Computer Attitudes and Computing Career Perceptions of First Year Computing Students

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Abstract

This paper reports on a longitudinal research study on the attitudes to computers, and the perceptions of a computing career, of students enrolled in an introductory computing course in the years 1995 to 1998. Previous programming experience had a positive effect on computer confidence, and ownership of a home computer had a positive effect on computer anxiety and computer confidence. There was a gender difference in computer attitudes and perception of a computing career, with females scoring significantly lower than males on all measures. The analysis showed decreased computer liking over the semester and an inconsistent semester effect on computer confidence over the four years. The differences between male and female computer attitudes and perceptions of a computing career persisted over the semester.

Keywords: Gender issues, computing education research, gender differences, computer attitudes, computing career perceptions, (introductory) computing course attitudes, students of computing courses or IS students.

Introduction

There is a need both to encourage more women to enrol in computing courses and also to devise ways in which those women who do enrol in computing courses can be retained (Camp, 1997; Frenkel, 1990; Galpin & Saunders, 1993). In 1993 the retention rate of women in computing courses at La Trobe University, Bendigo was lower than should be expected - 37% (7 of 19). The overall Bendigo campus retention rate for all first year students in 1993 was 56%. Clearly there was a problem in retaining women students in our computing courses. Subsequent follow up of the 1993 cohort has shown that only one student of the original 19 women graduated.

This poor retention rate of women in our computing courses prompted us to propose and implement a range of equity initiatives in 1994. These included production of a promotional kit, contact with local secondary schools, a workshop for academic staff on gender inclusive curriculum and teaching strategies, and a pilot intervention program (Martin & Staehr, 1994). The aim of the pilot program was to provide a supportive environment for women students during their first year in computing courses. The success of the pilot program in 1994 encouraged us to continue to develop the intervention program. The details and results of the intervention program for the years 1995 to 1997 have already been reported (Staehr, Martin & Byrne, 1998; Staehr, Martin & Byrne, 2000).

During the course of the pilot program in 1994 two problems relating to the research reported in this paper were observed:

- a lack of confidence of the women students with computers, and
- women students had misconceptions of what a career in computing involved.

These findings are supported by reports in the literature (Newmarch, Taylor-Steele & Cumstan, 2000). Gender differences on computer confidence, anxiety and liking have been found at undergraduate level in some studies (Shashaani, 1997). Most reported studies examine computer attitudes in computer literacy courses. There are few studies that investigate the computer attitudes of students who have already chosen to complete major studies in computing.

Recent Australian research by Newmarch et al. (2000) suggests that young women are not attracted to a career in computing because they have mistaken perceptions of a computing career. Anecdotal evidence from our 1994 pilot program supports this view. The women's misconceptions appeared to arise from two different sources. Firstly, some of the women students thought that a computing career involved a job in office automation. This is not surprising considering that many of them had done a course called Information Processing and Management in their final year at secondary school. This course had replaced a secretarial studies course a few years previously, hence the connection with office automation. Another commonly held view of a computing professional is of a "geeky" male with few social skills whose occupation involves working on his own (usually at night and in the early morning hours), with little variety in his work tasks and with no need of oral and written communication skills. Unfortunately this stereotype is a common perception of careers teachers, parents, and consequently secondary school students (Newmarch et al.).

The main research questions were:

1. What factors have an effect on students' computer attitudes and perceptions of a career in computing at the beginning of the semester?
2. Is there a change in computer attitudes and perceptions of a career in computing at the end of the semester?

The remainder of the paper describes the method used the results obtained, includes a discussion of the results and the limitations of the study, and contains concluding remarks including future work.

Method

This research was conducted in the period 1995 to 1998 at La Trobe University, Bendigo. The students surveyed were enrolled in an introductory computing course either as a compulsory part of a computing degree or were voluntarily enrolled in minor (four computing courses) or major (ten computing courses) studies in computing. The survey was designed to obtain information about our students' attitudes to computers and their perceptions of the general characteristics of a computer professional's skills and work.

The Questionnaire

The students were surveyed at the beginning of the semester and again at the end of the semester. The first part of the questionnaire obtained information on demographics that included gender, age, previous user computing experience, previous programming experience, level of mathematics studied, course and whether they had access to a home computer. The demographics were collected only at the beginning of the semester. The second part of the questionnaire consisted of nineteen 5 point Likert scale questions about computer attitudes and perceptions of a computing career administered at the beginning and again at the end of the semester. A copy of the questions from the second part of the questionnaire is in the Appendix.

The Likert scale questions had a dual purpose. We were interested in student attitudes to computers and in their perceptions of what skills are required for a career in computing. Thirteen of the questions were computer attitude questions. The questions used were a selected subset of the questions in the Computer Attitude Scale of Gressard and Loyd (1986). This instrument has three different subscales: Computer Anxiety, Computer Confidence and Computer Liking. Each subscale consists of ten questions. Table 1 shows the number of questions we used from each subscale. Gressard and Loyd (1986) established the reliability and factorial validity of the three subscales. Their work also supported the use of the Computer Attitude Scale when the analysis of differences in pre and post testing was required (Gressard & Loyd, 1986). Subsets of these scales were chosen in order to reduce the overall size of the questionnaire. It was thought this would encourage a higher response rate. The remaining six Likert scale questions were statements about skills required for, or characteristics of a computing career. The common stereotype of a computer professional described above in the introduction of this paper provided some of the statements. One of the statements came directly from a 1993 Australian Computer Society Victorian Branch brochure aimed at attracting students from diverse backgrounds to consider computing as a career. The statement "You have to be really good at mathematics and science to work in IT" (The terms computing and information technology (IT) are used interchangeably in this paper.) was presented as a myth on the brochure. It was possible that this perception among students may have arisen from the fact that in the Victorian Education Department many of the current pool of comput-

Table 1: Reliability of Questionnaire

Subscale	**Number of questions**	**Cronbach alpha**
Computer Anxiety	4	0.66
Computer Confidence	5	0.83
Computer Liking	4	0.73
Computing Career Perceptions	6	0.55

ing teachers have come from the ranks of mathematics and science teachers, also stereotypically male. Computing is therefore associated with mathematics and science. A similar statement was included in the questionnaire. Initially we also believed that the statement was a myth. However, our previously reported research (Staehr et al., 1998) on a subset of the same group of students (1995 to 1997) indicates that although being really good at mathematics may not be important, proficiency in mathematics certainly is, as level of mathematics background was found to be a significant factor in student success in our first programming course (Staehr et al.). Other researchers (Campbell & McCabe, 1984) have found that background in high school mathematics is a predictor of success in computer science. Therefore the statement was coded as true.

Questionnaire Reliability

Since we used a subset of the questions presented by Gressard and Loyd [6], estimates of internal consistency (alpha coefficients) for each subscale were calculated and are shown in Table 1. A Cronbach alpha of 0.7 is thought to demonstrate good reliability (De Vries, 1990) although some authors report values as low as 0.5 to be satisfactory (Laukkanean, Halonen & Viinamaki, 1999). The subsets of questions chosen from the Computer Attitude Scale show good reliability for the Computer Confidence and Computer Liking subscales and satsfactory reliability for the Computer Anxiety subscale. The removal of some questions from the original scales is the most likely cause of this (Kopalle & Lehmann, 1997). The reliability of the Computing Career Perception questions is lower than desired although still satisfactory (Laukkanean et al., 1999).

Method of Analysis

The pre-test scores were analysed with a main effects ANOVA. It would have been ideal to conduct a single repeated measures analysis incorporating all between subjects factors. However, the dearth of end of semester responses would have resulted in a significant loss of statistical power resulting in significant pre-test factor effects going undetected. For this reason it was decided to analyse the pre-test scores with a main effects ANOVA incorporating all factors thought to be important. This allowed a number of non-significant factors to be eliminated and a separate repeated measures analysis incorporating the retained factors to be performed. The excluded factors were student age (Age), whether or not the student had done a user computer course (User) and whether or not a student had completed a year 11 or 12 mathematics subject (Maths).

Table 2: Demographics of Students in the Sample (N=381)

Factor	**Values**	**No. of Students (N)**	**Factor**	**Values**	**No. of Students (N)**
GENDER	Female	90	PROG	No prev. prog. course	282
	Male	291		Has prev. prog. course	99
YEAR	1995	125	MATHS	No yr 11 or yr 12 maths	26
	1996	86		Has yr 11 or yr 12 maths	355
	1997	79	HOMECOMP	No	116
	1998	91		Yes	265
AGE	< 20	319	DEGREE	BComp	225
	>=20	62		BBus/BComp	105
USER	No user comput. course	78		BBus	27
	Has done user comput. course	303		BAppSc/BComp	10

Results

The characteristics of the sample and the factors involved in the pre-test analysis are displayed in Table 2. The small number of females compared with males needs to be considered when interpreting results. This imbalance leads to more accurate score estimates for males. Similar comments can be made for other factors in Table 2.

The pre-test analysis involved 381 useable responses and the eight factors displayed in Table 2. Of these factors, gender, year of study, previous programming course, home computer and degree were significant on at least one subscale and were retained for the subsequent repeated measures analysis. The multivariate tests of the pre-test scores showed that gender, year, previous programming experience, having a home computer and the degree in which a student was enrolled all exerted a significant effect on at least one of the four measures. The univariate tests showed that women students were significantly more anxious ($p = 0.008$) and less confident ($p = 0.000$) in using computers compared with male students. The year of study had a significant effect on the perception of a computing career. Students who had previously done a programming course were significantly more confident with computers ($p = 0.005$). Those students with a home computer scored significantly higher on lack of computer anxiety ($p = 0.002$), computer confidence ($p = 0.001$) and computer liking ($p = 0.031$). Students in the BComp and BAppSc/BComp degrees scored significantly higher on the three computer attitude question subsets (all p values <= 0.013).

Table 3 shows the raw means of male and female scores expressed as a percentage of the maximum possible score for the pre-test results. These may be interpreted as females being 5.75% more anxious and 9.72% less confident than males. For all measures students scored above 70% at the beginning of the semester.

Table 3: Pre Test Means and Percentages (N = 381)

Measure	Female Mean	Male Mean	Overall	Maximum	Female	Male	Overall
Computer Anxiety (pre) [1]	16.31	17.46	17.18	20	81.55%	87.30%	85.90%
Computer Confidence (pre)	17.82	20.25	19.67	25	71.28%	81.00%	78.68%
Computer Liking (pre)	14.83	15.70	15.49	20	74.15%	78.50%	77.45%
Career Perception (pre)	21.03	21.75	21.58	30	70.10%	72.50%	71.93%

[1] note that a high mean indicates less computer anxiety

The repeated measures analysis involved 163 useable responses, the five between subjects factors retained from the pre-test analysis and, the within subjects factor semester. That is, the factor semester allows end of semester responses to be compared with those at the beginning of the semester while accounting/adjusting for student variability.

A standard repeated measures model involving main effects and two-way interactions was used for the analysis. Table 4 below shows the multivariate (Wilk's lambda) and univariate p-values from this analysis. Significant p values are shown in bold type. To control for type I error, a univariate effect was not considered significant unless both the multivariate and univariate p-value was less than 0.05.

For the between subjects factors, the main effects show a similar pattern of significance to that found in the pre-test analysis. The main semester effect was significant on computer liking and showed a significant decrease on this measure. That is, students liked computers less at the end of the semester than at the beginning. The gender effect was significant for both anxiety and confidence, with females being significantly more anxious and less confident than males overall. The semester by gender interaction effect was not significant indicating that the main semester effect was similar for males and females. In other words, the gender difference in anxiety and confidence levels persisted over the semester. The main year effect was not significant indicating that computer attitudes and perceptions of a computing career are consistent from year to year. The significant semester by year interaction effect for computer confidence is due to a decrease in this measure in 1995 and 1997 and an increase in 1996 and 1998. The main previous programming course effect was significant on the confidence measure indicating that students with a previous programming course were more confident overall than those without programming exposure. The main home computer effect indicates that students with a home computer were significantly more confident and less anxious overall. The degree effect was significant for the liking measure and indicates that students in the Bachelor of

Table 4: P-values from Repeated Measures Analysis

Factor Effect	Wilk's Lambda	Anxiety	Confidence	Liking	Career
Main Effects					
Semester	**.012**	.666	.835	**.006**	.070
Gender	**.001**	**.005**	**.001**	.418	.481
Year	.457	.816	.425	.273	.151
Prev Prog Course	**.004**	.135	**.001**	.157	.945
Home Computer	**.022**	**.002**	**.014**	.079	.096
Degree	.072	.523	.060	**.028**	.863
Interactions					
Semester.Gender	.381	.406	.181	.377	.581
Semester.Year	**.007**	.809	**.019**	.194	.080
Semester.Prev Prog Course	.446	.557	.210	.884	.333
Semester.Home Computer	.530	.911	.167	.169	.461
Semester.Degree (de-	.129	.977	.355	.030	.432

Computing degree and the Bachelor of Computing/Bachelor of Applied Science double degree like computers significantly more than students in other courses.

Table 5 shows the raw means, standard errors and percentages for the Computer Liking subscale for the pre and post-tests. The post-test sample contained 41% of the females in the pre-test sample and 44% of the males.

Table 5: Comparison of Pre and Post Test Means (N = 163)

Measure	Semester	Mean	Standard Error	%
Computer Liking	Beginning	16.002	.479	80.010
	End	14.987	.522	74.935

The students liked computers 5.075% less at the end of the semester. Disturbing aspects of this analysis are the decreased computer liking apparent at the end of the semester, the inconsistent semester effect on confidence over the four years and the persistent gender differences over the semester.

Assumptions of the Analysis

As in any analysis of this kind the validity of the conclusions rest on the assumptions underlying the model used. An analysis of the residuals from the repeated measures model showed mild deviations from normality and that the variance and independence assumptions were reasonably well satisfied. The deviation from normality will have minor effects on the p values from the analysis in that the actual values will vary slightly from the reported values. The reader is urged to use caution when interpreting significant effects when the reported p value is close to 0.05. As most significant effects had p values much less than 0.05 we are confident in our conclusions.

Other issues are generalizability of the findings and self selection bias. Since the sample was not randomly chosen the results really only apply to cohorts with similar characteristics. We feel that the cohorts in the four years of the study are typical of students enrolled in our computing courses and so we are confident that the observed factor effects will be evident in future cohorts unless some action is taken. Self selection bias should work in favour of higher scores on the measures than would be the case with a zero drop out rate. This does not appear to be the case in this study since there was a significant decrease in three of four post-test scores.

Discussion

The results of the pre-test analysis in Table 3 show that our students beginning an undergraduate computing degree score over 70% on all the measures. Overall, our commencing students are not anxious about computers, are confident in using computers, like using computers and appear to have a reasonable idea of the skills required for, and characteristics of a computing career. These results are not unexpected as the students have made a decision to undertake major studies in computing. However, the women students begin the semester significantly more anxious and less confident with computers than the males. This gender difference in computer attitudes is supported by other research (Shashaani, 1997).

The repeated measures analysis showed a significant positive effect of previous programming experience on computer confidence. Home computer ownership had a significant positive effect on computer attitudes, specifically less anxiety and more confidence. These findings are supported by other research (Levine & Donitsa-Schmidt, 1997; Shashaani, 1997).

Observation has shown that students in the double degree Bachelor of Business/Bachelor of Computing, single degree Bachelor of Business and “Other” degree categories are usually more committed to another discipline e.g. business and therefore it is not surprising that these students like computers less than those in the Bachelor of Computing and Bachelor of Applied Science/Bachelor of Computing degrees.

The reason for the decrease in computer liking by students over the semester in all years is open to speculation. It may have been due to over exposure to computers or the competition for scarce resources.

There was a decrease in the confidence students had with computers in the years 1995 and 1997 and an increase in the years 1996 and 1998. A possible explanation for these differences may be found in examining the changes that took place in our first year first semester program over the four years 1995 to 1998. These changes are shown in Table 6.

A possible explanation for the decrease in confidence in 1995 was the acquisition of new hardware resources. As the full complement of new hardware was purchased over two years, insufficient new hardware was available in 1995. This meant that students had to learn to use three different types of computer systems. The arrival of more new computer hardware at the end of 1995 meant that students did not have this problem in 1996.

In 1995 students did their first programming course (Programming Concepts) in the first semester. In 1996 the first programming course moved to second semester and has remained there ever since. In its place an introductory computing course (Programming Environment) was introduced that aimed to familiarise students with our computer systems. It contained minimal programming content. The decrease in confidence in 1997 may have been due to the course Programming Environment being taken by two different lecturers, each having different styles and presenting

Table 6: Changes to First Year First Semester Program

Change	1995	1996	1997	1998
Computing courses and the lecturer(s) denoted by letter	Computer Fundamentals (A and B) Programming Concepts (C)	Computer Fundamentals (A and B) Programming Environment (D)	Computer Fundamentals (A and B) Programming Environment (D and E)	Computer Fundamentals (A and B) Programming Environment (E)
Content Changes		First programming course moved to second semester. Replaced by course with minimal programming content.	Some content changes to Programming Environment due to new lecturer.	Major content changes to both courses.
Hardware resources	New hardware resources meant that students had to learn to use three different types of computer systems.			

different content.

In 1998, Lecturer E was solely in charge of the course and made major content changes. The other computing course (Computer Fundamentals) had no changes in lecturers but had a major change of content in 1998. It is possible that the changes in content and/or lecturer contributed to the increase in computer confidence in 1998. The changes to the two computing courses in 1998 involved an increase in "hands on" work for students and may have caused the increase in confidence.

The most disturbing finding in this research is the persistence of the gender difference in all measures over the semester. In the four years studied, an intervention program was available to all women students in our computing courses (Staehr et al., 1998; Staehr et al., 2000). The intervention program incorporated elements of peer mentoring, peer tutoring and supplemental instruction. Attendance at the intervention program sessions was voluntary.

Qualitative evidence (Staehr et al., 2000) strongly suggested that the program provided a real benefit for women students. In addition the retention rates of women students have improved relative to 1993, in subsequent years when the intervention program was offered (Staehr et al., 2000). Clearly ways need to be found to reduce the gap in computer attitudes between males and females in our courses.

Conclusion

Students enrolled in our computing courses do not seem to hold the common misconceptions about computing careers. Changes to our first year, first semester courses and the acquisition of new hardware resources may be responsible for the decrease in computer confidence of students in two of the four years. However, a major concern is that these changes, coupled with the implementation of an intervention program for women students, have had no impact on decreasing the gap in computer attitudes between male and female students. Further research is required to discover appropriate methods to improve and sustain the attitudes to computers of our women students.

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Appendix

The Attitudes and Career Perceptions Part of the Questionnaire

1. I do not feel threatened when other talk about computers.
2. A career in information technology involves a lot of teamwork.
3. Computers make me feel uncomfortable.
4. Generally, I feel OK about trying a new problem on the computer.
5. I get a sinking feeling when I think of trying to use a computer.

6. Good writing skills are important in information technology.
7. I would feel comfortable working with a computer.
8. It is a big advantage in information technology to be good at maths and science.
9. A career in information technology means mostly working on your own.
10. You must have good communication/interpersonal skills in information technology.
11. Once I start work on the computer, I find it hard to stop.
12. I don't understand how some people can spend so much time working with computers and seem to enjoy it.
13. I am sure I could learn a computer language.
14. I don't think I would do advanced computer work.
15. I have a lot of self-confidence when it comes to working with computers.
16. I could get good grades in a computer course.
17. A career in information technology means mostly sitting at a keyboard and screen all day.
18. The challenge of solving problems with computers does not appeal to me.
19. I think working with computers would be enjoyable and simulating.

Biographies

Lorraine Staehr is a Lecturer in the Information Technology Department at La Trobe University. Her research interests are in mathematical modelling of adsorption processes, women in computing, information systems education and ERP systems implementation. She has published research papers in several international conferences and journals.

Mary Martin is a Senior Lecturer in the Information Technology Department at La Trobe University, Bendigo and has been lecturing since1984. She has been involved in researching the participation of Women in IT since 1993, but also has a special interest in Object Oriented languages and systems as an approach for effective management and production of software systems.

Graeme Byrne is a Senior Lecturer in the Department of Mathematics at La Trobe University. He has taught in a wide variety of mathematical and statistical areas. His academic research interests revolve around approximation theory, statistical computing and analysis, educational research, demographics and marketing research. He has published a number of papers in these areas and is currently working on a major research project looking at the socio-economic impacts of community banking. Recent consulting projects include the analysis of farm survey and economic impact data, demographic and statistical analysis of census data.