COMPUTERS FOR LEARNING MATHEMATICS: GENDERED BELIEFS

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The fields of mathematics and computing have been stereotyped as 'male domains'. Efforts to challenge the stereotype within mathematics appear to have had some measure of success. Computers are now common in schools and it is widely believed that using them for mathematics will enhance student learning. However, not much is known about students' beliefs about using computers for the learning of mathematics. In this paper, findings from a large scale survey that included questions tapping attitudes towards mathematics, computers, and computers for mathematics learning are presented. The results appear to confirm recently reported changes in beliefs about the gender stereotyping of mathematics, but lend some support to the view that computers for the learning of mathematics may be more suited to boys.

INTRODUCTION

Historically mathematics was viewed as a *male domain*, that is it was considered a discipline more suited to males than to females. Research on affective dimensions and gender issues in mathematics education is extensive (see Leder, 1992). A range of affective variables was included in models explaining gender differences found to favour males in mathematics learning outcomes – achievement and participation rates (Leder, 1992). In general, males have been found to have more functional (likely to lead to future success) patterns of beliefs and attitudes associated with these affective dimensions. More recently, it has been reported that students' gendered patterns of beliefs associated with the stereotyping of mathematics as a male domain appear to be changing, at least in some countries (see, for example, Forgasz, 2001a, 2001b).

The same male stereotype has been attached to the field of computing. The variables examined and the research findings on secondary school students' attitudes towards computers are similar to those in the mathematics education literature. Compared to males, females are generally reported to be less positive about computers, like them less, perceive them as less useful, fear them more, feel more helpless around them, view themselves as having less aptitude with them, and show less interest in learning about and using computers; 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). Shashaani (1993) concluded that gender differences were influenced by socialisation and, as a result, females "have low expectations for success in computing" (p.179). Loyd, Loyd and Gressard's (1987) findings were at variance with those reported by others. They found that grade 7 and 8 female students' computer anxiety levels were lower and their liking of computers was higher than males' and suggested that it may be possible to compensate for females' less positive

attitudes towards mathematics "by using computers more extensively in mathematics curricula at the middle school level" (p.18).

Galbraith, Haines and Pemberton (1999) developed a computer attitudes instrument and found that their computer-mathematics subscale correlated more strongly with computer confidence and computer motivation than with the equivalent mathematical scales. They claimed that the consistent and strong relationship often reported between mathematics confidence and performance meant "that the implications of a nexus between technology and mathematics needs specific research attention" (p.216). Gender should also be included as a variable in such research. Hoyles (1998) claimed that introducing computers into mathematics classrooms might widen the gap between males and females, typically those with less confidence or prior experience with technology.

Computers are now commonly found in mathematics classrooms and there is much pressure to use them. It is crucial to know whether using computers for mathematics learning exacerbates or challenges previously identified gender differences in mathematics education. Of interest in this study were students' gendered perceptions of mathematics, of computers, and of computers for the learning of mathematics.

THE STUDY

Aims

The findings reported in this paper are based on data gathered in the first year of a three year study [1]. The main aims of the entire 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. Students' attitudes and beliefs about using computers for the learning of mathematics were gathered in the first year of the study.

Sample, instrument and methods

Students in grades 7-10 from 28 co-educational schools in Victoria (Australia) participated in the study. There were 15 metropolitan and 13 rural schools from across the three educational sectors — government (17), Catholic (4), and Independent (7). The total sample size was 2140 (F=1015, M=1111, ?=14).

A survey questionnaire was administered to the students in semester two of the 2001 academic year. Included in the survey were three sets of ten items tapping students' perceptions of the gender stereotyping of mathematics (*Who & mathematics*), of computers (*Who & computers*), and of computers for learning mathematics (*Who & computers for mathematics*) — see Table 1 for the three sets of ten items.

Nine of the ten *Who & mathematics* items were drawn from the 30 item instrument described in more detail elsewhere by Forgasz (2001a, 2001b) and Leder (2001). The tenth item — *Tease kids who are good at mathematics* — was a combination of two of the 30 items — *Tease girls who are good at mathematics* and *Tease boys who are*

good at mathematics. The ten items reflected several dimensions previously identified as associated with the gender stereotyping of mathematics: ability, general attitude, future careers, parents, teachers, and classroom factors (see Leder, 2001). The ten *Who & computers* and the ten *Who & computers for mathematics* items were developed to replicate the same dimensions of gender stereotyping — see Table 1.

For each item in each of the three sets of ten items, students were required to consider the wording of the item and then to select one of the following responses with respect to the behaviour or belief represented by the item:

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

Analyses, results and discussion

In order to determine an average directional response to each item, 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 reflect the behaviour or belief encompassed by 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 mean score obtained was significantly different from 3. Response directions for each item are shown in Table 1:

F = "girls are more likely than boys to..."
M = "boys are more likely than girls to..."
nd = mean not different from 3 ie. "no difference between girls and boys".

The mean scores are shown graphically in Figure 1. It should be noted that the vertical axis passes through 3, the score indicating a belief that there is "no difference between girls and boys". Bars to the right of the axis therefore reflect means > 3; those to the left, means < 3. The length of the bars shows the extent of deviation from 3, thus revealing the relative strength of students' beliefs with respect to each item.

Interesting patterns emerged when responses to the three sets of items were examined individually and then compared. The data were also analysed by gender to explore for differences in the response patterns of male and female students.

Who and mathematics

The directional responses to the ten items replicated those reported by Forgasz (2001a, 2001b) for a different sample of grade 7-10 Australian students. The findings appear to challenge the stereotype of mathematics as a *male domain*. The results indicate, for example, that students believe that girls are more likely than boys to say

that mathematics is their favourite (item 2), to find mathematics interesting (7) and easy (1), and to get on with their work in class (10). Boys are believed to be more likely than girls to give up when a problem is too difficult (item 6), to need more help with mathematics (4) and to tease students who are good at mathematics (3).

Table 1. *Who & mathematics* (10 items), *Who & computers* (10 items), *Who & computers for mathematics* (10 items) and response directions

Who & mathematics		*Who & computers*		*Who & computers for mathematics*	
1. Find mathematics easy (Ability)	F	11. Like using computers (General attitude)	M	21. Are good at using computers for learning mathematics (Ability)	M
2. Mathematics is their favourite subject (General attitude)	F	12. Are good at fixing software problems (Ability)	M	22. Mathematics teacher gives them more help when using computers in class (Teacher)	F
3. Tease kids who are good at mathematics (Classroom)	M	13. Need more help with computer activities (Ability)	F	23. Think it important for their future jobs to be able to use computers for mathematics learning (Career)	M
4. Need more help in mathematics (Ability)	M	14. Teachers expect them to be able to use computers (Teacher)	M	24. Find using computers for mathematics to be boring (General attitude)	M
5. Think mathematics will be important in their adult life (Career)	F	15. Tease kids if they are good with computers (Classroom)	M	25. Do not like using computers for doing mathematics (General attitude)	nd
6. Give up when they find a mathematics problem is too difficult (Ability)	M	16. Give up when something goes wrong with the computer (Ability)	F	26. Tease kids who are good at using computers for their mathematics work (Classroom)	M
7. Think mathematics is interesting (General attitude)	F	17. Need to be able to use computers well to get a good job when they leave school (Career)	M	27. Give up when they find using computers for mathematics to be difficult (Ability)	nd
8. Mathematics teachers spend more time with them (Teacher)	F	18. Parents encourage them to use computers (Parents)	M	28. Like to take control of the computer when students work together in mathematics classes (Classroom)	M
9. Parents think it is important for them to study mathematics (Parents)	nd	19. Take control of the computer when working with others (Classroom)	M	29. Distract others as they work on computers in mathematics classes (Classroom)	M
10. Get on with their work in class (Classroom)	F	20. Are easily distracted when using computers (Classroom)	M	30. Parents think it is important for them to use computers for learning mathematics (Parents)	nd

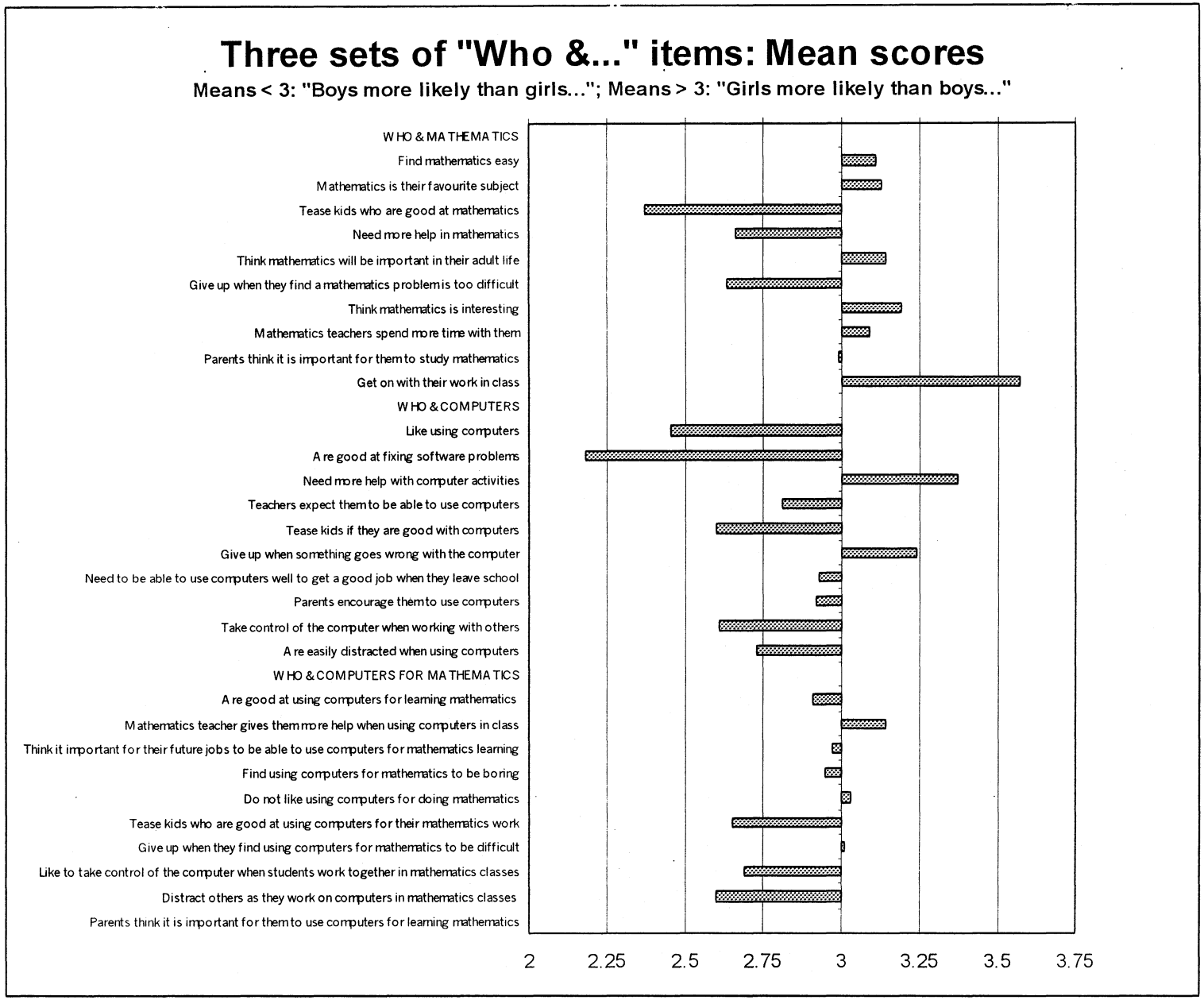

Figure 1. The three sets of "Who & ..." items: Mean scores (Australian grade 7-10 students)

Who and computers

For these ten items, students' beliefs appear to reflect the stereotyping of the field of computing as a *male domain*. The results indicate that students believe boys like using computers (item 11), are good at fixing software problems (12), are encouraged by parents (18), and that teachers expect them to be able to use computers (15). Boys are considered more likely than girls to take control of computers in the classroom (19), tease students who are good with computers (15), be easily distracted when using computers (20), and be able to use computers for future jobs (17). Girls, on the other hand, are believed to need more help with computer activities (item13) and to give up when something goes wrong with the computer (16).

Who and computers for mathematics

The extent of stereotyping seems less marked on these ten items than for the *Who and computers* items and more consistent with the *Who and mathematics* items. Students believed, for example, that there was no difference between girls and boys in not enjoying using computers for mathematics (item 25), giving up when using computers for a mathematics problem is difficult (27), and regarding who parents think it is important use computers for mathematics (30). Students considered that boys were more likely than girls to be good at using computers for mathematics (item 21). Although it was boys who were also believed to think that using computers for mathematics was boring (item 24) but important for their future job prospects (23), these beliefs were not strongly held (mean scores just less than 3). Boys were strongly considered to be the teasers of students who were good at using computers for mathematics (26), as well as the ones to distract others (29), and to take control of the computer when working with others (28). Students believed girls received more help from the teacher (item 22).

Gender differences

For each item, independent samples t-tests were conducted to determine if there were statistically significant differences by gender. The results of the t-tests including mean scores by gender and significance levels for the 30 items are shown in Table 2 [See Table 1 for wording of items].

A close inspection of the means in Table 2 reveals that for the vast majority of items males and females responded in the same direction, that is both means were either >3 or both were <3. [Some means were not significantly different from 3 indicating a belief that there was "no difference between girls and boys" and are shown in *Italics*.]

As can be seen in Table 2 there were many items with statistically significantly different means by gender. Among those for which males and females responded in the same direction, there is no consistent pattern of either males or females holding the stronger view. Interestingly, there were only four items with significantly different means for which males and females held beliefs that were in opposite directions: items 8, 9, 24 and 25. For item 25, for example, females believed it was girls who were more likely than boys "not to like using computers for doing

mathematics"; males believed that boys were more likely to do so.

Table 2. Results of t-tests by gender on items from the three sets of ***Who &...*** items

Who & mathematics				*Who & computers*				*Who & computers for mathematics*			
Item	F	M	p-level	**Item**	F	M	p-level	**Item**	F	M	p
1	3.19	*3.04*	***	**11**	2.56	2.36	***	**21**	*2.98*	2.85	***
2	3.08	3.19	***	**12**	2.23	2.13	**	**22**	3.06	3.21	***
3	2.28	2.45	***	**13**	3.30	3.44	***	**23**	*3.03*	2.92	***
4	2.69	2.63		**14**	2.83	2.79		**24**	3.03	2.84	***
5	3.27	*3.01*	***	**15**	2.56	2.63		**25**	3.11	2.95	***
6	2.64	2.63		**16**	3.23	3.26		**26**	2.59	2.70	**
7	3.11	3.24	***	**17**	*3.00*	2.88	***	**27**	*3.03*	*2.99*	
8	2.91	3.25	***	**18**	*2.99*	2.86	***	**28**	2.68	2.71	
9	3.06	2.93	***	**19**	2.63	2.60		**29**	2.56	2.64	*
10	3.67	3.48	***	**20**	2.73	2.73		**30**	3.02	*2.98*	*

NB. p-levels: * = <.05 **=<.01 ***=<.001
Means shown in *Italics* – not significantly different from 3.

CONCLUDING COMMENTS

It would appear that Australian grade 7-10 students no longer stereotype mathematics as a *male domain*, at least along the affective dimensions previously reported in the mathematics education research literature and tapped in this study. The same cannot be said about the discipline of computing. The students' beliefs seem consistent with the traditional gendered perception of male competence and female incompetence with the technology. Interestingly, however, when computers are associated with the learning of mathematics the students appear a little more ambivalent. Their views appear to sit somewhere between their beliefs about the stereotyping of mathematics and of computing. Within the constraints of the affective dimensions included in the three sets of items examined here, the data revealed that the views of male and female students were remarkably similar, at least with respect to the gendered directions of their responses to individual items. Although numerous statistically significant differences in mean scores were noted, there was also no clearly apparent pattern that one group held consistently stronger views than the other.

Further work is needed. The study needs to be replicated in different contexts. When other variables such as school type, socio-economic status, and ethnicity are considered, more clearly discernible patterns of differing stereotyped perceptions may emerge.

ENDNOTES

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