GENDERED DIFFERENCES IN THE PARTICIPATION OF AUSTRALIAN TERTIARY COMPUTER SCIENCE: IMPLICATIONS FOR SCHOOLS

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Abstract

The representation of males continues to dominate that of females in Information Technology (IT) related studies at both the secondary and tertiary levels. This mixed method study utilises Eccles et al. (1983) Expectancy Value Model for exploring the social, psychological and motivational factors that influence individuals’ participation in Computer Science (CS) or non Computer Science (NCS) undergraduate courses (or majors) in Taiwan and Australia. This paper reports on the Australian data set, from a selected university in Melbourne, of surveys (n=106) and subsequent interviews (n=7). It was found that the most important reason for choosing to study CS for 55% of females was “career prospects” as opposed to “personal interest” for CS males and the majority of the NCS sample. However the reasons indicated by interviewees were in contrast to the survey finding. A conclusion is that the strength of subjective task values (STVs) which individuals attach to IT related subjects and or activities at the secondary level could very likely affect their subsequent participation or non-participation in an IT related field such as CS at the undergraduate level.

The representation of males continues to dominate that of females in Information Technology (IT) related studies at both the secondary and tertiary levels. This difference is also reflected in the IT workforce: while women make up 45% of the Australian workplace, only 18% of the IT workforce were women (Fisher, 2011). Despite considerable research on gendered participation in the general IT field, few studies have investigated the issue of female underrepresentation in a specific IT course (or major) such as Computer Science. This paper specifically aims to understand why there are a disproportionate number of females applying for entry into IT related university degrees. Since the millennium Australian tertiary institutions have reported decreasing enrolments in their IT-related programs overall (Clayton, 2006). The aggregate proportion of females enrolling as new undergraduate IT students in Australian universities declined from 26.2% in 2001 down to 19.5% in 2010 (Department of Education Employment and Workplace Relations, 2012), a total enrolment decline rate of 6.7% in less than a decade. To better understand the trend of dwindling female enrolment in IT, reasons behind individuals’ pursuits of a Computer Science (CS) or non Computer Science (NCS) course (or major) needed exploration. This study is focused on CS as fewer studies focused on reasons accounting for the gender gap in CS.
Expectancy Value Model

The Expectancy Value Model (EVM) is premised on the notion that individuals’ expectancies for success, confidence in one’s ability to succeed and personal efficacy are important determinants of their motivation to perform different achievement tasks, and their choices of which tasks to pursue (Wigfield & Eccles, 2002). Eccles et al.’s (1983) model was designed to examine the social, psychological and motivational factors which influence educational and vocational choices by gender. Additional studies have further validated the model as useful for understanding course enrolment decisions by males and females in mathematics and general IT studies (Eccles, 1994, 2005; Lupart, Cannon, & Telfer, 2004; Zarrett & Malanchuk, 2005).

Of particular interest to this study is Eccles and her colleagues’ (1994) analysis of longitudinal data that revealed senior high school females had less confidence in the science related professions, whereas males had less confidence in the health related professions. In this, and other cases, the subjective task value (STV) component of the Eccles et al. expectancy-value model was found to significantly mediate individuals’ achievement-related decisions, such as the choice to pursue a particular course or major. The STVs are:

- **Interest value (the enjoyment one gets from engaging in the task or activity)**
- **Utility value (the instrumental value of the task or activity for helping to fulfil another short or long range goals)**
- **Attainment value (the link between the task and one’s sense of self and identity)**
- **Cost (defined in terms of either what may be given up by making a specific choice or the negative experiences associated with a particular choice)**  

(Eccles, 2005, p. 9)

Eccles’ research on gender differences in educational and vocational choices explain why females tend to participate more in activities which require people and social interactions, in contrast to males who prefer activities related to abstract concepts or manipulating physical objects (Eccles, 2005). While this difference was felt by Eccles to explain why males were more likely than females to pursue an IT-related course, other studies reveal a number of other potential issues. For instance, Zarrett and Malanchuk’s (2005) six-year longitudinal study involving 700 participants of grades 8 and 11 students found males more highly regarded IT as a prosperous career than females. Additionally, Lupart, Cannon and Telfer (2004) found females were less likely to consider IT-related occupations, as they perceived themselves as less capable than their male peers in advanced computer skills and tasks. Clearly the STVs (such as interest—enjoyment value, utility value, attainment value and relative cost) are important facilitating factors for course (or major) participation. However, while these studies examined gendered decisions and participation in broad fields such as IT-related careers, the research contexts were mainly US based and had not explored individuals’ participation in a specific IT tertiary course (or major). In response to the need for international and fine grained analysis a study was conducted specifically to examine gendered differences in factors for CS and NCS course (or major) participation at the undergraduate level, across two different educational contexts, in Australia and Taiwan.

Research design

Individual’s participation in a tertiary CS or NCS course (or major) is often due to a range of social, cultural, educational, and familial factors. In order to examine the complexity of these factors, a mixed methods approach was utilised. A quantitative study consisting of surveys was taken during Phase 1,
of which the survey results were followed up to develop interview questions for Phase 2. The survey instrument used during Phase 1 was adapted from an original survey instrument used by the Women in IT-Swinburne (WIT-S) project which investigated the decreasing number of women enrolled in IT courses at Swinburne University (Lang, McKay, & Lewis, 2006). The modified survey instrument used items from the WIT-S survey (Lang, et al., 2006) were carefully selected for their relevance to the research aim of this study: to explore the key factors for CS and NCS course (or major) participation at the undergraduate level in Australia and Taiwan. The modified survey was created by using the EVM as a guide to explore a range of social, psychological and motivational factors which affect individuals’ tertiary course (or major) pursuits by examining three particular aspects: a) participants’ demographics and secondary educational experiences and IT-related exposure prior to enrolment; b) participants’ perceptions of own skills in IT-related tasks or activities, and reasons and influences over their course (or major) pursuits during the decision-making process; and c) participants’ interpretations of the usefulness and relative link between their courses and their desired professions after graduation. The modified survey was piloted and revised before it was administered via SurveyMonkey to undergraduate participants at two selected universities in Australia and Taiwan.

The survey results were analysed and a list of interview questions were compiled and used to conduct in-depth interviews to gain richer, more personal accounts of individuals’ choices of CS and NCS undergraduate courses (or majors) in Australia and Taiwan. The interview questions were designed to specifically examine the social factors (e.g. stereotypical notions of CS, family or other influences for course or major pursuits), psychological factors (e.g. rapport with lecturers, classroom environment) and motivational factors (e.g. anticipation of success in chosen studies and in future professions).

Using the EVM model, the interview findings were then further used to interrogate with the survey findings in further identifying and understanding the similarities and differences in course (or major) pursuits by gender and/or within samples (CS and NCS). This paper presents findings from the Australian sample. The Australian survey sample consisted of 32 (M=21, F=11) participants studying a CS degree (or major), and 74 (M=23, F=51) participants who were studying in fields other than CS (NCS). Chi-square tests were conducted to explore if the reasons for course (or major) participation were statistically significantly different by gender in the CS and NCS samples. There were also seven (M=3, F=4) participants who participated in a 45 minute interview: three CS participants (M=1, F=2) and four NCS participants (M=1, F=3).

Findings

Eccles (2011) argues that gender differences in course (or major) enrolment in the physical sciences and engineering are mediated by gender differences in the relative subjective task values (STVs) attached to these fields. The findings of reasons for course (or major) participation are presented in this paper due to two main observations: a) although “career prospects” was the most common reason selected by the majority of the CS sample and NCS females, CS participants revealed that career prospects were not the main reason for their pursuits of a CS course (or major) when interviewed, and b) while half of CS males and the NCS sample explained personal interest (“other reason”) as the most important reason for their course (or major) pursuits, half of CS females nominated “career prospects”. The frequencies (and percentages) of participants’ responses to reasons for course (or major) participation are presented in Table 1.
Table 1.
Frequencies (and percentages) of responses to reasons for course (or major) participation by gender and group membership (CS and NCS).

<table>
<thead>
<tr>
<th>Item choice</th>
<th>Why did you choose your current course? (You may choose one or more)</th>
<th>Which one of A to F was the most important reason?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS Group</td>
<td>Male N (%)</td>
</tr>
<tr>
<td>A. Challenging</td>
<td>CS</td>
<td>12 (67%)</td>
</tr>
<tr>
<td></td>
<td>NCS</td>
<td>15 (68%)</td>
</tr>
<tr>
<td>B. Future income</td>
<td>CS</td>
<td>5 (28%)</td>
</tr>
<tr>
<td></td>
<td>NCS</td>
<td>9 (41%)</td>
</tr>
<tr>
<td>C. Career prospects</td>
<td>CS</td>
<td>13 (72%)</td>
</tr>
<tr>
<td></td>
<td>NCS</td>
<td>13 (59%)</td>
</tr>
<tr>
<td>D. Peer influence</td>
<td>CS</td>
<td>2 (11%)</td>
</tr>
<tr>
<td></td>
<td>NCS</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>E. Encouragement from family/friends</td>
<td>CS</td>
<td>2 (11%)</td>
</tr>
<tr>
<td></td>
<td>NCS</td>
<td>4 (18%)</td>
</tr>
<tr>
<td>F. Other reasons</td>
<td>CS</td>
<td>4 (22%)</td>
</tr>
<tr>
<td></td>
<td>NCS</td>
<td>7 (32%)</td>
</tr>
</tbody>
</table>

Table 1 shows that while “challenging” was selected by two-thirds of NCS males (15: 68%) for their course or major participation, “career prospects” was the most common reason for course participation for the CS sample (M=13: 72%, F=8: 73%) and NCS females (35: 71%). However, CS participants interviewed revealed career prospects were not the most important reason when they first decided to enrol in CS.

I was first enrolled in materials engineering. I realised I didn’t like it at all. So I switched back into something that I enjoyed. (Jarrad, CS male).

I chose CS as it would support what I will later be learning in geodynamics… (Sinead, CS female).

I could do double degrees, like primary teaching and computer science…I was also told by my teacher that it was probably a good idea to do double degrees. (Kerryn, CS female).

In these quotes, the participants reveal that they had attached various STVs to CS which prompted their enrolment in CS. Jarrad attached a strong “interest—enjoyment” value to CS, hence the reason for changing from materials engineering to CS. Sinead in contrast appeared to have attached a strong utility value to CS as it will enable her to advance in her degree aspirations, while for Kerryn it was to achieve her short-term goals (doing a double-degree course) as well as meeting her long-terms goals of becoming a computer scientist and a CS teacher.

In contrast, the NCS participants explained in their interviews that career aspirations were a large reason why CS was not attractive to them. For instance, Ryan (NCS male) stated that CS ‘just didn’t have an attractive end of career… I saw more attractive options with the course I currently chose.’ Ryan’s decision indicated a perception of the relative cost of pursuing CS was too high and outweighed other preferred options, therefore a CS pursuit became unlikely. The STV of cost also appeared to be particularly influential in Zoe’s (NCS female) decision: ‘I was more interested in biology and chemistry, and working with people as well. I think in CS, you probably don’t work with people as much, it’s more of a solo profession.’ Zoe clearly valued working with other people and that this was contrary to her perception of CS. Similarly Tess (NCS female) reported that CS was deficient
because she wanted a ‘more hands on course.’ In the cases of both Zoe and Tess it is possible that they were also influenced by the attainment value, in that CS did not sufficiently align with their sense of self and identity, that is, as socially oriented (Zoe) and hands-on (Tess) workers.

Even though career prospects were reported by NCS participants interviewed as an important factor for their course (or major) participation, personal interest (“other reasons”) was deemed as the most important factor by one-third (7: 39%) of CS males and half of the NCS sample (M=11: 50%, F=25: 51%). Chi-square tests revealed no statistically significant differences by gender in the CS sample and the NCS sample. However, the interview findings did find that personal interest facilitated course (or major) pursuits for CS females than “career prospects” as revealed by the survey finding. For example, ‘I like using computers’ was what prompted Kerryn to pursue a tertiary CS course. It was also Kerryn’s career goal of becoming a female computer scientist that motivated her CS course pursuit. Jarrad’s strong “interest—enjoyment” value attached to the CS course was highly evident when he expressed ‘I’m good at it…if you’re doing a course you enjoy it’s probably going to lead to a line of work that you’ll also enjoy.’ Other studies also found that previous successful experiences in IT-related studies during secondary school often prompted subsequent pursuit of an IT related course (or major) (Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008). Sinead’s perception of her ‘good logical thinking’ appeared to encourage her pursuit of a CS major ‘...the more logical you are, the more likely you are to enjoy programming and I found that was the case.’ McInerney (2006) also identified that females’ strong interest in programming served as the primary motivation for studying CS. In contrast, Zoe’s main reason for choosing her current study (medicine) rather than CS was due to her stereotypical perception of CS as ‘stuck with computers all day’. Clayton’s (2005) study also found that females are more likely to consider professions which value working with people than occupations which seem more technical and solitary. In addition to stereotypical perceptions of CS related professions, it was also found that a lack of female role models in IT could discourage some females from entering the field (Stockdale & Stoney, 2007; Wasburn & Miller, 2004). For instance, when Zoe (NCS female) was asked if she would have considered studying CS at the tertiary level, she stated “yes” but only if she had obtained real-life accounts from female IT professionals of what it is like to work in IT while she was at school.

Overall, findings from the Australian sample on reasons for choosing a CS or NCS course (or major) suggested that in addition to self-efficacy beliefs in IT-related tasks (Bandura, 1997), parental influences (Clayton, 2006; Margolis & Fisher, 2002) and previous IT-related experiences at school (McInerney, 2006; Messersmith, et al., 2008), personal interest (e.g. enjoyment—interest value) attached to the subject matter (course or major) and anticipation of success in prospective careers associated with the studies were the two most important factors for participants’ pursuits of CS and NCS courses (or majors).

Conclusion

Using Eccles et al.’s (1983) model for exploring key factors for course (or major) participation, it was found that the subjective task values (STVs) strongly influenced course (or major) pursuits. In particular a strong “interest—enjoyment value”, or a strong “utility value” attached to IT-related activities and tasks promoted subsequent CS course (or major) participation at the tertiary level. This means that initiatives to increase female participation in IT undergraduate courses need to consider both interest and utility values. At the tertiary level females should be encouraged to work on projects which appeal to their particular interests, as well as to engage in industry-based learning (IBL) opportunities related to their studies. Similarly at the secondary school level female students can be encouraged to engage in collaborative projects which appeal to their interests while using a range of technological tools to complete set tasks, and most importantly, be clearer about how they can use
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their IT skills in current and future studies, as well as in their envisaged professions. Similar to that of Murphy’s (2006) finding, this study also found that teachers can make IT (or CS) careers more appealing by considering female students’ interests, such as by showing them how technology can make a difference in helping people (e.g. track and monitor the progress of seriously-ill patients who are receiving intensive medical treatments over time).

The STVs individuals attached to IT during secondary years are likely to affect their subsequent pursuits of an IT (or CS) course (or major); yet individuals often choose not to due to a lack of understanding of the IT-related studies and professions. It is clear that when individuals, and particularly females, have a fuller awareness of the possibilities in the field of IT, they will be less likely to associate IT-related careers with the same routine tasks they had to complete at school (Leech, 2007). This study helps to describe individuals’ decision making in choosing to participate in CS and NCS courses (or majors) and can serve as a guide for schools and educators to reconsider existing curriculum and to provide additional programs for students who may have other IT-related interests which are not catered for in traditional IT curriculum or classes. Other extracurricular programs such as computer clubs can also provide individuals with more opportunities to do hands-on activities, such as developing programming codes for operating robots can also appeal to more students to value IT (or CS) as a creative, fun and interesting domain which offers attractive study and career opportunities.

References


