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Factors that influence students' plans to take Computing and Information Technology subjects in senior Secondary School

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This paper explores factors that contribute to low participation rates in Computing and Information Technology (CIT) courses in senior secondary school, particularly for females. Partly drawing on the Values-Expectancy Theory the following variables are explored separately and within a single model: gender, ability and values beliefs, access and use at home and at school. As well as presenting results consistent with current literature, an inclusive and eclectic model is developed. The model indicates that, in addition to gender and the student's beliefs about the value of the subjects, plans to take CIT subjects are also affected by the amount of use of IT at school. These school-related factors are inter-connected either directly or indirectly with students' beliefs about their IT abilities at both school and home, as well as the amount of use at home. For educators who seek to improve participation rates, particularly for females, the identification of school-related variables is encouraging, as the school - unlike the home - is a relatively accessible site of intervention.

Keywords: computing studies, schooling, participation, gender

Introduction

For the past decade participation rates in Computing and Information Technology courses at schools and universities have been declining in countries such as Australia and the United States (Downes & Kleydish, 2007). As both the rates of participation and the rates of decline are gendered there has been much interest in identifying the factors that contribute to this gendering (Anderson, Lankshear, Timms & Courtney, 2008; Barker & Aspray, 2006; Clegg, 2001; Dryburgh, 2000; Miura, 1987). Sitting alongside these studies have been critiques of approaches that position the decline and the gender differences as 'problems to be solved' or in terms of girls' disadvantage or deficit (Abbiss, 2008; Jenson, de Castell & Bryson, 2003). Similarly there are critiques of approaches that focus on the gender differences rather than the similarities, or report only on girls, even though the decline has also included boys, and overall, more boys choose not to participate than to participate in CIT subjects in secondary schools (Barker & Aspray, 2006).

It is within this framework that this paper reports the findings of an analysis of survey and focus group data from both males and females who participated in a Girls and IT (GaIT) study, funded by the Australian Research Council. That study explored the gendered nature of participation, experience and performance in senior secondary Computing and Information Technology (CIT) subjects from a variety of perspectives (Lynch, 2007). The results of the GaIT study reveal a complex interplay of factors that position senior CIT subjects in particular ways in secondary schools, and that influence male and female students' decisions to choose, or more commonly not choose, these subjects as part of their senior studies in secondary schools. These factors include the broader social milieu; the nature and perception of the field and careers; the curriculum framework and pedagogies in the schools' early secondary years as well the imagined curriculum of the senior years; and the gendered identities of the students (Lynch, 2007).

The analysis of the curriculum framework in the GaIT project revealed a real disjuncture between experiences and expectation in the junior years, and the nature and content of the major Computing and IT syllabuses in the senior years (Downes, 2007; Downes and Kleydish, 2007; Vickers and Ha, 2007). This is important, because at the end of Year 10 (aged 15) students select their senior-years subjects which, along with the compulsory study of English, collectively count for their end-of-school certificate and for entry into further education. Students select their subjects based on information provided by the various teaching departments in their school. In the GaIT study, many students came to their decision point believing that they were rejecting subjects that taught them more about how to use computers and/or how computers can be used rather that how computers and computing 'worked' – the actual content of CIT subjects. In contrast, another Australian study found that non-takers associated senior CIT subjects with programming and other highly technical skills and were not able to differentiate between different types of senior CIT subjects (Lasen, 2010). Nevertheless, subsequent analysis of participation rates of the state-wide cohort who went on to take CIT subjects for their 2007 New South Wales (NSW) Higher School Certificate revealed that the students who chose the various CIT options (takers) had some understanding of both the nature and difficulty of these subjects (Downes & Thiessen, under review). This is shown by the fact that the more able students took the more difficult subjects and the less able students the vocationally oriented subject. Further, the gendered patterns of participation reflected were stereotypical, with the lowest proportion of girls taking the subject with the most programming, and the greatest proportion taking the more information/application based subject. Abbiss (2009) reflects on this stereotyping as a 'paradox of choice'. That is, curriculum options designed to meet the needs and interests of students do not necessarily challenge existing gendered stereotyping. These complexities and confusions raise the question as to whether the relationship between factors identified in the traditional literature on subject choice would be applicable in a case where such complexity and confusion exist.

In the general literature on subject choice the Values-Expectancy Theory (Wigfield & Eccles, 2000) provides a comprehensive framework to predict choice. This theory suggests that both ability beliefs (self perceptions of ability) and value beliefs (perceptions of importance, usefulness, enjoyment and cost) influence academic choices, performance and career paths. Research confirms that in 'gendered' academic domains, boys and girls differ in their ability and value beliefs in ways consistent with the gendered norms (Abbiss, 2005; Meece, Glienke & Borg, 2006). For example, there is evidence that females tend to downplay their abilities in mathematics and science related subjects, including CIT, while males tend to overstate theirs (Thiessen, 2007). Research specific to IT in education and on CIT studies in secondary schools and colleges identifies gender differences in interest, self-perceived ability in the subject, perceived usefulness and value of the knowledge involved and perceived contribution to career or further study (Adey & Biddulph 2001; Elsworth, Harvey-Beavis, Ainley & Fabris 1999; Nagy, Trautwein, Baumart, Koller & Garrett 2006; Vickers & Ha 2007, Watt 2006). The same body of literature also describes historical differences between boys' and girls' access to and use of computers at home and school (Colley & Comber, 2003; Durndell, Glissov & Siann, 1995; Schumacher & Morahan-Martin, 2001), differences in types of use (Colley & Comber, 2003; Durndell, Glissov & Siann, 1995; Schumacher & Morahan-Martin, 2001) and socialization and cultures of practice and use (Cockburn & Ormrod, 1993; Turkle, 1984; Downes, 2005).

In the more recent studies, including the early GaIT work, the focus is on particular relationships and factors related to choice of CIT subjects. Teachers, curriculum and pedagogy have been the focus of work by Abbiss (2009), Gannon (2007), Reid & van den Akker (2007) and Vekiri (2010), and student perceptions of interest and usefulness and scope of subjects, of work by Anderson et al (2008) and Lasen (2010). Each study provides interesting pointers to some of the factors that influence choice, particularly in the area of value beliefs (from the Values-Expectancy Theory). However, while some studies from the 1980s and 1990s explore beliefs about self-efficacy (Bandura, 1977, 1986, 1991 Miura, 1987), few of the recent studies, focus on beliefs about ability, one of the key elements of the Values-Expectancy Theory. Those that do raise interesting questions about the relationship between perceived ability and subject matter choice. For example, Vickers & Ha (2007) found that students with high perceived ability with technical tasks were no more likely to select CIT subjects than students with low perceived ability with these tasks.

The study presented in this paper addresses this gap in the literature by engaging in further analysis of the GaIT survey and focus group data to generate a deeper understanding of the relationship between CIT subject choice and ability and value beliefs, as well as access to and use of IT at home and school. By drawing these factors together in a single analysis, an attempt is made to identify the relative impact of different factors or pathways of influence that better illuminate the multiplicity of factors. This will enable further investigation of the role that gender plays in CIT subject choice within the context of variables drawn from Value-Expectancy theory as well as those drawn from several decades of literature on access and use.

An obvious limitation to the analysis is the constraints imposed by the original data set (see Lynch, 2007 for details). However, there are three very important strengths of the original data set. Firstly, it includes data for both male and females students, so both similarities and differences can be examined; secondly the data includes questions relating to the value that students place on taking computing and other classes at school; and thirdly the data was collected at the point of decision making as the students were making their choice to be takers or non-takers of CIT subjects, as they imagined them to be. This is in contrast to most other studies that work with students who are already taking/not taking the CIT subjects. The data set also allows us to look more generally at factors that affect choice of CIT subjects, regardless of gender.

Data

Data in this study are drawn from the Australian Research Council funded Girls and IT (GaIT) study undertaken between 2005 and 2007. The original study involved surveys and discussion groups with students and interviews with teachers in secondary schools across three Australian states (New South Wales (NSW), Victoria and South Australia), as well as a content analysis of formal curriculum frameworks and senior secondary CIT syllabuses, and interviews with curriculum designers/managers. As only the surveys from the 11 NSW schools had the full range of questions related to the focus of this paper, they are the only schools included in our analysis. They generated 722 surveys that included information on plans to take one or more of the CIT subjects on offer in NSW senior secondary schools.

The schools in NSW as in the other states were selected to maximise variation in the participation rates of girls taking the CIT subjects available in that state and include a range of locations (urban and regional) and community backgrounds (based on known data of SES of school community). The students who participated in the survey and the discussion groups were in Year 10, and were about to select their subjects for their two senior secondary years and end-of-school credential. It is the surveys and the student discussion groups that form the basis of the current analysis.

The three CIT subjects available in senior years are: Information Processes and Technology (IPT); Software design and development (SDD); and Information Technology, a Vocational Education and Training Curriculum Framework subject (ITVET). These subjects can best be described as focusing respectively on: information systems and technologies; computing and software development; and the foundations of technical and user support (a vocationally oriented subject). All three subjects have distinct content orientations, so students are able to choose to do one, two or three of these subjects. In terms of level, Software Design and Development (SDD) is the most difficult, and Information Technology (ITVET) is the least difficult, though more technical and vocationally orientated.

The survey contains a range of demographic questions, as well as questions about: sites of use and learning about IT; nature of use; self-perceived ability; interest/attitudes to school, CIT and other subjects such as Mathematics and English; reasons for choosing/not choosing various school subjects and CIT subjects in particular; and post-school plans. Where appropriate, questions used either yes/no, 5 point rating scales or open ended responses. The key data selected from the surveys for this analysis[1] were:

- Student demographics: gender; parental education; access to and use of computers at home and at school.
- Plans to take CIT subjects in Years 11 and 12.
- Self perceived ability in nine different IT home-related tasks.
- Self perceived ability in CIT subjects in school.
- Attitudes towards CIT subjects and other school subjects (Mathematics and English) and schooling in general from which measures of 'value' were constructed

[1] The students were also asked about their perceptions of an "ideal" job and their perceptions of jobs in IT fields. These measures were examined, but found not to be related to the plan to take CIT courses, and so are not reported here.

The key gender differences are presented in terms of percentages; in many cases response categories were collapsed from 5 to 3 categories for readability of the tables. The multivariate analyses towards the end of the paper involve (a) logistic regression for Table 10, where the dependent variable is the dichotomy "planned to take/did not plan to take a CIT subject", and (b) ordinary least squares regression for all other, multi-category dependent variables. For the regression analyses the full range of response options (five categories) were utilized for the relevant measures (that is, without the recodes used to simplify the presentations in the cross-tabulation tables).

Forty-two student discussion groups were held in NSW. They were held with students in small groups ranging from three to seven students with most comprising four or five students. In most cases, students were selected and grouped according to gender and level of interest in CIT (as indicated by their survey responses) such that, where practical, groups could be categorised as high interest girls, low interest girls, high interest boys, and low interest boys. In some cases, due to practicalities in particular schools, student groups included both boys and girls. The interviews were designed to gain insight into students' perceptions of IT and their IT behaviours, their ideas about the CIT subjects offered in their school and of the teachers who teach them, their views of the IT industry and careers, and their explanations of the gender gap in CIT education and careers. Student interviews were audio-recorded and subsequently transcribed. Much of the analysis of the qualitative data has already been reported (Gannon, 2007; and Reid & van den Akker, 2007). For the purpose of this paper, a further content analysis of the transcriptions was undertaken using NVIVO, drawing on an emergent coding approach using categories identified from preliminary analyses. Where students commented on or mentioned ability in one way or another, notes were made on who made the comment, and whether gender was explicitly addressed. The comment was then coded using the following categories: *natural* ability (for example, boys naturally good at computers); *learned* ability (for example, experience and interest/do it more/girls are just as good ...but they don’t do it as much); *relative* ability (for example, boys better at it than girls); *mediated* ability (for example, boys good at machines, hence good at computers, girls good at talking hence good at emails).

Findings

Two key issues of this paper are the overall low participation rates in CIT subjects, particularly the relatively low rates for girls, and the relationships/pathways between the various access and use factors, abilities beliefs and value beliefs, and participation. The results will be reported under the following headings: Planning to take/Not planning to take CIT subjects, Access and Use, Ability Beliefs and Value Beliefs.

Taking/Not taking CIT subjects

Students were asked whether or not they planned to take any of the three different types of CIT subjects. As Table 1 shows, female students are much less likely than male students to report to be planning on taking any CIT subject in their senior years; 90% of females compared to 67% of males say they will take none of the three types of subjects. Another way to look at this finding is to emphasize the fact that the majority of males as well as the majority of females say they plan to take none of these CIT subjects. However, the fact remains that males are more likely to do so. What is more, males are more likely to plan to take more than one of these subject options.

Table 1. Gender by number of CIT subjects planned for senior years.

	Total number of students	No CIT subjects (%)	One subject (%)	Two subjects (%)	Three subjects (%)
Males	314	67	26	7	1
Females***	408	90	9	1	0

Note: ***$p < 0.001$.

If we look at each of the types of subjects individually (see table 2), we find that IPT is, by far, the more popular subject for both males and females, then ITVET and then SDD. Across all three subjects however the above gender difference persists. Table 2 indicates that twice as many males as females say they will take Information Processes and Technology (IPT) – 19% versus 8% of females. For the Information Technology (ITVET) subject the difference is even larger – 14% of the male students and only 3% of the female students reported planning on this type of subject. Finally 9% of males and just 1% of females said they were going to take the Software Design and Development (SDD) subject in the senior years. In other words, female participation dwindles more dramatically across the three subjects than does that for males, with the proportions being approximately 1:2, 1:5 and 1:9 (comparing % of all females to all males taking a course).

Table 2. Gender by type of CIT subject planned for the senior years.

	IPT	ITVET	SDD
Number of students taking CIT subject	89	55	30
Percent of breakdown by type of subject (%)	51	31	17
Percent of all males taking this subject (%)	19	14	9
Percent of all females taking this subject (%)	8***	3***	1***
Females as percentage of total planning to take the subject (%)	35	18	3

Note: ***$p < 0.001$

It is worth noting that these profiles are relatively consistent with the actual state-level participation rates in the 2007 Higher School Certificate which these students would have undertaken. Using 2007 student entry data publicly available from the NSW Board of Studies (NSWBOS) http://www.boardofstudies.nsw.edu.au/ebos/static/EN_SX_2007_12.html of the CIT takers, 57% took IPT, 22% ITVET and 20% SDD (compare to the second row of Table

2). Further, the NSWBOS data show that, of these, females represent 29%, 22% and 8% of the subject cohorts respectively (compare to the bottom row of Table 2). The remainder of this paper explores in more detail this persistent gender difference and related factors.

Access and Use

The results in Table 3 suggest that there is no longer a difference in access to computing at home for these students. Almost all (98%) of them, both female and male, report having at least one computer in their home. Over 90%, regardless of gender, have at least one computer with Internet access. The only small (not statistically significant difference) is that males are more likely to report having more than one computer in their home with at least one having an Internet connection.

Table 3. Gender by access to IT in the home.

	No home computer (%)	At least one computer, no Internet (%)	At least one computer with Internet (%)	More than one computer with Internet (%)
Males	1	4	35	61
Females	2	5	39	55

Note: Not significant. $N = 712$.

Overall, students (both male and female) report using the computer more often at home than at school, whether in class or out of class (see Table 4). Most students use the computer at home almost once a day or more, and use a computer at school once a week or less. Over 80% of students indicate that they have little or no constraints on home use, and over half of the students surveyed (and more males than females) say they learn more about computers at home than in school.

There is however, a gender difference in how often female students report using the computer in their home and in their classes in school compared to male students. Table 4 indicates that females are more likely than males to say they rarely use the computer – less than once a week (7% versus 4% in the home and 69% versus 46% in school classes). On the other end of the scale, males are more likely than females to report using the computer in these locations several times a day (32% for males versus only 17% for females in the home, and 3% and 2% for males and females, respectively in school classes).

Table 4. Gender by home use and class school use of computers.

	Less than once a week or never	Once or twice a week	Almost every day	Several times a day
Home use (%)				
Males	4	17	47	32
***Females	7	22	55	17
School use in class (%)				
Males	46	37	13	3
***Females	69	26	4	2

Note: ***$p < 0.001$, $N = 715$.

Overall, 15% of the students say they never use the computer in school classes; another 44% say they use it less than once a week (details not shown). This means that over half the respondents use a computer in their classes less than once a week. If we look at use in school outside of classes the number reporting rare use is even higher; fully 71% say they use a school computer outside of class less than once a week; and only 14% use computers at school this way once or twice a week. About the same percentage (15%) use school computers outside class once a day or more.

Ability Beliefs

There are three sources of information about students' self-perceptions of IT ability. Within the survey there were two distinct groups of questions. The first related to ability in the range of activities commonly associated with computer use in the home, and the second to ability in CIT subjects at school. A third source of relevant information stemmed from the discussion groups.

With regards to IT ability for use in the home, the students ranked themselves on a five point scale (“very good”, “good”, “OK” “not very good”, “not good at all”) on thirteen different IT related activities. There is a statistically significant gender difference in the responses to ten of these items. (There is no gender difference in reported levels of ability in “Connecting to the Internet and looking up information, for school subjects, homework, leisure and hobbies”, in “Designing, painting, creating and sharing visual images, digital photos, pictures, etc., creating PowerPoint programs, etc.” or in “Writing songs, lyrics or music on the computer”.) There is only one task for which more females than males say they have high levels of skill, namely “Emailing friends, family etc.”. For all other nine items, more males than females say they are skilled; and more females than males say they are “no good at all”. These nine items, which more males say they do well, include:

(1) Downloading music, videos, images, ring tones, etc.;

(2) Downloading and installing games, programs etc., looking up information on computers, programming or web design;

(3) Ordering/buying stuff on-line (Clothes, music, food, equipment, software, etc.) or tickets (for concerts, movies, airlines);

(4) Customising toolbars, desktop, browsers;

(5) Fixing the computer when it crashes, fixing printers, scanners, digital cameras, scanners, etc, making software work;

(6) Playing computer games;

(7) Building web pages using templates or other tools;

(8) Creating web pages using programming scripts;

(9) Swapping/sharing data, images, files, information between computers, mobile phones, PDAs, or other devices.

There is a number of ways one can combine the information from these items into a self-reported ability scale. One is to combine all thirteen measures in a simple summary score. If we do this, and collapse response categories to create three categories (negative rating, neutral, positive) rather than the original five, we find there is a clear and statistically significant gender difference. In Table 5 we see the overall pattern in terms of specific numbers. Females are much more likely than males to say they have lower ability levels: 22% compared to 13% of males. At the other end of the spectrum, males are much more likely to report higher levels of abilities (56% versus 37% of females).

Table 5. Gender by self-reported ability with IT in the home, summary of thirteen items.

	Low (%)	Medium (%)	High (%)
Male	13	30	56
Female***	22	41	37

Note: $***p < 0.001$, $N = 714$.

Within the full list of 13 items there are those that focus on “high-end” IT skills and others that focus on more everyday skills. The high-end items include: fixing the computer when it crashes; fixing printers, scanners, digital cameras etc; making software work; building web pages using templates or other tools; and creating web pages using programming scripts. Regardless of how we group the items, the pattern is the same – even for the low-end skill items, more females rate themselves as having low ability levels, while more males say they have high. In other words, the finding of a gender difference is not an artefact of how we created the summary scale.

With regards to ability with CIT subjects at school, the students ranked themselves on a scale of 1-5 on both of the following: “I am good at IT subjects at school” and “I expect to get high marks in the CIT subjects I choose”; and in items related to reasons for planning to take/not take CIT subjects in their senior years, students indicated their agreement with the statement: “I find CIT subjects easy/difficult”.

Table 6 clearly indicates that male students report higher levels of ability on all three individual items. When combined into the single measure “Ability in CIT subjects at School” (after reversing the order of the negatively worded item so that a high score means a positive attitude to CIT) the patterns of difference remain consistent with the three separate items.

Table 6. Gender by self-reported ability in CIT subjects at school.

	Disagree	Neutral	Agree
I am good at CIT subjects at school (%)			
Male	18	35	47
***Female	30	41	30
I expect to get high marks in CIT subjects I chose (%)			
Male	25	33	42
***Female	36	39	25
I find CIT subjects easy/not difficult (%)			
Male	18	38	43
***Female	32	38	31
Ability in CIT subjects at School (combined) (%)			
Male	19	38	44
***Female	31	43	26

Note: ***$p < 0.001$, N varies from 632 to 719.

In the discussion groups with students, we further explored this notion of ability and found that ability as demonstrated in the school classroom was generally perceived as gendered. While both male and female students commented on gendered ability, not all did so, and more often than not, those that did, linked gender to ability through learning/interest/opportunity. Very few students attributed *natural* or *relative* ability: “Computers are a boy thing, don’t know why like they’re born with it” (F).

When students did refer to *learned* or *mediated* ability they did so in relation to interest, and to amount and ways of using IT, especially in their homes: “I think because they [boys] get into video games and stuff on computers, they get into more computer-like other stuff on computers. So they start off playing their games and then they start doing other stuff. They get to know more about computers.” (F); “... if like someone is interested in it then obviously they are going to know something about it, whether it is a girl or a boy.”(F); “Like they spend all the time on the computer, lunch time, recess, when they get home, before school, after school” (F). “Like people just get interested in computers and then just keep on using them all the time and they get good.” (M). “Boys like tinkering with things” (F); “… practice … time … you just need to give it time, anyone can be good at it just but have to like it to want to learn more about it to get good at it” (M); "boys like fumbling around with computers ... and girls don't tend to like that" (F); and "we like to do different things, they [girls] just like to do what they are told sort of thing, we experiment" (M). The taken for granted gendering seemed unproblematic to both females and males: "...you like it or you don't like it, and that's it" (M); "as a generalisation… girls don't participate in this type of area" (F); "I guess I always had impacted into my head that boys would be more interested in computers. I don't know why (F)".

Absent from the student statements was any reference to ability in one or more school subjects underpinning ability in CIT subjects. In particular what is generally missing is an insight into the relationships between problem solving, logical thinking and/or mathematics and IT ability. When specifically asked about the relationship between being good at mathematics and IT, generally students responded in the negative or had not really thought about it: “It’s just a good knowledge of our computers and like it doesn’t really fit in with Maths at all …” (M); “I’ve never used real Maths just like reading the numbers on the keyboard like. You gotta know like how to read numbers.” (F); “I don’t know, anything is possible … no it doesn’t really help being good at maths depends on the programming side, it would help and all of that technical side, but not just in general it wouldn’t help” (M). One student indicated an understanding, mediated through the experience of his brother and sisters: “My brother and sisters we all like maths so that’s one thing that like makes computers more interesting if you’re good at maths” (M).

Value Beliefs

There is a range of sources of information about the students’ value beliefs in the survey. These include a number of questions that reveal student attitudes to CIT subjects in general, to CIT subjects as explanations for plans to take/not take CIT subjects in the senior years, and their attitudes to other school subjects, in particular English and Mathematics.

The data about attitudes to CIT subjects explaining reasons for planning/not planning to take CIT subjects came from two separate sets of items. The students who were planning to take one or more CIT subjects were asked the importance of various reasons for this decision, all relating to their attitudes to CIT subjects. Those who indicated they did not plan to enrol in any CIT-related subjects were asked similar questions about why they did not want to take these subjects. For example, those taking a CIT subject were asked to what extent they thought CIT subjects were interesting; those not taking one were asked to what extent they thought these subjects were boring. The resulting measures were created by adding the two alternative items together, after reversing the order of the negatively worded items so that a high score means a positive attitude to CIT. The five responses were again collapsed into 3 categories. Then all five measures were combined into a composite measure of value-based beliefs about CIT at school.

Table 7 indicates that, on the whole, both male and females students were more likely to agree or be neutral than to disagree with each of the value-based beliefs statements about

CIT subjects (enjoyment, interest, utility, want to know more) at school. However, males were more likely to be more strongly positive than females, who were more evenly spread across the three responses. In all cases, males were at least 1.5 times more likely to be positive than negative, whereas in one case, females were more likely to be negative than positive ("I enjoy computer subjects at school") and in another were more likely to be negative than positive or neutral combined ("I find CIT subjects interesting/not boring"). These patterns are reflected in the aggregated variable which shows that, overall, males tend to be more positive, and females more neutral: almost half of the male students, compared with a quarter of the female students score positively on this measure, with more of the female students being either neutral or negative. This is not, however, simply a reflection of males having a more positive attitude to school in general. There is, in fact, no gender difference to responses to the questions about how much they enjoy school or whether they feel they would leave school if they could (See appendix 1 for details).

Table 7. Value-based beliefs about CIT subjects at school.

	Disagree	Neutral	Agree
Enjoyment of computers subjects at school			
Male	21	22	57
***Female	38	30	32
Rationale for planning/not planning to take CIT subjects			
I find CIT subjects interesting/not boring			
Male	32	20	48
***Female	53	22	25
Studying CIT will help me get into University			
Male	21	40	40
**Female	28	41	31
Doing CIT now will help me get a job later on			
Male	16	35	49
**Female	22	40	38
I want to learn more about computers/I don't already know enough about computers			
Male	25	29	46
*Female	33	30	37
Value-based statements (combined)			
Males	19	36	46
***Females	26	50	24

Note: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$, N varies from 631 to 720.

Males and female students also differ in their ability and value beliefs to other subjects, as we can see in Table 8. Females tend to report more positive attitudes to their English subjects – enjoying them more (Value) and more likely to believe that they are good at it (Ability), while males seem more positively disposed towards Maths. Indeed, males are more likely to give a positive response to all of the questions that were combined to form the "Beliefs about Maths" measure. That is, they are more likely to say that Maths is easy for them, they are good at Maths, they enjoy Maths, and to disagree that Maths is difficult (See appendix 2 for details).

Table 8. Gender by attitude to English and Maths subjects.

	Negative	Neutral	Positive
Beliefs about English (%)			
Males	13	29	59
***Females	8	24	69
Beliefs about Maths (%)			
Males	14	27	60
**Females	27	33	40

Note: $^{**}p < 0.01$; $^{***}p < 0.001$, $N = 714$.

However, neither of these sets of beliefs is related to whether or not they choose to take CIT subjects in their senior years. When separated out into Value and Ability beliefs for each of Maths and English, they still don't relate (correlation of taking at least one CIT course are: with attitude to Maths, .07 n.s.; with attitude to English, -.05 n.s.). Only their value-based CIT-related statements correlates with this intention (see Table 9).

Relationships /Pathways between factors affecting taking/not taking CIT subjects.

To this point we have identified a number of overall patterns and gender differences in use and access, ability beliefs and value beliefs which the literature suggests are related to taking/not taking CIT subjects. The question is: which of these help us account for the plans that male and female students make to take CIT subjects in their senior secondary years?

As an initial step we have examined which of the factors correlate individually with plans to take at least one CIT subject in the senior years. Table 9 shows the results of the correlation at the two-variable level. In terms of gender, females are less likely than males to plan to take at least one CIT subject in the senior years. Parental education is included as a background control. While not related at the two variable level, it is related to the students' plans concerning CIT subjects when other measures are controlled (see right hand column of odds ratios). Home access, amount of use at home and school, the two ability beliefs and the value-related beliefs are all related to these plans at the two variable level.

Table 9. Correlations and logistic regression with plans to take a CIT subject.

	Correlation	Odds ratio
Gender (0 = male, 1 = female)	−0.29***	0.32***
Parental education (1 = low, 2 = high)	−0.01	0.54*
Access & use		
Home IT access (number of computers with Internet)	0.06*	1.08
Home use of IT (5 levels, amount of use)	0.20***	1.01
School use of IT (5 levels, amount of use)	0.42***	3.89***
Ability beliefs		
Self-reported IT ability-home (5 levels, 5 = highest)	0.25***	1.78**
Self-reported ability in CIT subjects in School (5 levels, 5 = highest)	0.32***	0.79
Value beliefs		
Value-related (5 levels, high = positive)	0.45***	5.44***

Note: $*p < 0.05$; $***p < 0.001$; N varies from 635 to 725; Naegelkerke's $R^2 = 0.58$.

The right hand column of Table 9 gives the results of a logistic regression, with "plans to take at least one CIT subject" as the dependent variable. This procedure allows us to see the effect of each of these other measures on the CIT subject plans of the students, controlling all other measures. Given that the outcome measure of interest (plans to take/does not plan to take a CIT subject) is a dichotomy, logistic regression is the appropriate procedure.

The coefficients in a logistic regression are odds ratios. They indicate the odds of one group versus another (e.g. females versus males) taking a subject, controlling on all other measures. If the odds ratio is 1.0, the independent variable has no effect on plans to take a

CIT subject. If the odds ratio is less than 1.0 (as is the case for gender) the higher category (1=female) is less likely than the other (0=male) to plan to take a CIT subject. If the odds ratio is greater than 1.0, (as is the case for amount of school use of IT, at 3.89) it means the odds increase as one goes from one category to the next in that measure. That is, the odds of planning to take a CIT subject in the senior years increase by 3.89 for each of the five response categories for level of activity in school use.

Overall, in addition to gender, the variables that continue to have an effect on plans to take a CIT subject, after controls are: amount of use of IT at school (the more use, the more likely to take a CIT subject); and value-based beliefs (the more positive, the more likely to take a CIT subject). Home based ability-beliefs appear to be related to plans to take a CIT course, but further analyses (not shown) document that this holds only for males. School based ability and use at home have no direct effect on these plans, once other measures are controlled.

The logistic regression was run separately for male and female students to explore gender differences (data not reported). It is noteworthy that, with the one exception mentioned above, the same pattern of variables and levels of significance were found for both sub-groups.

However, despite the similarities found above, gender continues to have an impact, even after controls. The odds ratio for gender, without controls, is .22. This means that the odds of a female taking a CIT subject is one-fifth compared with a male taking it. Adding the additional control measures included in the right hand column of Table 9 changes this value very little, to a value of 0.3[2]. That is, the gender differences in home and school use, and

[2] Adding the control variables does increase the Naegelkerke's R^2 from .13 to .58. Naegelkerke's R^2 is interpreted as the parallel in logistic regression to R^2 in an Ordinary Least Squares regression.

value and ability beliefs do not explain all of the gender differences in the take up of CIT subjects. There are other factors, not explored in this paper, that account for this gender difference.

These findings on variables affecting plans to take CIT courses do not mean that home access and use is irrelevant to the choice outcome. Ordinary least squares regression analyses (see Table 10) allow us to explore the factors that influence the various control variables in Table 9. Table 10 shows the results of six separate regression analyses, with one per column and the dependent variables listed in the top row.

Table 10. Ordinary least squares regressions (beta coefficients).

Factors affecting	Value (CIT subjects)	Ability (CIT subjects)	Ability (home)	Amount school use	Amount home use	Home access
Gender	−0.07*	−0.08*	−0.16***	−0.20***	−0.15***	−0.06
Parental education	−0.03	0.01	0.09**	0.09*	0.03	0.15***
Home access	−0.04	0.07	0.06	−0.07	0.34***	
Amount home use	0.03	0.09*	0.37***	0.19***		
Amount school use	0.16***	0.14**				
Ability (home)	−0.08	0.22***				
Ability (CIT subjects)	0.52***					
R^2	0.33	0.15	0.21	0.09	0.14	0.02

Note: $*p < 0.05$; $**p < 0.01$; $***p < 0.001$; N varies from 635 to 725.

In addition to gender, the amount of school use and school based ability beliefs are both related to the value placed on CIT subjects in school (see Column 1). Those who use computers more at school value CIT subjects more and high self-perceived ability in CIT has an even stronger relationship to valuing CIT subjects (as indicated by the beta of .52). School does, therefore, seem to play a role in creating and reinforcing the value of these subjects.

The second column of results shows that perception of ability in CIT subjects is related to both amount of use in school (beta=.14) and home based ability beliefs (beta=.22). Gender also continues to have an impact.

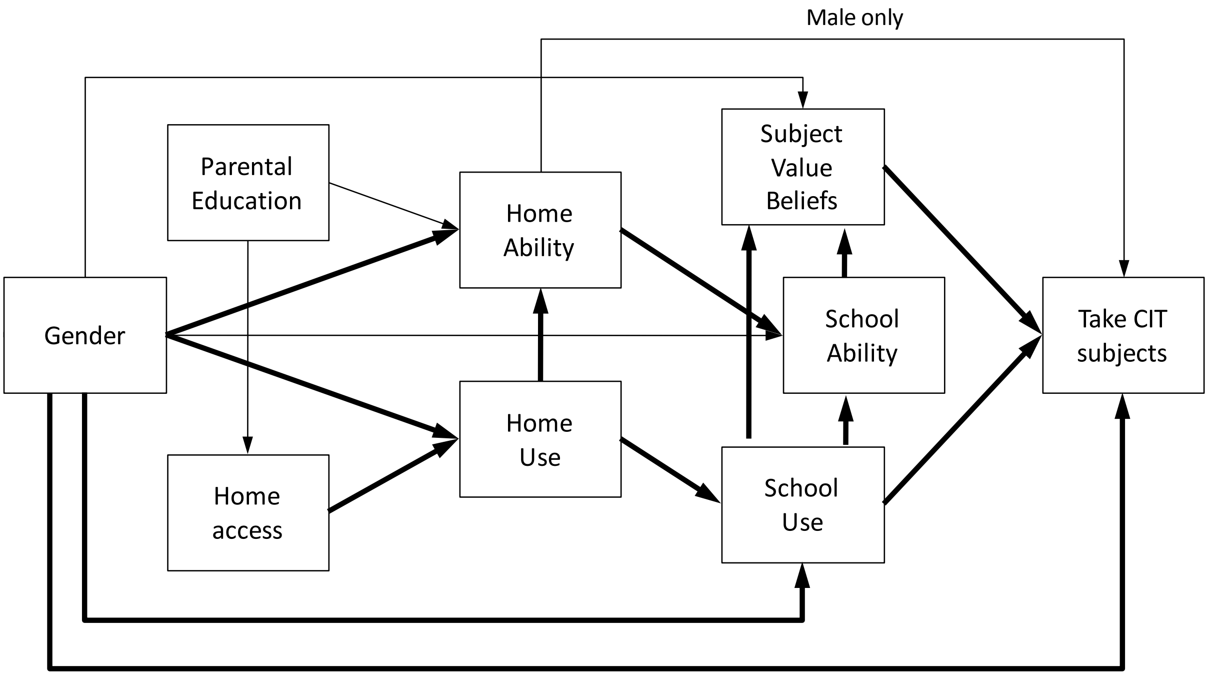
The third column looks at factors that affect students' reports of their home based abilities. Not surprisingly, home use has an impact here – for both males and females. Gender does have an effect, however, as females report lower levels of these abilities, even after controls. Further, the effect of parental education on these reported abilities is present only for females.

The three right hand columns show how background measures and home access feed into this complex process. In addition to gender, amount of home use is related to amount of school use. Not surprisingly home access affects home use (as does gender). Finally, parental education enters the picture again by influencing the amount of access in the student's home.

Figure 1 presents a diagram mapping the relationships identified in Tables 9 and 10. The thicker lines represent relationships significant to $p<.001$. The direction of the arrows indicates our understanding of the most likely causal direction, based on our knowledge of the research literature. It clearly shows that all variables that are related at the two variable level, are also inter-related directly or indirectly with the three variables that, when controls are in place, are related to plans to take CIT subjects. For both male and female students these are the amount of IT use at school (the more use, the more likely to take a course), value-based beliefs (the more positive, the more likely to take a CIT subject) and for males only, home-based ability beliefs (the more positive, the more likely to take a CIT subject). It is noteworthy, that the nature and strengths of the relationships are similar for males and females, except in two cases: for females, parental education and home ability belief are related, and for males, home ability beliefs directly influence plans to take CIT subjects.

Figures

Figure 1: Factors related to student plans to take CIT courses.



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Notwithstanding the above findings, gender, as a variable, remains a significant indicator of students' subject-taking plans. With and without controls, the odds of a female taking a CIT subject are significantly less than the odds of a male taking it. That is, the factors in this study do not fully explain the gender differences.

Discussion

Our findings about who plans to take or not take CIT subjects confirm the existing literature (Barker & Aspray, 2006). What our study adds is information on this process *at the time the students are making their decisions* about course selection. Most existing literature relies on retrospective accounts of decisions made in the past. While the majority of both male and female students indicate that they do not plan to take any CIT subjects in their senior years, more females than males plan not to do so, and where they do plan to take a course, they are less likely than males to take more than one. Similarly the trend for female students being less likely to take programming-related subjects or technical subjects is consistent with the literature (Zarrett & Malanchuk, 2005, Looker, 2008). It is worthy of note that, while parental education (a placeholder for socio-economic status) did have an impact on access, and for girls an impact on their home-related ability beliefs, it did not have a direct influence on plans to take CIT subjects.

Similarly our findings related to home access and use fit with existing literature (Colley & Comber, 2003). Both male and female students had almost universal access to at least one computer at home, the majority with internet access. Both report using computers more often at home than at school, and that use at school happens more often in class than out of class. They also report that they learn more about computers at home than at school. It is noteworthy that well over half of the students in this study, both female and male students, report using a computer in classes less than once a week. This may be a pragmatic reflection on the practical constraints and inconveniences of use in school as compared to home, or it may reflect other factors at work, such as school policies, curriculum, or teacher interest and expertise (Cuban, 2001; Nagy et al, 2006; Looker and Naylor, 2010). Given that amount of IT use at school is one of the variables that affects plans to take CIT courses, discovering and overcoming constraints or reframing policies and teaching practices to increase student use may prove useful in increasing participation in CIT courses.

However, despite finding similarities between male and female students, important gender differences do exist in the frequency and amount of use both at home and at school. Females are more likely than males to say they use the computer less than once a week at home, while males are more likely than females to report using it several times a day.

Furthermore our findings link school use and home use, home use and access, and access and parental education. This suggests that while interventions taken to improve school use in relation to the above may improve overall participation, interventions specifically aimed at increasing use by females may be required in order to reduce gender differences in participation, and that these would need to take account of less use at home and all that that might entail.

Ability beliefs

Our second area of analysis was ability beliefs in relation to home- and school-based tasks. Home-based ability beliefs are related to gender and amount of home use, with male students reporting higher levels of ability and females reporting lower levels. This gender difference is interesting, given the various ways that home-related ability beliefs affects plans to take/not take CIT subjects in the senior years. For male students, there is a direct link to plans to take CIT subjects, but not for females. More generally, home-related ability beliefs are indirectly linked to plans, through direct relationships with amount of home use which, in turn, is related to amount of school use.

School-related ability is closely connected to a number of variables. It is linked to home-related abilities, amount of home and school use, and valuing of CIT subjects. Like home-related ability, school-related ability is also gendered, with male students reporting higher levels than female students. Its direct relationship to school use and value of CIT subjects makes it a key factor when thinking about interventions as these other two variables are directly related to plans to take CIT subjects. This would suggest that any school interventions would need to include a focus on increasing use at home and at school as well as building female student confidence in their home- and school-related abilities. This is not a simple goal, as in the discussion groups both males and females commented on the gendered nature of ability and linked it to interest as well as use.

Value beliefs

Overall, both male and female students were more likely to have neutral or positive attitudes than negative attitudes to CIT subjects at school, with males more likely to have positive and females more likely to have neutral attitudes. Given the strong link between positive attitudes towards CIT subjects and plans to take CIT subjects, working on attitudes of both males and females would be important in any intervention. The large numbers of students in the neutral range suggests that any intervention related to this might well have the potential for increasing participation. What is more, the gender similarities suggest that addressing this factor has potential for increasing participation by both males and females.

Our study found that valuing CIT subjects is most related to self perceived ability in CIT (with higher ability equalling higher value), and also to a lesser extent by amount of school use (with higher use equalling higher value). Given that school plays a role in both perceptions of self-perceived ability in CIT, and in creating and reinforcing positive value, it again suggests school-based interventions may well prove an effective strategy.

Curiously this study did not find obvious links between attitudes and self-perceived abilities in English or Mathematics. The study was consistent with the literature however, in finding that females tend to report more positive attitudes to their English subjects, both in terms of their self-perceived ability and the value which they ascribe to the subject. Males, on the other hand, seem more positively disposed towards Maths. In the discussion groups, one or two students did make comments about mathematics, logical thinking and/or problem solving and IT skills, but this did not show through in the quantitative data, differing from a recent Canadian study where students believed such a connection existed (Thiessen, 2007).

Conclusion

While many of our findings are consistent with various bodies of literature that report students' access, use, attitudes and abilities in using IT at home and at school, our study adds value in that it builds an eclectic model showing the relationship between these factors and student's plans to take CIT subjects in their senior secondary years. The model is eclectic in the sense that, as well as drawing on ability beliefs and value beliefs, factors fore-grounded in the Values-Expectancy Model of subject choice, it also includes access and use, and investigates all of these in both the home and school setting. In the literature on choice and participation in CIT in secondary schools, few studies, if any, try to bring the full range of factors together into one model and investigate the direct and indirect relationships between the factors. By doing so, this study creates an evidence base that can guide thinking about possible interventions, if it were desirable to increase participation in CIT subjects in the senior secondary years.

Our study revealed that there are three key factors that influence plans to take CIT subjects in senior secondary years. These are gender, amount of use at school and the value students place on CIT subjects. The latter two factors relate to schools, where educational interventions are possible. As Figure 1 indicates, these two factors are inter-related either directly or indirectly to home use and home- and school-related ability beliefs, so any school-based interventions that focus on increasing use of IT at school, and increasing the 'value' of CIT subjects, need to also address increasing home use, and self–perceived skill levels in tasks associated with both home and school use. This would require very careful curriculum and pedagogical planning and a concomitant increase in teacher expertise and dispositions towards use of IT in classrooms. In particular it might require a rethink about the main purpose of computer literacy, computer use, and early-years study of CIT related topics, and also require a shift in balance between a focus on discipline-based subject-matter-knowledge and skills, and designed focus on building confidence and relevance as well as knowledge and skills within the early and middle years.

At a time when the New South Wales Government in Australia has launched a laptop for every secondary school student for the middle and senior secondary years as part of a national program (Department of Education, Employment and Workplace Relations, nd), it is timely to consider the matter of curriculum and pedagogy design with regards to the use of IT in schools and the formal study of CIT subjects. In the context of a 'laptop for every student' it is not inconceivable to design a framework that does integrate home and school computing use, and focuses on building positive value and ability beliefs in both boys and girls as part of the core experiences of secondary students. The notion of core experiences is important for, as Abbiss (2009) and ourselves have found, when choice exists, gendered interests lead to stereotypical participation patterns. The enduring gender difference, however, does remind us that any design framework will only partly address subsequent gendered choice.

Appendix 1

Figure A1.1: Most of the time I enjoy being at school .

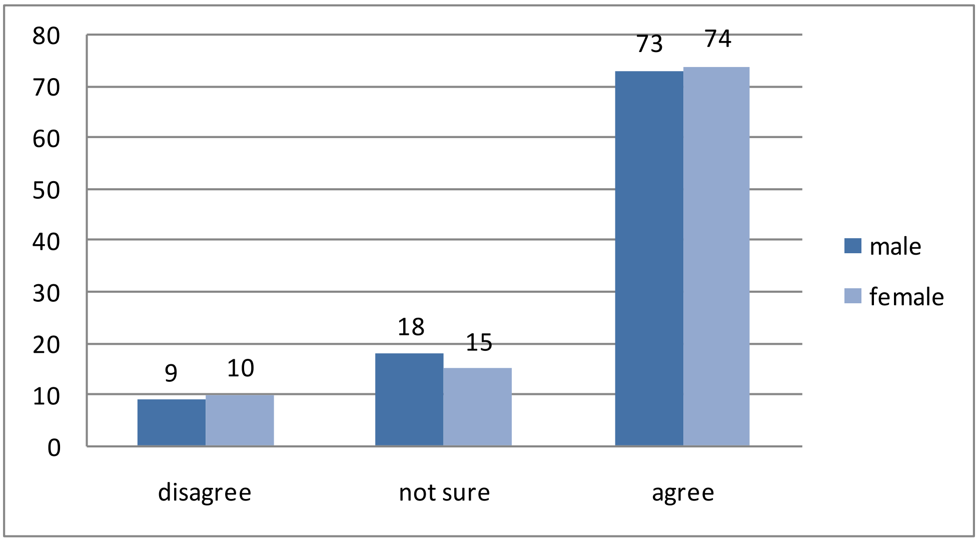
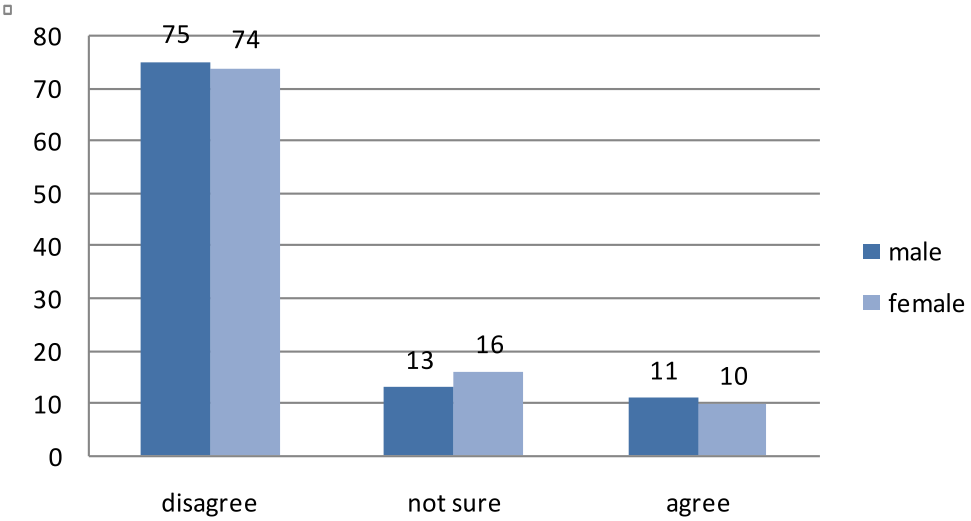


Figure A1.2: I would leave school now if I could.



Appendix 2

Figure A2.2: I often enjoy doing math.

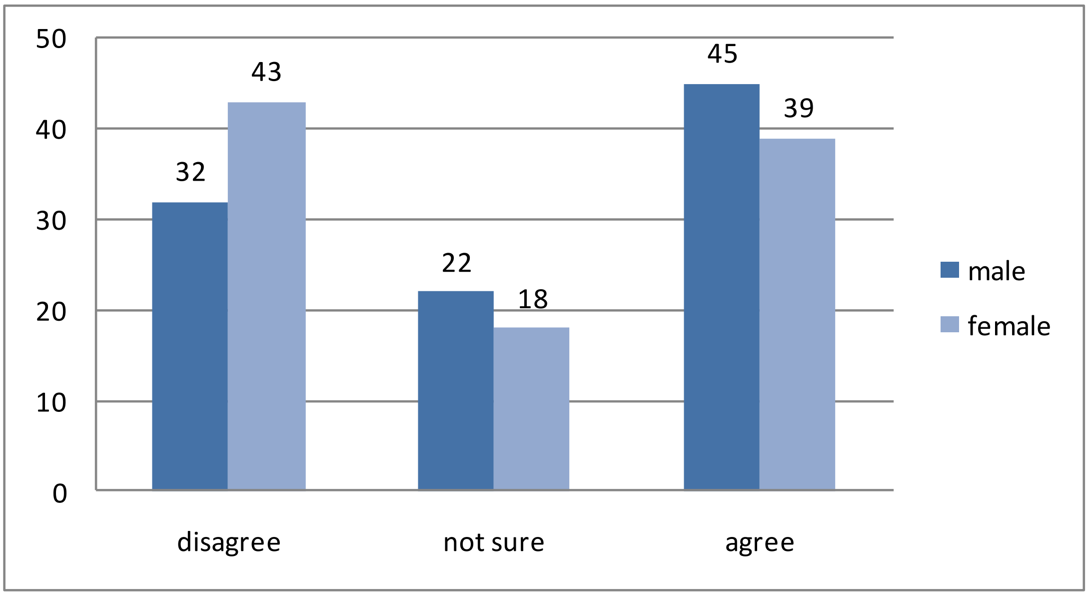


Figure A2.2: I often enjoy doing math.

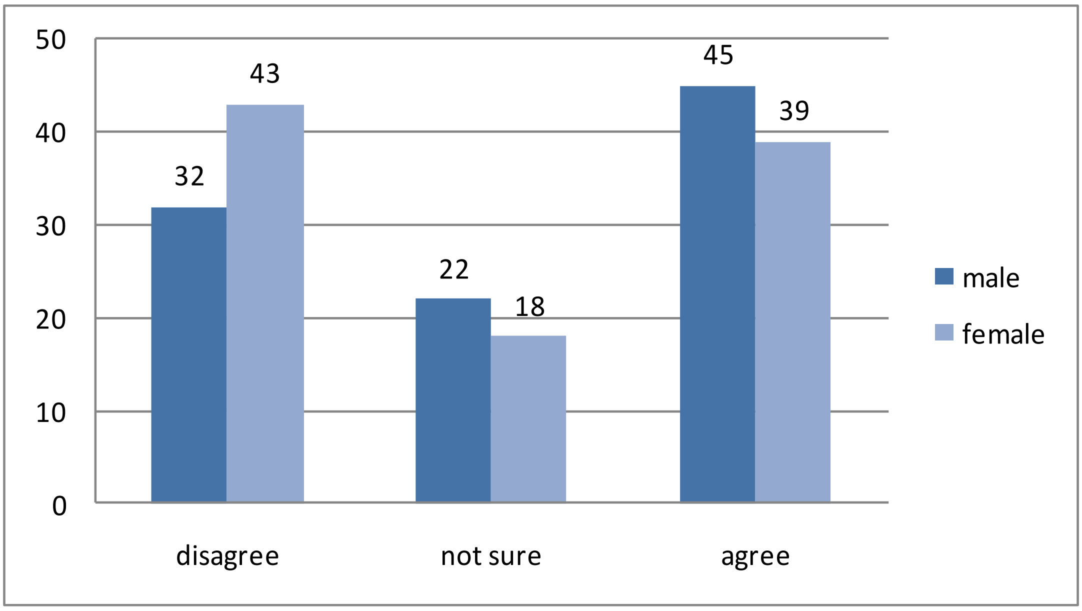


Figure A2.3: Math is a foreign language to me.

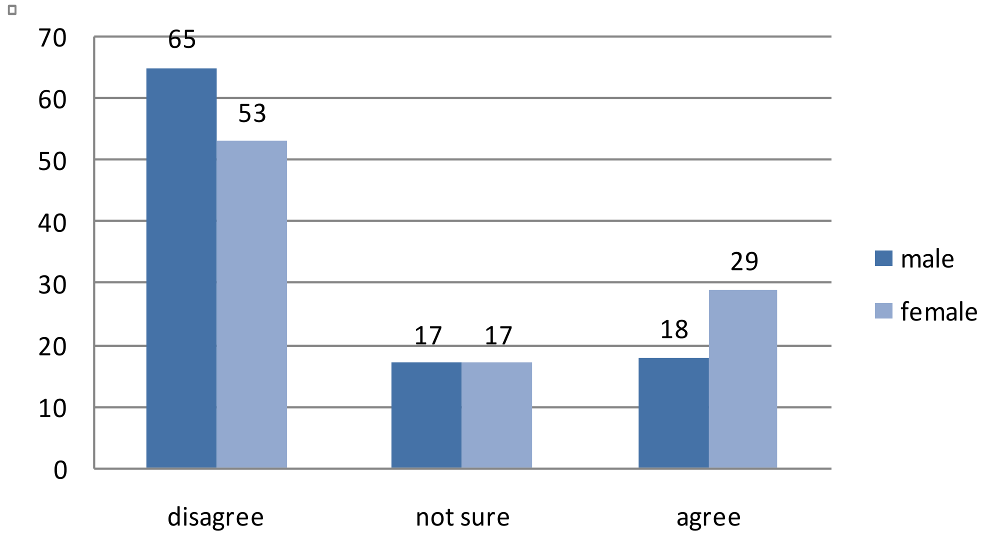


Figure A2.4: English is easy for me.

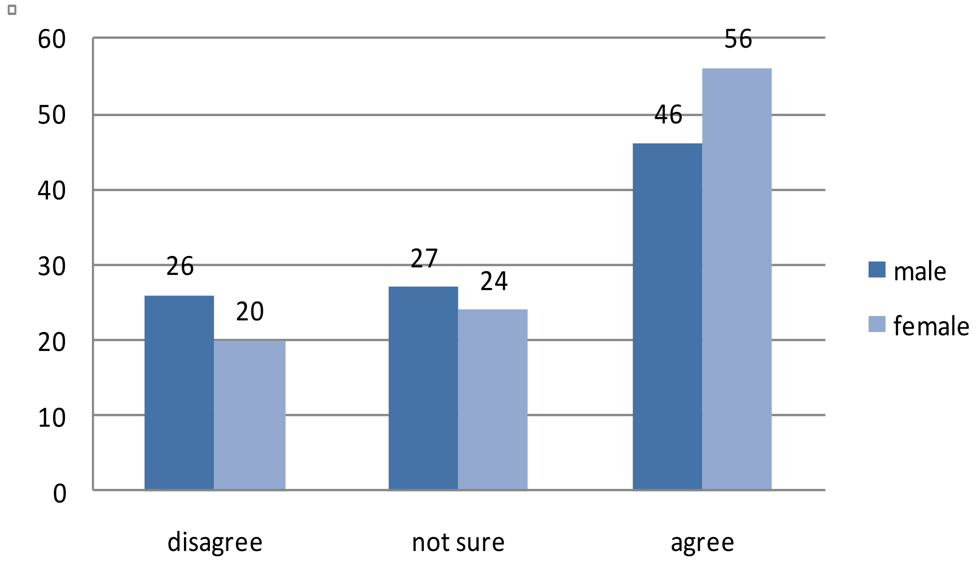
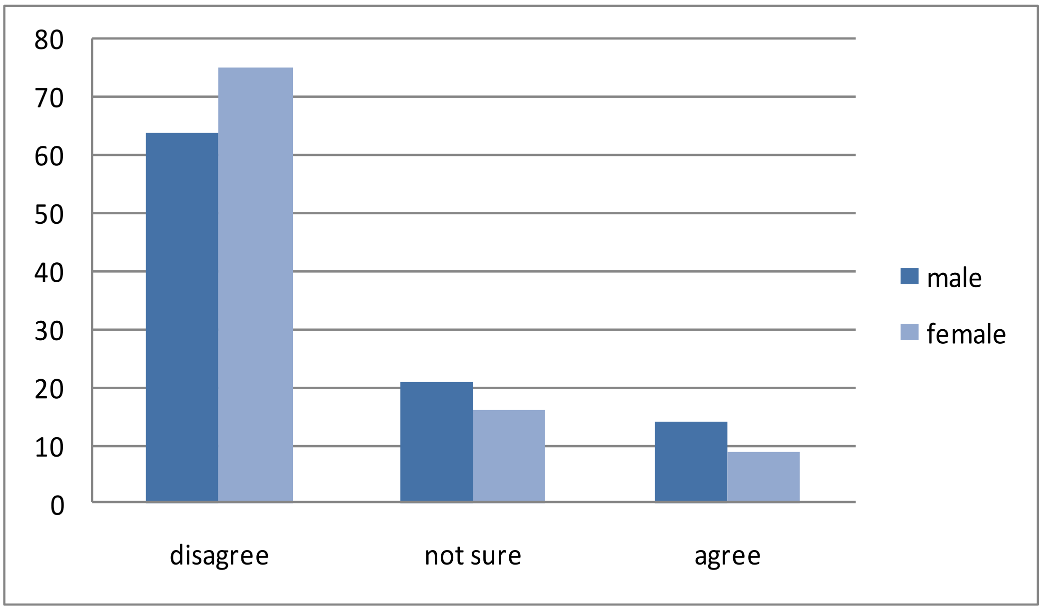


Figure A2.5: I am hopeless at English.



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