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MATHEMATICS, COMPUTERS IN MATHEMATICS, AND GENDER: PUBLIC PERCEPTIONS IN CONTEXT

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In Australia, national tests of mathematics achievement continue showing small but consistent gender differences in favor of boys. Societal views and pressures are among the factors invoked to explain such subtle but persistent differences. In this paper we focus directly on the beliefs of the general public about students' learning of mathematics and the role played by computers, and then we compare the findings with data previously gathered from students. Although many considered it inappropriate to differentiate between boys and girls, gender based stereotyping was still evident.

Keywords: Beliefs; Computer in mathematics; Gender; Test of mathematics achievement

Matemáticas, Ordenadores en Matemáticas y Género: Percepciones Públicas en Contexto

En Australia, los test nacionales del logro matemático continúan mostrando pequeñas pero consistentes diferencias de género en favor de los chicos. Las presiones y visiones sociales están entre los factores invocados para explicar tales diferencias sutiles pero persistentes. En este trabajo nos centramos directamente en las creencias del público en general acerca del aprendizaje matemático de los estudiantes y del papel desempeñado por los ordenadores, y después comparamos las conclusiones con datos previamente obtenidos de los estudiantes. Aunque muchos consideran inapropiado diferenciar entre niños y niñas, todavía son evidentes estereotipos basados en el género.

Términos clave: Creencias; Género; Ordenadores en matemáticas; Test de rendimiento matemático

Forgasz, H. J., & Leder, G. C. (2011). Mathematics, computers in mathematics, and gender: public perceptions in context. *PNA*, *6*(1), 29-39. HANDLE: http://hdl.handle.net/10481/16012

National tests of academic achievement are an integral part of the educational system in many countries. In Australia, where the different states have traditionally had much autonomy in educational matters, national testing does not have a long history. In mathematics, a uniform national test replaced the various state sponsored tests as recently as 2008. Now, "each year, over one million students nationally sit the NAPLAN (National Assessment Program—Literacy and Numeracy) tests, providing students, parents, teachers, schools and school systems with important information about the literacy and numeracy achievements of students" (NAPLAN, 2009, p. 2). Considerable media prominence is given to these test results. Schools, too, now rely heavily on these results in their reporting of students' achievement back to parents.

The mathematics results for students in grades 3, 5, 7, and 9—the target groups for NAPLAN testing—for the years 2008 and 2009 are shown in Table 1.

Table 1
Mathematics 2008-2009 NAPLAN Results for Grades 3, 5, 7, and 9

	2008		2009	
Grade	Male	Female	Male	Female
3	400.6	393.1	397.5	390.2
5	481.6	469.9	492.6	480.6
7	552.3	537.3	549.1	538.0
9	586.5	577.6	592.4	585.6

We can readily infer from Table 1 that there is much overlap in the performance of males and females, but that, on average, males slightly outperformed females in each year and at each of the grade levels tested. Data such as these support the continuing interest in gender differences in mathematics achievement.

The subtle gender differences described in many previous publications (Corbett, Hill, & Rose, 2008; Leder, 2001; Leder & Forgasz, 2008) have, it seems, not yet disappeared. Noteworthy there are persistent gender differences when students' views about the increasingly common use of computers for mathematics learning are sought. For example, Forgasz (2002) found that Australian grade 7-10 students held gender-stereotyped views of mathematics, of computers, and of the use of computers for mathematics learning. Pierce, Stacey, and Barkatsas (2007) similarly reported that while most of the students they surveyed agreed that it was better to learn mathematics with technology, boys agreed with this more strongly than girls.

Academic achievement is influenced by various factors, clustered by Leder (1990) as learner related variables—both cognitive and affective—and environmental variables such as home, school, and society. In Wigfield and Eccles' (2000) detailed model of achievement motivation—and implicitly of academic success—due emphasis is again given to the broader context in which learning occurs, that is, to the attitudes (actual and perceived) of critical "others" in the students' home, at school, and in the broader environment. In this paper we focus on societal attitudes, that is the public's perceptions of, and beliefs about, mathematics and the related issue of the use of computers in the teaching of mathematics. These views are compared with those held by secondary school students.

THE STUDY

In this section we present the methodological details of the empirical study, in terms of background information, aims, instruments, method and samples.

Background Information

In 1989 the Victorian (Australia) state government conducted a state-wide media campaign, *Maths Multiplies Your Choices*, to combat the prevalent sex segregation of the labour market and encourage parents to think more broadly about their daughters' careers. The role of mathematics as a critical filter to career and employment opportunities was highlighted. The success of the campaign was measured in various ways. Many schools subsequently reported an increase in girls' enrolment in mathematics subjects once they were no longer compulsory. A market research company was employed to determine how many parents had in fact "seen or heard advertising about encouraging girls to continue with maths and science in years 11 and 12" (McAnalley, 1991, p. 35) and to explore parents' attitudes to their daughters' education and career. Since then, in Victoria, there has been no concerted attempt to measure directly the public's views about mathematics learning and the role of mathematics in determining males' and females' career options.

Aims

The main aim of the study is expressed concisely in the excerpt below from the explanatory statement that was needed as part of the process for gaining ethical approval for the research; a copy of this statement was given to each participant.

> *We have stopped you in the street to invite you to be a participant in our research study.*
>
> *We are conducting this research, which has been funded by Monash University, to determine the views of the general public about girls and boys and the learning of mathematics. We believe that it is as important to know the views of the public as well as knowing what government and educational authorities believe.*

Comparing the responses gathered in the survey with those previously obtained from high school students was a secondary aim. Given the importance of ensuring that questionnaires prepared for different audiences are suitable for their intended target group, there are inevitable differences in the wording of items used in the different data gathering tools. However, it was not difficult to match comparable items from the two instruments on which this study draws.

Instruments

To ensure maximum cooperation from those stopped in the street, the survey was limited to 15 questions. In addition, we asked details about age—under 20, between 20 and 39, between 40 and 59, and over 60—, and noted respondents' gender. As well as readily code-able responses such as "yes/no/don't know" and "boys/girls/the same", respondents were encouraged to explain the reasons for their answers. To comply with space constraints, we limit our discussion to four of the survey items:

- Has the teaching of mathematics changed since you were at school?
- Who are better at mathematics, girls or boys?
- Who are better at using computers, girls or boys?
- Who are more suited to working in the computer industry, girls or boys?

As noted above, we were also interested in exploring reactions to the use of computers in mathematics classrooms. Since preliminary testing of survey items showed it was confusing to ask this directly, we relied on simpler questions.

The instrument used to gather data from high school students was described in some detail in Forgasz (2002, 2004). In brief, some items included Likert-type response formats; others asked students to indicate whether they believed a particular characteristic was definitely or probably more likely for boys, definitely or probably more likely for girls, or that there was no difference between the groups. The items on the student questionnaires that were considered to match those found on the survey of the general public are listed in the results section and not repeated here.

Method and Samples

Data were gathered at a number of heavy foot-traffic sites in the metropolitan area of Melbourne (two main sites), in a large regional centre, and in a rural city. Permission to conduct the study was obtained from each local city council. Individual pedestrians were stopped in the street, handed a copy of the explanatory statement, and invited to respond to the survey.

The public survey sample thus comprised diverse groups located in different parts of the state. One morning or afternoon (about four hours) was spent at each site. Our goal was to have 50 completed surveys at each site, a minimum number considered adequate for data to be analysed using chi square tests (Muijs, 2004). The overall sample size was 203, 95 males and 108 females. These respondents were aged as follows: 35 were under 20 years old, 90 were between 20 and 39 years old, 45 were between 40 and 59 years old and 33 were over 60 years old.

The student sample comprised students in grades 7-10, attending co-educational schools in Victoria (Australia). Metropolitan and rural schools across the three educational sectors—government, catholic, and independent—were represented. The instrument was administered in 2001 and again in 2003; the combined sample size was 3753 (1906 males, 1825 females, and 22 unknown).

Results and Discussion

We present the results and the discussion organized by four aspects.

Has the Teaching of Mathematics Changed Since you Were at School?
We first present findings from the public survey, followed by the comparative student data, and a summary of the findings.

Public Survey
Almost half ($N = 101$; 48.3%) thought mathematics had changed since they had been at school; fewer ($N = 84$; 41.4%) said they did not know. The rest ($N = 21$; 10.3%) thought there had been no changes.

Some of the respondents believed the changes had been for the better:

It's easier now. Teachers explain a lot more.

It's better now. In the past you had to learn. Now you can ask questions.

More computers, I hope that's better. But enough time should be spent on mathematics.

Others were more critical:

I imagine so (things have changed). For example, electronics, scientific calculators. It's bad. Students don't know how things happen. They just punch in a formula and that's it.

It's too computerized now.

Probably (things have changed). But people don't seem to be able to do much without calculators. My daughter is lazy now with computers.

Of particular interest in the explanations put forward was the perceived role of technology (computers and calculators) in contemporary mathematics class-rooms. From the comments reproduced, and others not listed, there appeared to be greater concern that technology use had a negative rather than a positive effect on learning.

Chi square tests revealed statistically significant differences in responses to this question by age [$\chi^2 = 51.514$; $P < .001$; $df = 6$; effect size $(\varphi) = .50$], but not by gender. Those in the older two age groups, that is, those aged 40 and over were more likely to say that mathematics teaching had changed; those in the younger two age groups that they did not know.

Comparative Student Data

Students were asked if computer use for mathematics learning helped their understanding of mathematics. A higher proportion of males than females said that computers did aid their understanding, and a higher proportion of females than males indicated that this was not the case; about the same proportions of males and females were uncertain (see Table 2). A chi square test revealed that the gender difference in views was statistically significant [$\chi^2 = 42.4$; $p < .000; df = 2$; effect size $(\varphi) = .11$].

Table 2
Student Responses on if Computers Aid Their Understanding

Answers	*N* (M)	% (M)	*N* (F)	% (F)
Yes	565	31.9	379	22.2
No	640	36.1	729	42.6
Uncertain	568	32.0	603	35.2

M: Male, F: Female

Summary

The public survey data suggest that the older respondents were aware of changes to mathematics teaching over time, particularly the advent of technology. They were somewhat skeptical of the effects the technology would have on mathematics learning. Overall, the students were fairly ambivalent whether computers aided their mathematical understanding, but more males than females indicated a positive effect.

Who are Better at Mathematics, Girls or Boys?

We start by the findings from the public survey, and continue by the comparative student data, and a summary.

Public Survey

Just under half ($N = 88$; 43.3%) of the respondents thought boys and girls were equally good at mathematics; 17% were unsure. Of the remainder more than half thought boys were better ($N = 53$; 26.1%); fewer believed girls were better ($N = 26$; 12.8%). Reasons given for the nominations included:

> *Boys are always better at mathematics. Girls are good at English.*
>
> *Boys. They like to figure things out.*
>
> *Girls. They can multi-task.*

Girls are better in junior school and boys are better in senior school.

Depends on the individual, on interest. Whichever one spends more time.

Chi square tests revealed no statistically significant differences in responses to this question by respondent gender or age.

Comparative Student Data

Data on items from which students' beliefs on whether boys or girls are better at mathematics could be inferred are shown in Table 3. Scores ranged from 1 (strongly disagree) to 5 (strongly agree). The data reveal that the male and female grade 7-10 students agreed to the same extent that they have to work hard to succeed in mathematics. However, the males disagreed more strongly than the females that they lacked confidence in mathematics and that mathematics was difficult for them.

Table 3
Student Responses on Selected Items

Item	$\bar{x}$ (M)	$\bar{x}$ (F)	t_{df}	p-level
I have to work hard to do well in mathematics	3.84	3.81	$t_{3651} = .84$	Ns
I am not confident about mathematics	2.52	2.76	$t_{3651} = -5.98$	<.001
Mathematics is a difficult subject for me	2.69	2.91	$t_{3633} = -5.43$	<.001

M: Male, F: Female

Summary

Data from the survey of the public indicated that boys are more likely than girls to be considered good at mathematics; although many believed there were no gender differences. Compared to the males, the female students held less positive views of themselves as learners of mathematics.

Who are Better at Using Computers, Girls or Boys?

We first present findings from the public survey, followed by the comparative student data, and a summary of the findings.

Public Survey

Half of the respondents ($N = 101$; 49.8%) thought there was no difference; 10 (4,9%) stated that they did not know. Of the remainder, far more ($N = 81$; 39.9%) nominated boys, compared with 11 (5,4%) who nominated girls. For this question, relatively few comments were given. Representative examples included:

Boys. They like action.

Boys, but they spend more time on computers. But girls are catching up.

Depends on what. For general clerical work, girls are better; but for hard core mathematics and computing, boys are better.

Boys seem to have affinity with computer.

Chi square tests revealed statistically significant differences by respondent age [$\chi^2 = 23.709$; $p < .01; df = 9$; effect size $(\varphi) = .34$], but not by gender. For all age groups, very few believed that girls are better at using computers. The proportions nominating boys as the better group decreased as age increased: 54.3% (19 of 35) of those under 20 compared with 21.2% (7 of 33) for those aged 60 and older.

As a group, the responses strongly reflected the gender stereotyped view that males are better than females at using computers. Interestingly, a higher proportion of younger than older respondents held this view.

Comparative Student Data

When asked to indicate whether "needs more help with computers" was more descriptive of boys or girls, 1977 students (54.5%) specified that there was no difference, 253 (7%) thought boys were more likely to need help, and 1400 (38.5%) considered this to be definitely or probably true for girls.

On another item, with the focus on "being good at using computers for learning mathematics", rather than on computers per se, the majority of students ($N = 2870$; 79%) chose "no difference", 13.6% (493) nominated boys as being better, virtually twice as many as the 271 (7.5%) who selected girls.

Summary

On both surveys, many considered that boys and girls were equally competent with computers. Among the others, males were more likely to be viewed as competent. Based on data from the public survey it appeared that younger people are more likely to hold gender stereotyped views than are their elders.

Who are more Suited to Working in the Computer Industry, Girls or Boys?

We start by the findings from the public survey, and continue by the comparative student data, and a summary.

Public Survey

On the public survey, just over half ($N = 108$; 53.2%) of the respondents thought boys and girls were equally suited for such work. Only 3 (1.5%) nominated girls, compared with 86 (42.4% 42.4%) who nominated boys. Reasons for the answer given included:

Experience shows this. There are more males in IT.

Boys. Girls get fed up.

The industry is dominated by boys, but girls are trying to get into the computer industry.

It seems to be boys, but both are capable.

It's mostly boys, but it really should be the same.

Boys, but because boys are more into computers.

No statistically significant differences were found by respondent age or gender.

Comparative Student Data

Student responses on two items were particularly relevant. "Think it is important for their future jobs to be able to use computers in mathematics" was viewed as equally relevant for boys and girls by 2961 students (78.9%). Of the remainder, nearly equal proportions of students chose boys and girls ($N = 361$; 9.9% and $N = 312$; 8.6% respectively).

For the item, "I would like a job working with computers when I leave school", the mean ratings of male ($N = 1832$; $\bar{x} = 3.07$) and female ($N = 1767$; $\bar{x} = 2.42$) students differed significantly ($t_{3597} = 15.856$; $p < .001$); females disagreed (mean score < 3) and males were neutral (mean score ≈ 3) about wanting to work with computers in the future.

Summary

Boys were considered more likely than females to be suited to the computer industry by the respondents to the public survey, and female students indicated with greater certainty than the males that they did not want to work with computers in the future.

Final Words

The similarities in the patterns of responses shown by students and the general public, and their congruence with the gender differences found in the NAPLAN data, are noteworthy. However, no causal inferences can be drawn. Overall, both males and females in both groups rejected the notion that gender is a factor influencing mathematics performance and computing proficiency. Yet there were still substantial proportions of males and females in both groups who continue to think of mathematics, and the associated role of computers, as more suitable for males. The finding that significantly a bigger proportion of younger than older respondents believe that boys are better than girls at using computers is of concern and worthy of further investigation.

Acknowledgement
The financial support of the Faculty of Education, Monash University, and the help of Glenda Jackson and Calvin Taylor in data collection are gratefully acknowledged.

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This document was originally published as Forgasz, H. J. & Leder, G. C. (2010). Mathematics, computer in mathematics, and gender: public perceptions in context. In M. M. F. Pinto & T. F. Kawasaki (Eds.), *Proceedings of the 34th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 361-368). Belo Horizonte, Brazil: PME.

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