Computers For Learning Mathematics: Equity Considerations[1]

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Mathematics and computing have been stereotyped as 'male domains'. Contemporary mathematics teachers are encouraged to use computers in class and it is believed that students' learning will thus be enhanced. In this paper, findings from a large survey tapping students' attitudes towards computers for mathematics learning are presented. The results were analysed by several equity factors – gender, student socio-economic background, ethnicity, school type and location (rural/metropolitan, and socio-economic location) – to explore the gender stereotyped beliefs of these groups of students.

Introduction

Over time, the disciplines of mathematics and computing have been viewed as *male domains*, that is, both have been considered more suited to males than to females. Compared to females, males have generally been found to hold more functional (likely to lead to success) beliefs and attitudes towards mathematics and about themselves as learners of mathematics (see Leder, 1992). More recently, it has been reported that Australian students' gendered patterns of beliefs associated with the stereotyping of 'mathematics as a male domain' appear to be changing (e.g., Forgasz, 2001a, 2001b). The extent of these changes has been found to differ among ethnic groups (Barkatsas, Forgasz, & Leder, 2001).

Research on secondary students' attitudes towards computers reveals that compared to males, females are generally found to be less positive about computers, to like them less, to perceive them as less useful, to fear them more, to feel more helpless around them, to view themselves as having less aptitude with them, and to show less interest in learning about and using them. Females are also less likely than males to stereotype computing as a male domain, to have received parental encouragement, to use computers out of school or to own one (e.g., Busch, 1995; Colley, Gale, & Harris, 1994; Durndell, Glissov & Siann, 1995; Levin & Gordon, 1989; Makrakis & Sawada, 1996). Makrakis and Sawada (1996) also found that male and female students from both Japan and Sweden perceived the usefulness of mathematics and computers and boys' and girls' aptitudes in these fields as male stereotyped. Miura (1986) reported that undergraduate males were more likely than females to consider being able to use a computer to be important in their future careers. Andre, Whigham, Hendrickson, and Chambers (1999) found that among older primary level children, boys perceived jobs requiring life science, computer science and team sports as more male dominated than did girls and that parents held stereotyped perceptions of the importance of school subjects and of their children's competencies. Shashaani (1993)

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concluded that gender differences were influenced by socialisation and, as a result, females "have low expectations for success in computing" (p.179). Schools policies and practices may also contribute to these expectations (Ogbu, 1992).

Computers are now commonly found in mathematics classrooms and there is much pressure to use them. Maintaining that it was crucial to know whether using computers for mathematics learning would exacerbate or challenge previously identified gender differences in mathematics education, Forgasz (2002) examined students' gendered perceptions of mathematics, of computers, and of computers for the learning of mathematics. The students' beliefs about computers were found to be the most traditionally gender-stereotyped and their beliefs about using computers for learning mathematics seemed to fall somewhere between their beliefs about the stereotyping of mathematics and of computing.

In this paper, results are presented of an examination of students' beliefs about computers for the learning of mathematics by a range of equity factors – student gender, socio-economic background and ethnicity (first language, and aboriginality), school type and location (rural/metropolitan, and socio-economic location). Within the Australian context, these dimensions of equity have been identified as contributors to educational disadvantage in government policy (e.g., Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA], 1999), and in research into factors associated with differences in performance levels (e.g., Teese, Davies, Charlton, & Polesel, 1995). The extent to which students in the various equity groups hold gender-stereotyped beliefs about computers for the learning of mathematics are compared and discussed.

The Study

Aims

The findings reported here are based on data gathered in the first year of a three year study[1]. The aims of the main study are: (i) to determine the effects on students' affective and cognitive learning outcomes of using computers for mathematics learning, (ii) to identify factors which may contribute to inequities in these learning outcomes, and (iii) to monitor how computers are being used for the learning of mathematics in grades 7-10 (see Forgasz & Prince, 2001). Students' attitudes and beliefs about using computers for the learning of mathematics are the focus of the findings presented in this paper.

Sample, Instrument and Methods

Students in grades 7-10 from 28 co-educational schools in Victoria participated in the study. There were 15 metropolitan and 13 rural schools from the three educational sectors — Government (17 schools), Catholic (4 schools), and Independent (7 schools). The total sample size was 2140. Frequencies and percentages of students in the various equity categories of interest in this study are shown in Table 1.

A survey questionnaire was administered to the students in semester two of the 2001 academic year. As well as gathering information on several student background characteristics (e.g., gender, ethnicity, and socio-economic status [SES]), the survey included a set of ten items (*Who & computers for mathematics*) tapping students' beliefs about using computers for learning mathematics (see Table 2 for the items used). The ten items were developed and adapted to reflect dimensions that have been associated with the gender stereotyping of mathematics: ability, teacher, classroom, general attitude, career (see Leder, 2001). For each item, students were required to select one of the following responses with respect to the behaviour or belief reflected in the wording of the item:

BD	boys definitely more likely than girls	GP	girls probably more likely than boys
BP	boys probably more likely than girls	GD	girls definitely more likely than boys
ND	no difference between boys and girls		

Table 1
Frequencies and Valid Percentages of Grade 7-10 Students by Grouping Categories

Category	Total N=2140[a]		
School type	Government	Catholic	Independent
(Valid N=2140)	1316 (61.5%)	339 (15.8%)	485 (22.7%)
School SES location[b]	High	Medium	Low
(Valid N=2140)	683 (31.9%)	1047 (48.9%)	410 (19.2%)
Student SES[b]	High	Medium	Low
(Valid N=2066: 96.5%)	500 (24.2%)	1185 (57.4%)	381 (18.4%)
Gender	Female	Male	
(Valid N=2127: 99.4%)	1015 (47.7%)	1112 (52.3%)	
School location	Metropolitan	Rural	
(Valid N=2140)	1211 (56.6%)	929 (43.4%)	
Ethnicity: (Non-)English speaking background	NESB[c]	ESB	
(Valid N=2134: 99.7%)	491 (23.0%)	1643 (77.0%)	
Ethnicity: Aboriginality	ATSI[d]	Non-ATSI	
(Valid N=2121:99.1%)	42 (2.0)	2079 (98.0)	

[a] Missing data account for 'Valid Ns' not being equal to 2140
[b] The socio-economic status [SES] of a school's location was determined from its postcode; the SES of a student was based on home postcode. The categorisations were derived from: Australian Bureau of Statistics (1990). *Socioeconomic indexes for areas*. Catalogue No.1356.0. Canberra: AGPS.
[c] NESB = Non-English speaking background; ESB = English speaking background
[b] ATSI = Aboriginal and Torres Strait Islander

Analyses, Results and Discussion

In order to determine an overall (average) directional response to each of the then *Who & computers for mathematics* items, mean scores were calculated based on assigning scores to each response as follows:

BD = 1 BP = 2 ND = 3 GP = 4 GD = 5.

Mean scores less than 3 thus indicate that, on average, respondents believe that "boys are more likely than girls" to behave or hold the belief reflected in the wording of the item; means greater than 3 that they believe that "girls are more likely than boys" to do so. For mean scores close to 3 (no difference between boys and girls), one-sample *t*-tests were used to determine if the score was significantly different from 3. In Table 2, the predicted response direction for each item, based on the literature in the field, as well as the actual response direction for the entire sample of students are shown as follows:

F = "girls are more likely than boys to…"
M = "boys are more likely than girls to…"

ND = "no difference between girls and boys" (mean not significantly different from 3)

From the data in Table 2, it can be seen that the results for the whole sample are consistent with six of the predicted response directions (Items 1, 2, 3, 6, 8 and 9) and generally confirm traditional gender stereotypical expectations about computer use for mathematics learning: males are more competent than females, females need more assistance from the teacher, males take control of the computers in the classroom setting, and that being able to use computers for mathematics is more relevant to males' than females' future careers. Counter to predictions, the students perceived that there was no difference between males and females in liking to use computers for learning mathematics (Item 5), in giving up when things get difficult (Item 7), nor for whom parents think that using computers for mathematics is important (Item 10). They also considered males more likely than females to find using computers for mathematics to be boring (Item 4).

Table 2

Who & Computers for Mathematics (10 Items), Predicted (Pred) and Actual (Act) Response Directions

	Items: Who & computers for mathematics	Pred	Act
1	Are good at using computers for learning mathematics (Ability)	M	M
2	Mathematics teacher gives them more help when using computers in class (Teacher)	F	F
3	Think it important for their future jobs to be able to use computers for mathematics learning (Career)	M	M
4	Find using computers for mathematics to be boring (General attitude)	F	M
5	Do not like using computers for doing mathematics (General attitude)	F	ND
6	Tease kids who are good at using computers for their mathematics work (Classroom)	M	M
7	Give up when they find using computers for mathematics to be difficult (Ability)	F	ND
8	Like to take control of the computer when students work together in mathematics classes (Classroom)	M	M
9	Distract others as they work on computers in mathematics classes (Classroom)	M	M
10	Parents think it is important for them to use computers for learning mathematics (Parents)	M	ND

A summary of the directions of student responses for the whole sample and by equity groupings is shown in Table 3. The item numbers (and total frequencies in square brackets) on which response directions were consistent with the traditional gender-stereotype are indicated. With respect to responses inconsistent with the traditional stereotype, two categories have been used: ND (no difference between girls and boys), and OPP (the opposite direction to the traditional stereotype).

Table 3
Beliefs by Equity Categories

	Traditional stereotype	Not traditional stereotype	
	Items [N]	ND – no difference [N]	OPP - Opposite direction [N]
Whole sample	1, 2, 3, 6, 8, 9 [6]	5, 7, 10 [3]	4 [1]
School type			
Government	1, 2, 6, 8, 9 [5]	3, 5, 7, 10 [4]	4 [1]
Catholic	2, 6, 8, 9 [4]	1, 3, 7, 10 [4]	4, 5 [2]
Independent	1, 2, 3, 4, 5, 6, 7, 8, 9 [9]	10 [1]	-
School SES location			
High SES	1, 2, 3, 5, 6, 7, 8, 9 [8]	4, 10 [2]	-
Medium SES	2, 6, 8, 9 [4]	1, 3, 5, 7, 10 [5]	4 [1]
Low SES	1, 2, 3, 6, 8, 9 [6]	4, 5, 7, 10 [4]	-
Student SES			
High SES	1, 2, 3, 5, 6, 7, 8, 9, [8]	4, 10 [2]	-
Medium SES	1, 2, 6, 8, 9 [5]	3, 5, 7, 10 [4]	4 [1]
Low SES	1, 2, 6, 8, 9 [5]	3, 5, 7, 10 [4]	4 [1]
Gender			
Female	2, 4, 5, 6, 8, 9 [6]	1, 3, 7 [3]	10 [1]
Male	1, 2, 3, 6, 8, 9 [6]	7, 10 [2]	4, 5 [2]
School location			
Metropolitan	1, 2, 3, 5, 6, 7, 8, 9 [8]	4, 10 [2]	-
Rural	2, 6, 8, 9 [4]	1, 3, 5, 7, 10 [5]	4 [1]
Ethnicity: (Non-) English speaking background			
NESB	1, 2, 6, 8, 9 [5]	3, 4, 5, 7, 10 [5]	-
ESB	1, 2, 6, 8, 9 [5]	3, 5, 7, 10 [4]	4 [1]
Ethnicity: Aboriginality			
ATSI	1, 6 [2]	2, 3, 4, 5, 7, 8, 9, 10 [8]	-
Non-ATSI	1, 2, 3, 6, 8, 9 [6]	5, 7, 10 [3]	4 [1]

The data in Table 3 reveal that:

1. Students in every equity category agreed with the traditional gender stereotype that 'boys tease kids who are good at using computers for their mathematics work' (Item 6)
2. Except ATSI students (conclusions drawn are very tentative due to the very small sample size), students from every other equity category held two traditional gender stereotypical views about boys:
    - Boys like to take control of the computer when students work together in mathematics classes (Item 8); and
    - Boys distract others as they work on computers in mathematics classes (Item 9) and one traditional gender stereotypical view about girls:
    - Mathematics teachers give girls more help when using computers in class (Item 2).

3. Except females, students from all sectors, backgrounds and locations believed that parents think it is equally important for girls and boys to use computers for learning mathematics (Item 10); females believed that parents think it is more important for girls.
4. Students at Independent schools held the most traditional gender stereotypical views (9 items), closely followed by students attending schools located in high SES areas (8 items), students form high socio-economic status backgrounds (8 items) and students attending metropolitan schools (8 items). The similarity in the pattern of items on which these groups reflected traditionally gender stereotypical beliefs is not inconsistent with the close relationships between these factors.
5. ATSI students appear to hold the fewest traditional gender stereotypical views (2 items), followed by students attending Catholic schools (4 items), schools in medium-level SES locations (4 items), and rural schools (4 items).
6. Of all of the equity categories, the patterns of beliefs of students from NESB and ESB backgrounds were the only ones that were virtually identical. Student ethnicity (whether of ESB or NESB) would therefore not appear to be a major factor associated with gendered beliefs about computers for learning mathematics.

Table 4
Statistically Significant Differences in Mean Scores by Equity Categories

Equity group	Statistically significant differences
School type	7 Items 1, 2, 3, 4, 5, 6 & 7
School SES location	7 items: 1, 2, 3, 4, 5, 6 & 7
Student SES	5 items: 2, 4, 5, 6 & 7
Gender	8 items; 1, 2, 3, 4, 5, 6, 9 & 10
School location	6 items: 1, 3, 5, 7, 8 & 9
Ethnicity: (Non-) English speaking background	2 items: 4 & 6
Ethnicity: Aboriginality	2 items: 1 & 9

NB. The large disparity in sample sizes may account for the apparent inconsistency in the number of items with different response directions and the number with statistically significant differences in mean scores.

Within each of the equity categories, *t*-tests (for two groups) or univariate ANOVAs (for three groups) were conducted to examine for statistically significant differences at the .05 level in the mean scores for each of the 10 *Who & computers for mathematics* items. The results are summarised in Table 4. Space constraints do not allow for the recording of the mean scores nor for a discussion of the post-hoc tests conducted to understand better the statistically significant differences found as a consequence of the ANOVAs.

It would appear that within each equity category, group members differ considerably in their gendered views about the use of computers for learning mathematics. Gender was the equity category with the largest number of items (8) with statistically significant differences in mean scores. The groups within each of the two categories of ethnicity (ESB/NESB and ATSI/non-ATSI) appeared to hold the most similar beliefs (only 2 items with statistically significant differences in mean scores).

Using the information on Tables 2 and 4 together, some of the statistically significant differences in mean scores are self-evident. For example, for Item 5 (do not like using computers for doing mathematics) by school type, it can be seen that students in the three school types responded quite differently: Government (ND); Catholic (OPP, opposite to traditional stereotype); and Independent (traditional stereotype). In many cases the statistically significant differences in mean scores were due to differences in the extent to which views were held. For example, there was a statistically significant difference in mean scores for Item 2 by gender. Although both males and females believed that girls received more help from the mathematics teacher when using computers in class, males believed this more strongly: mean score (M) = 3.26; mean score (F) = 3.06.

Conclusions

With respect to views on computer use for mathematics learning, there were six items on which the entire sample's beliefs were consistent with the traditional gender stereotype (Items 1, 2, 3, 6, 8 and 9 – see Table 2). When examined by equity groupings, there were fairly consistent traditionally gender stereotyped views associated with four of these six items (Items 2, 6, 8 and 9). For Item 6, all groups agreed with the traditional gender stereotype, and all groups except ATSI students responded in the direction of the traditional gender stereotype on Items 2, 8 and 9. Thus, it was generally believed that boys:

- tease kids who are good at using computers for their mathematics work (Item 6);
- like to take control of the computer when students work together in mathematics classes (Item 8); and
- distract others as they work on computers in mathematics classes (Item 9)

and that girls:

- receive more help from the mathematics teacher when using computers for mathematics (Item 2)

For the remaining six items (Items 1, 3, 4, 5, 7, 10), views varied across the equity groupings.

Interestingly, it was students from higher SES backgrounds, those attending schools in high SES locations, and those enrolled in Independent schools who held the most traditional gender-stereotyped beliefs about using computers for mathematics learning. Paradoxically, these are the students most likely to have wide access to computers at school and at home and who, historically, are disproportionately represented among the highest achievers in mathematics (see Teese et al., 1996).

At the other extreme were ATSI students, considered one of the most disadvantaged groups within Australia, who held the least stereotyped views about using computers for learning mathematics. As the ATSI students constituted only a very small sample (42 students), any conclusions drawn must necessarily be very tentative. It was therefore of interest to look at the groups that held the next least traditionally stereotyped views: students attending Catholic schools, schools in medium-level SES locations, and rural schools. More research is needed to understand why these groups, as well as ATSI students, are less stereotyped in their beliefs about computer use for mathematics learning. Could it be that students in rural areas do not consider it likely that their career paths will be dependent on using computers for mathematically-related activities, that is, the outcomes of using computers for mathematics learning are irrelevant to them? In non-metropolitan areas, are there fewer career opportunities in mathematics-based, computer-related professions and trades than in the big cities? Why is it that students attending Catholic schools hold less traditionally gender-stereotyped beliefs than their peers attending Government and Independent schools? Similarly, why are the views of students attending schools in medium level SES locations different from their peers who attend schools in high and low SES areas?

While clearly indicating that beliefs about the gender stereotyping of computer use for mathematics learning differ across and within the various equity groups examined, the findings reported here give rise to many more questions. Answers are needed if the envisaged enhancements in students' mathematics learning as a consequence of using computer technology are to be achieved equitably.

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