Gender and Attitudes to Computer Use in Junior Secondary Mathematics.

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The study described in this article compared the attitudes of girls and boys in two junior secondary classrooms regarding the use of computers in mathematics. Data were gathered by questionnaire. The relationship between the attitudes of girls and boys to computer-based mathematics and measures of their self-efficacy in mathematics and computing were explored. Boys held more positive attitudes to the use of computers in mathematics than girls. For both girls and boys the relationship between attitude to the use of computers in mathematics was more strongly associated with their attitudes to computers than mathematics. The implications for teaching practice and gender equity in mathematics requires more research.

Generally, the large body of research on the use of ICT in mathematics teaching and learning has not been concerned with issues of equity and social justice (Forgasz, Leder & Vale, 2000). In recent times, results from Australian studies have suggested that the use of technology in mathematics learning may exacerbate cultural inequalities (Forgasz, 2002). It may also erode advances toward gender equity in mathematics participation, affect and achievement (Forgasz, in press; Forster & Mueller, 2001; Vale, 2003). In a previous study I showed gendered patterns in the views of girls and boys in two middle years mathematics classrooms about the use of computers in mathematics (Vale, 1998). Girls were more likely than boys to express a view about computers in terms of whether their use would help and enhance their performance in mathematics or not. On the other hand boys expressed their views about using computers in mathematics in terms of whether their use was a source of pleasure and a way of making mathematics relevant or not. Further research that explored the culture of these two classrooms revealed that the culture of computer-based learning environments supported the learning of the higher achieving mathematics students, especially boys (Vale, 2003). In this paper I present a quantitative analysis of data collected using Likert scale items from students who were participants in these two studies to compare the attitudes of girls and boys. I also investigate gender-based relationships between their attitudes to mathematics, computers and computer-based mathematics.

Literature Review

In Australia, gender differences in mathematics achievement at the secondary level are not generally statistically significant, though this is not consistent across studies but differences in participation in post-compulsory mathematics persist (Forgasz, et al., 2000). Gender stereo-typed attitudes to mathematics may be shifting, away from beliefs that boys have a natural ability for mathematics and that mathematics is the domain of boys, to girls now being perceived as more competent mathematically (Forgasz & Leder, 2000). Gender stereotyping with respect to information and communications technologies in primary and secondary schooling continue to be reported by researchers (Volman & van Eck, 2001).

The extent and nature of these differences vary according to computer applications and environments.

Studies of computer use in secondary mathematics classrooms have not generally included a gender analysis of affective factors nor included an analysis of the relationship between affective factors. In a study of a small sample of grade 8 students (N = 47) Dix (1999) found that there was a significant difference in attitudes to computers in favour of boys before and after the use of *Geometer's Sketchpad*. Dix also reported a significant improvement in the attitudes of boys towards computers, after the short period of time taken for one topic in mathematics. Leder and Forgasz (2000), in an Australian study of over 860 secondary students, found that both girls and boys in their study believed that boys were more likely than girls to like using computers in mathematics. More recently, Forgasz has reported that secondary school boys are more positive about the use of computers for the learning of mathematics (Forgasz, in press). She has also found that students from either a high socio-economic background or a low socio-economic background are more likely than students from a middle class background to hold traditional male stereotyped views about the use of computers for the learning of mathematics (Forgasz, 2002). Perhaps surprisingly this study by Foragsz found that boys were more likely than girls to believe that boys thought that the use of computers in mathematics was boring.

Studies at the tertiary level in Australia have focussed on the relationship between a range of affective factors concerning the use of computers in tertiary mathematics. Using factor analysis, researchers have developed various scales to investigate these relationships (Galbraith et al, 2001; Fogarty, et al., 2001). They have consistently found that students' attitude to the use of computers in mathematics is more strongly related to their attitude to computers than their attitude to mathematics. Whether this relationship exists for both males and females studying at tertiary level has not been investigated, though Galbraith and colleagues (2001) reported gender differences favouring females for mathematics attitude and favouring males for attitude to computers attitudes and to the use of computers in mathematics.

Method

In the study reported in this paper the following two questions were of particular interest:

- Are there differences in the attitudes of boys and girls to the use of computers in junior secondary mathematics?
- What is the relationship between the attitudes of girls and boys to the use of computers in mathematics and their attitudes to computers and to mathematics?

Students from two mathematics classes in a lower/middle class secondary school in the metropolitan area of Melbourne participated in the study. The school was selected because it provided two different classroom environments in which computers were regularly used in the mathematics program. A total of 49 students (17 girls and 32 boys) from a grade 8 class and a grade 9 class participated. The ratio of boys to girls in the sample was almost 2:1. The gender bias was largely due to the majority of male students in the grade 9 class (18 boys and 7 girls).

The grade 9 class in the study was a "laptop class" with all students in this class leasing a laptop computer from the school for use in each of their subjects, including mathematics. These students were in the second year of the laptop program and had elected to be in the program at the beginning of the previous year. The grade 8 class was supposedly a "high achievers class" with a program that included regular use of computers. However, not all students in this class were high achievers in mathematics. Two mathematics lessons each week were timetabled in a computer laboratory. Though not compulsory, some students in the grade 8 class had purchased a laptop computer for their own use. The grade 8 students were in the first year of the computer-based program in which they use computers regularly for mathematics. At the time the study was conducted, the grade 9 students were working with a dynamic geometry application (*The Geometer's Sketchpad*) and had been using a spreadsheet (*Excel*) in the previous semester. The grade 8 students had been creating a presentation of the solution process for multi-step equations using presentation software (*Powerpoint*) and were completing exercises in financial arithmetic using a spreadsheet (*Excel*). They had also used a spreadsheet in mathematics in the previous semester.

A range of Likert items was included in a student questionnaire (see Table 1). They four included "How good are you ?" items (Forgasz, 1995) and items based on the Fennema & Sherman attitude scales (1976). New items were developed. Two of these items measured students' perceptions of achievement in mathematics and computing and a further two items measured their aspiration to achieve in mathematics and computing. Fourteen items were included for the development of a scale to measure students attitude to computer-based mathematics. A principal component factor analysis for these 14 items revealed that four components accounted for 68% of the variance. Eleven items with a correlation co-efficient greater than 0.4 clustered on the first component. Internal reliability of these eleven items was strong for the sample size (N= 49; Cronbach's alpha = .87) and they were retained as a scale called Attitude to Computer-based Mathematics Scale (ACBM, Table 1). The individual items are listed in the Appendix. The items show that the scale measures the degree to which students perceive that the use of computers in mathematics provides relevance for mathematics, aids their learning of mathematics and contributes to their achievement in mathematics.

Table 1
Summary of Data Gathered by Likert Items on Questionnaire

	Item/Scale	No. of items	Scoring
GMA	How good are you at mathematics?	1 item	Range of 1 –5.
MAB	How good do you want to be at mathematics?	1 item	Range of 1 –5.
GCO	How good are you at computers?	1 item	Range of 1 –5.
COB	How good do you want to be at computers?	1 item	Range of 1 –5.
ACBM	Attitude to computer-based mathematics	11 items (7 + ve & 4 –ve)	Range 11- 55.

Univariate analysis of variance was used to compare attitudes between males and females and between students in the two different year levels. This analysis was conducted to check whether differences may be confounded by classroom environment. As noted above the mathematics program and computer hardware and software used were quite different. The students who participated in each class were of different levels of academic achievement and the gender bias in enrolment was more pronounced in the year 9 class. Partial correlation co-efficients for males and females were computed for the variables in Table 1.

Results

The means and standard deviations for the variables and scales used to measure students' perception of their achievement in mathematics and computing, their aspiration for success in these areas of learning and their attitude to computer-based mathematics are presented in Table 2. The results of the analysis of variance are presented in Table 3. Interaction between gender and year level was not significant for any of these variables.

Table 2
Means and Standard Deviations for Attitudes to Mathematics, Computers and Computer-Based Mathematics

Variable	Girls		Boys		Grade 8		Grade 9	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
GMA	17	3.47 (1.23)	32	3.75 (0.76)	25	3.72 (1.02)	24	3.58 (0.88)
MAB	17	4.59 (0.62)	32	4.75 (0.51)	25	4.72 (0.61)	24	4.67 (0.48)
GCO	17	3.53 (0.87)	32	3.84 (0.99)	25	3.88 (0.78)	24	3.58 (1.00)
COB	17	4.65 (0.61)	32	4.84 (0.37)	25	4.84 (0.37)	24	4.71 (0.55)
ACBM	17	34.29 (7.80)	31	40.52 (6.45)	25	41.56 (5.89)	23	34.78 (7.58)

Table 3
ANOVA for Gender and Year Level Differences for Attitude Variables

	Gender				Year				Gender*Year			
	df	*F*	*p*	η^2	*df*	*F*	*p*	η^2	*df*	*F*	*p*	η^2
GMA	1,45	1.18	0.28	0.03	1,45	0.50	0.49	0.01	1,45	0.00	0.97	0.00
MAB	1,45	1.15	0.29	0.03	1,45	0.30	0.59	0.01	1,45	1.81	0.19	0.04
GCO	1,45	1.83	0.18	0.04	1,45	1.81	0.19	0.04	1,45	0.69	0.41	0.02
COB	1,45	2.69	0.11	0.06	1,45	1.69	0.20	0.04	1,45	0.70	0.79	0.00

	Gender				Year				Gender*Year			
	df	*F*	*p*	η^2	*df*	*F*	*p*	η^2	*df*	*F*	*p*	η^2
ACBM	1,44	20.35	0.00	0.32	1,44	24.28	0.00	0.36	1,44	1.48	0.23	0.03

Mathematics: Self-Efficacy and Aspirations

There were no significant gender differences in perceived achievement in mathematics ($F(1,45) = 1.10$, $p > 0.05$) or aspiration to achieve in mathematics ($F(1,45) = 0.50$, $p > 0.05$). There was no significant difference for year level despite the nature of students invited to participate in the grade 8 class. For this sample of students, girls and boys have similar perceptions of their achievement and aspirations with respect to mathematics.

Computers: Self-Efficacy and Aspirations

There were also no significant gender or year level differences in students' rating of their achievement in computing or their aspiration to succeed at computing (GCO and COB in Table 3). The mean scores show that there was a trend for boys to rate themselves higher than girls and to aspire to a higher level of achievement and for grade 8 students to rate themselves higher than grade 9 students. However, girls and boys have similar perceptions of their achievement and aspirations with respect to computers.

Attitudes to Computer-Based Mathematics

Boys were more positive about computer-based mathematics than girls (ACBM in Table 3) and this factor was statistically significant ($F(1,44) = 20.35$, $p = 0.00$, partial $\eta^2 = 0.32$). On average, boys were more positive about computers enhancing relevance, learning and achievement in mathematics than girls were. This gender difference was evident irrespective of the students' year level since the interaction between gender and year level was not a statistically significant factor in the attitudes of students to computer-based mathematics. However, year level was also a statistically significant factor in the attitudes to computer-based mathematics ($F(1,44) = 24.28$, $p = 0.00$, partial $\eta^2 = 0.36$). Grade 8 students were more positive about computer-based mathematics than grade 9 students were, irrespective of their gender. Hence grade 8 girls were more positive than grade 9 girls, and grade 8 boys more positive than grade 9 boys were.

Relationships Among Attitude Variables

Partial correlation co-efficients were calculated for each of the "How good are you?" items and the measure for attitudes to computer-based mathematics for girls and boys. The results of the correlation analysis are displayed in Table 4. The top section of the table shows correlation co-efficients for girls and the bottom shows the results for boys.

Table 4

Partial Correlation Co-Efficients for Attitudes to Mathematics, Computers and Computer-Based Mathematics for Male and Female Students

females

		GMA	MAB	GCO	COB	ACBM
m	GMA		0.845**	0.044	-0.182	0.271
a	MAB	0.333		-0.034	-0.245	0.169
l	GCO	0.375*	-0.16		0.492*	0.526*
e	COB	0.086	0.129	0.285		0.407
s	ACBM	0.153	-0.056	0.364*	0.464**	

* $p < 0.05$, ** $p < 0.01$

For girls there was a moderate and significant relationship between attitude to computer-based mathematics and their perception of their achievement in computing (r = 0.526, p = 0.03). For boys both the perception of achievement in computing and their desire to achieve at computing were correlated moderately and significantly with attitude to computer-based mathematics (r = 0.364, p = 0.04 and r = 0.464, p = 0.01 respectively). The strongest relationship revealed by the correlation analysis was between girls' perception of their achievement in mathematics and their desire to achieve in mathematics. Hence girls who experienced success in mathematics also desired to do well in mathematics, however there was no relationship with attitude to computer-based mathematics. Likewise girls who do not experience success in mathematics do not aspire to do well in mathematics and they do not necessarily have a positive or negative attitude to computer-based mathematics. For boys a significant but weak relationship was shown between their perception of their achievement in mathematics and that for computing. However boys perception of their success in mathematics was not related to their attitude to computer-based mathematics.

Discussion and Conclusion

Even though boys and girls were similar in their perceptions of their achievement in mathematics and in computing and their aspirations to achieve in mathematics and in computing, boys were more positive about computer-based mathematics than girls. The correlation analysis reveals that girls who rate themselves highly in achievement in computing are more likely to have a positive attitude to computer-based mathematics, however girls who experienced success in mathematics did not necessarily perceive that computers enhanced relevance, learning and achievement in mathematics. Similarly boys who rated themselves highly in achieving with computers were more likely to hold a positive view that about the use of computers in mathematics. The relationship was just as likely for those boys who aspired to do well in computing. These findings suggest that for boys the opportunity to enhance their computer skills in mathematics is valued, irrespective of effects on learning of mathematics.

Care needs to be taken when interpreting these results because this study has been based on a small sample (with small effect sizes and hence low power), whose teachers interpreted the use of computers within their own classroom in particular ways. Despite the weaknesses in this study the findings are consistent with previous findings (Dix, 1999; Forgasz, 2002; Galbraith et al., 2001; Vale, 1998; Vale, 2003).

The findings indicate that girls were more likely to be positive about using computers in mathematics if they perceived themselves to be good at computers. Success in mathematics did not necessarily make for positive attitudes to the use of computers. Teachers therefore need to take into account that not only do girls want to understand the mathematics that they are doing as established by feminist research, they also want to be able to use the software with competence if they are to find value in computer-based mathematics tasks. The current findings may explain why girls have persisted with algebraic methods rather than used new technology. They also lend support to the suggestion made by Forster and Mueller (2001) that the use of technology in senior secondary mathematics may be contributing to falling participation rates of girls.

The questionnaire, and hence the scale for attitudes to computer-based mathematics, did not include items concerning pleasure (or boredom) derived from the use of computers in mathematics. In the previous studies it was shown that boys were more likely than girls to like using computers and also not to like using them (Vale, 1998). They also were observed to undertake a range of computer-based non-mathematical tasks during the lessons (Vale, 2003). That some computer-based mathematics tasks in mathematics lessons are not perceived to be relevant by boys aspiring to be excellent with computers may account for boys' perception that boys will find computers in mathematics boring (Forgasz, 2002).

The results also revealed that year level was a factor in attitudes to computer-based mathematics. Clearly the teacher, the curriculum, the computer software, and the computer hardware differed for the two classes from the one school involved in the current study. Previous qualitative analysis of these two classroom environments showed that girls and boys who were low achievers in mathematics were not engaged in meaningful mathematics learning when using technology and the knowledge and skills of girls were not valued in computer-based mathematics lessons (Vale, 2003). Gendered patterns of behaviour were especially evident in the year 9 classroom where the students used laptop computers and dynamic geometry software for a series of tasks in a geometry unit. More needs to be understood about what makes the difference and what role teachers can play to support the learning of mathematics in computer-based environments for both girls and boys. Teachers will need to balance the learning of computer skills with the enhancement of mathematical understanding and make explicit the mathematical learning to be achieved with computers if girls are to value computer-based mathematics and boys are able to pursue their interests with computers.

For neither girls nor boys was there a relationship between their perception of achievement in mathematics or their desire to do well in mathematics and their attitude to computer-based mathematics. Maintenance of participation in mathematics may depend on teachers taking into account gender differences in attitudes when using computers in mathematics.

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Appendix

Items used in Attitude to Computer-Based Mathematics Scale (ACBM)

I've improved in maths since we started using computers in maths.	I find that using computers helps me to learn maths.
I've gone backwards in maths since we started using computers in maths.*	Using computers in maths means you won't be able to maths without them.*
I am sure I could do difficult maths with the use of a computer.	Maths is easier to understand when you use computers.
Even a computer can't help me learn maths.*	Using computers in maths makes maths more confusing.*
Using computers in maths gives you a reason for doing maths.	Computers are excellent for doing things for maths.

Using computers in maths does not make maths any more useful.*

* Indicates negatively scored items.