness in expecting to be a practicing professional is high, as the ANOVA test as opposed to multiple t-tests is as follows. Every time one conducts a t-test there is chance of making a type I error that corresponds to the confidence interval. Therefore, when more hypothesis tests are carried out, there can be more risk of making a Type I error and the power of the test can be significantly reduced. However, the ANOVA test controls these errors and the Type I error remains at 5%.

Repeated measures of ANOVA indicated significant differences among the four factor scores (F(3,396)=39.41, p<0.05). The ‘Change orientation’ was shown as the most important for the participants (mean=5.7). This was followed by the ‘Perception of research’ factor (mean=4.3), ‘Financial Factor’ (mean=4.1) and the ‘Career Orientation Factor’ (mean=3.6). However, repeated measures of ANOVA do not indicate where these differences occur exactly. Therefore, we conducted a post hoc test using the Bonferroni technique which indicated significance (p<0.05) differences between ‘Change Orientation’ and all other factors.

6 Discussion and Conclusions

The results reveal interesting variations and similarities across the university groups considered in this study. The large majority of students surveyed across the three universities intended to leave the university system and find a job on completing their current undergraduate or Masters degree. Their readiness in expecting to be a practicing professional is high, as the ANOVA test as opposed to multiple t-tests is as follows. Every time one conducts a t-test there is chance of making a type I error that corresponds to the confidence interval. Therefore, when more hypothesis tests are carried out, there can be more risk of making a Type I error and the power of the test can be significantly reduced. However, the ANOVA test controls these errors and the Type I error remains at 5%.

Repeated measures of ANOVA indicated significant differences among the four factor scores (F(3,396)=39.41, p<0.05). The ‘Change orientation’ was shown as the most important for the participants (mean=5.7). This was followed by the ‘Perception of research’ factor (mean=4.3), ‘Financial Factor’ (mean=4.1) and the ‘Career Orientation Factor’ (mean=3.6). However, repeated measures of ANOVA do not indicate where these differences occur exactly. Therefore, we conducted a post hoc test using the Bonferroni technique which indicated significance (p<0.05) differences between ‘Change Orientation’ and all other factors.

6 Discussion and Conclusions

The results reveal interesting variations and similarities across the university groups considered in this study. The large majority of students surveyed across the three universities intended to leave the university system and find a job on completing their current undergraduate or Masters degree. Their readiness in expecting to be a practicing professional is high, as the ANOVA test as opposed to multiple t-tests is as follows. Every time one conducts a t-test there is chance of making a type I error that corresponds to the confidence interval. Therefore, when more hypothesis tests are carried out, there can be more risk of making a Type I error and the power of the test can be significantly reduced. However, the ANOVA test controls these errors and the Type I error remains at 5%.

Repeated measures of ANOVA indicated significant differences among the four factor scores (F(3,396)=39.41, p<0.05). The ‘Change orientation’ was shown as the most important for the participants (mean=5.7). This was followed by the ‘Perception of research’ factor (mean=4.3), ‘Financial Factor’ (mean=4.1) and the ‘Career Orientation Factor’ (mean=3.6). However, repeated measures of ANOVA do not indicate where these differences occur exactly. Therefore, we conducted a post hoc test using the Bonferroni technique which indicated significance (p<0.05) differences between ‘Change Orientation’ and all other factors.

6 Discussion and Conclusions

The results reveal interesting variations and similarities across the university groups considered in this study. The large majority of students surveyed across the three universities intended to leave the university system and find a job on completing their current undergraduate or Masters degree. Their readiness in expecting to be a practicing professional is high, as the ANOVA test as opposed to multiple t-tests is as follows. Every time one conducts a t-test there is chance of making a type I error that corresponds to the confidence interval. Therefore, when more hypothesis tests are carried out, there can be more risk of making a Type I error and the power of the test can be significantly reduced. However, the ANOVA test controls these errors and the Type I error remains at 5%.

Repeated measures of ANOVA indicated significant differences among the four factor scores (F(3,396)=39.41, p<0.05). The ‘Change orientation’ was shown as the most important for the participants (mean=5.7). This was followed by the ‘Perception of research’ factor (mean=4.3), ‘Financial Factor’ (mean=4.1) and the ‘Career Orientation Factor’ (mean=3.6). However, repeated measures of ANOVA do not indicate where these differences occur exactly. Therefore, we conducted a post hoc test using the Bonferroni technique which indicated significance (p<0.05) differences between ‘Change Orientation’ and all other factors.

6 Discussion and Conclusions

The results reveal interesting variations and similarities across the university groups considered in this study. The large majority of students surveyed across the three universities intended to leave the university system and find a job on completing their current undergraduate or Masters degree. Their readiness in expecting to be a practicing professional is high, as the ANOVA test as opposed to multiple t-tests is as follows. Every time one conducts a t-test there is chance of making a type I error that corresponds to the confidence interval. Therefore, when more hypothesis tests are carried out, there can be more risk of making a Type I error and the power of the test can be significantly reduced. However, the ANOVA test controls these errors and the Type I error remains at 5%.

Repeated measures of ANOVA indicated significant differences among the four factor scores (F(3,396)=39.41, p<0.05). The ‘Change orientation’ was shown as the most important for the participants (mean=5.7). This was followed by the ‘Perception of research’ factor (mean=4.3), ‘Financial Factor’ (mean=4.1) and the ‘Career Orientation Factor’ (mean=3.6). However, repeated measures of ANOVA do not indicate where these differences occur exactly. Therefore, we conducted a post hoc test using the Bonferroni technique which indicated significance (p<0.05) differences between ‘Change Orientation’ and all other factors.
important tentative conclusions can be drawn from this finding. Firstly, these may be the individuals who are most likely to come back to study after a period of working in industry (Baytiyeh and Naja 2011). If this is so, the data suggest that universities would be wise to create easy pathways for such “returners” (Peters and Daly 2013) to re-enter the university system as doctoral candidates; universities should also actively promote this possibility to undergraduates and coursework Masters students.

The second conclusion (and this is supported by a broader range of data as is reported earlier in the paper) is that students’ decision-making about undertaking a research degree is something which is fluid rather than fixed. There is evidence in the responses that some students are not interested in undertaking a research degree because they are not sure what ‘research’ involves. Approximately one third of respondents expressed uncertainty about the form this could take in ICT, and we believe students would benefit from hearing more about their lecturers’ own research experience and research projects, as well as the cutting-edge research being undertaken in their areas. Again, the EFA identified that ICT students’ perception of research was an important barrier to choosing the research pathway on completing their current degrees. Other studies have shown that positive undergraduate experiences of research can influence the choices students make in this regard in related fields (Guerin and Ranasinghe 2010). Because students are expressing a degree of fluidity in their decision-making regarding research degrees, universities would be well advised to make sure that undergraduates understand the nature of research in their disciplines, think of research as a legitimate career path, and know how to pursue such a course of action. The widening participation discourse has promoted this approach in undergraduate education; it is time to apply these insights to doctoral study (McCulloch and Thomas 2013). This type of activity would also contribute to strengthening the teaching–research nexus that has been the subject of considerable discussion in higher education over the last decade (Jenkins et al. 2003; Barnett 2005, Brew 2006, Healey and Jenkins 2006, Simons and Elen 2007, Verburgh et al. 2007, Trowler and Wareham 2008, Brew 2010).

To conclude, the vast majority of students in ICT want to move into the workforce on completing their degrees rather than continuing into research degrees. This may be motivated largely by a desire to start earning money, but there is evidence here (mirroring that found by Crede and Borrego (2011)) that many also find their courses demanding and feel that they need a break from study. Many identify that they are tired of studying and want a change. This is reflected by the high means as a whole in Table 3 (I want to earn money at 5.71; I’m tired of studying at 5.11) and is further supported by the EFA that not only links these two elements as one of the factors, but also indicates that this is the most important factor in the decision-making of this group.

Nevertheless, there is clearly a substantial group who are interested in pursuing a research degree after a break from higher education; ICT departments should make it clear to undergraduate students that this is a possibility, and should also find ways to create smooth pathways back into study for this group. This is particularly important in view of the fluidity in decision-making that we have identified here.

The experiences students have of research during their undergraduate study may be the inspiration that brings them back to study later in their careers. If research can establish what motivates ICT students to continue their studies, including what kinds of undergraduate experience of the teaching–research nexus might influence their decisions, we will be in a good position to support greater numbers of students to pursue research degrees in ICT.

7  Acknowledgements

The authors wish to gratefully acknowledge the support of the Australian Council of Deans of ICT (ACDICT) Learning and Teaching grant (ALTA) which made this research possible.

8 References

Crede, E. and Borrego, M.J. (2011). Undergraduate engineering student perceptions of graduate school and the decision to enroll. American Society for Engineering Education.
Gorard, S. (2006). Review of widening participation research: Addressing the barriers to participation in higher education: A report to HEFCE by the University of York, higher education academy and institute for access studies; HEFCE.


