Are girls disadvantaged by the use of calculators and computers for mathematics learning?

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Abstract. *In this article, the findings from two studies on gender issues associated with the learning of mathematics with technology are presented. Both studies are set in Australia. The first study involved secondary analyses of publicly available enrolment and achievement data from high stakes, grade 12 mathematics examinations. In the second, different types of data were gathered including: survey data from large samples of grade 7-10 mathematics teachers and their students, and from a large sample of grade 11 students; and interviews, observations, and self-report data from six grade 10 teachers and their students. The focus in each study was on the role of technology (calculators or computers) for mathematics learning, whether gender differences were evident and, if so, if factors contributing to them could be identified. Gender differences favouring males were identified in mathematics teachers' beliefs about, expectations of, and behaviour towards students as they learn mathematics with computers, and in students' beliefs about the effects of technology on their mathematics learning. Overall, it seems that technology may be implicated in explaining these gender differences, as well as in the clearly identified differences in enrolments and achievements in two parallel running grade 12 mathematics subjects in which different types of calculators are mandated.*

1. Introduction

Mathematics and Computing/IT are two fields that can generally be considered *male domains.* At the upper levels of high school, at college/university, and in career areas, both fields are generally male dominated. In about 30 countries, Galpin [1] showed that women were very much in the minority in the field of computing. The American Mathematical Society [AMS] revealed that while males continue to dominate the field, there has been some indication that the gender gap has begun to close [2]. It is therefore of interest to examine what the impact is on females of an increasing emphasis on technology use for mathematics learning.

In this article, the findings from two studies conducted in the past few years are brought together. The focus of the studies was on technology (computers or calculators) for mathematics learning. Of particular interest was whether gender differences were evident, and if explanations for any differences found could be identified. Each study is described in turn and the results presented and discussed. The findings from both studies are then synthesised, and implications and directions for future research put forward.

1.1 Context of the research

The studies presented and discussed in this article were conducted in the state of Victoria, Australia. In Australia, the school curriculum has historically been a state/territory, rather than national, responsibility; a national curriculum is currently being developed for the first time [3]. Victoria is the second most populous state in the country and has been in the vanguard nationally, and internationally, in mandating graphics calculators, and now CAS calculators, for use in mathematics classes and in the external, high stakes, examinations for grade 12 mathematics subjects [4, 5] in the Victorian Certificate of Education [VCE] – a two-year program for the final two years (grades 11 and 12) of schooling used for university selection.

In 1997, Victoria was the first state in Australia to permit the use of the graphics calculator in grade 12 examinations [6]. Since 2002, there have been two parallel forms of the intermediate level [7] grade 12 mathematics subject offered. In one version, *Mathematical Methods*, graphics calculators are mandated; in the other, *Mathematical Methods CAS*, CAS calculators must be used. The content of the two subjects is identical, and the students enrolled in both subjects complete a common technology-free examination. Schools decide which one of the two courses will be offered to their students, and all students enrolled in a particular school must use the same type of calculator, that is, students do not have the choice of calculator to use in the examination. In 2010 the graphics calculator version of the subject will be phased out, and only CAS calculators will be able to be used in the grade 12 examinations for the subject.

As well as various types of calculators, computers are widely used for mathematics learning in the lower grade levels of schooling, that is, from the first year of schooling (the 'preparatory' grade) to grade 10 (P-10). The P-10 curriculum in Victoria strongly encourages the use of technology, including computers, across all mathematics topic areas at all grade levels [8].

2. Previous research on gender, technology and mathematics learning

Gender differences in the outcomes of mathematics learning have been studied extensively internationally [9, 10, 11] and in Australia [12]. The recently published results from the 2007 *Trends in Mathematics and Science Study* [TIMSS] [13] and the 2006 *Programme for International Student Assessment* [PISA] [14] show different patterns of gender difference for students in different countries around the world. For Australian students, significant gender differences favouring males were noted in PISA 2006 [14] and for the 2007 grade 8 TIMMS results [13]. Although not statistically significant, in Australia males also scored higher than females in the 2007 grade 4 TIMSS [13]. A return to statistically significant gender differences in favour of males in Australia was noted by Thomson et al. [13] who wrote:

> *The gender differences in favour of males in both mathematics and science at Year 8 are of concern, particularly after a number of years in which there were no such differences and in an international setting in which the number of countries with gender differences is declining.* (p. 205)

A similar trend was noted by Thomson and De Bortoli [14] for Australian students' performance in PISA 2006:

> *In many countries, including Australia, male students significantly outperformed female students in 2006. In Australia, this represented a change from 2003 when there was no significant difference between male and female students in mathematics.* (p. 213)

Concern has been expressed about this regressive trend, and it has been postulated that the increased emphasis on technology for the learning of mathematics may be implicated [15]. The penetration and use of technology in Australian mathematics classrooms is extensive. The 2007 TIMSS results [13] revealed that 95% of Australian grade 4 teachers and 99% of grade 8 teachers allow calculators to be used in their classrooms; 78% of grade 4 students had access to a computer in their mathematics classrooms and, with most classes at grade 8 taught in general classrooms, 51% still had access to computers [14]. As discussed above, the graphics calculator has been used for high stakes examinations in Victoria since 1997 and by 2010 it will be replaced by the more sophisticated CAS calculator.

2.1 International research on gender and technology use for mathematics learning

While not an extensively researched area, there have been several studies exploring gender issues related to the effects of the use of calculators for mathematics learning.

Several studies of tertiary (college) level students' use of calculators of various kinds have been conducted in the USA. The focus was on achievement scores and gender was often included as a variable of interest. Runde [16] conducted a study with tertiary students attending a Florida college. Adopting an experimental design, one group used the TI-92, a CAS-capable calculator while the control group did their work by hand. It was found that the experimental group outperformed the control group and there were no gender differences in performance. Some years later, Huddleston [17] reported that both male and female college level students exposed to student-centred teaching approaches including the use of calculators had higher achievement scores than those experiencing traditional teacher-centred approaches. Similar findings were reported by Cassity [18] for a college algebra class using graphics calculators.

While studies of gender effects and high school students' use of calculators are not extensive, both achievement and attitudinal differences have been explored. In 1995, Bridgeman, Harvey and Brasswell [19] examined the effects of using calculators[1] in an experimental SAT examination for pre-college bound students who were all experienced calculator users. Slightly improved SAT achievements were reported, and there were no gender differences. In an analysis of the 1996 National Assessment of Educational Progress data, Wareham [20] revealed that frequency of calculator use was related to improved scores for both males and females. In a recent study of a large sample of Greek secondary students, Barkatsas, Kasimatis, and Gialamas [21] found that boys had more positive views than girls about mathematics and the use of technology for mathematics learning. It was also reported that confidence in mathematics and in technology use, positive attitudes to learning mathematics with technology, and high levels of engagement were associated with high levels of mathematics achievement. Isiksal and Askar [22] also found that computer self-efficacy was higher among boys than girls among a cohort of high school students in Turkey.

2.2 Australian studies on gender and technology use for mathematics learning

In Australia, education is in the jurisdiction of each state. Several states have been in the vanguard internationally of mandating calculator use in mathematics classes. "As of March 2000, Victoria and Western Australia have adopted graphics calculators" [23, p. 3] in their grade 12 external examinations. Since 2002 Victoria has allowed CAS-enabled technologies – see [20] for an overview of the history of technology use for senior secondary mathematics in Victoria. In 2003, CAS enabled technologies had only been used in five other countries and for the International Baccalaureate mathematics examinations [24].

There have been several Australian studies focussing on gender issues with respect to the learning of mathematics with technology, both computers and calculators. The Mathematics and Technology Attitudes Scale (MTAS) were administered to 350 students in six Victorian schools [25]. Boys' attitudes towards the learning of mathematics using technology were found to be positively correlated with their confidence with technology, whereas there was a negative

[1] The type of calculator was not specified but was probably a scientific calculator.

correlation between girls' attitudes towards learning mathematics using technology and their mathematics confidence. In another study [26] involving a large number of high school students, a strong and significant correlation was found between attitudes to computers for learning mathematics and attitudes to computers, while the correlation between attitudes to computers for learning mathematics and attitudes to mathematics was not significant. In a qualitative study of two classrooms in which computers were used for mathematics learning, gender differences favouring males were identified in attitudes towards computers and classroom behaviours [27]. In taking greater control of their mathematics learning with the computers, boys benefitted more in the classroom setting, and girls' needs and interests were not met. The girls viewed the computer-based environment less favourably than did the boys, they did not contribute much to classroom discussions, their achievements were derided by the boys, and the teachers seemed unaware of their computer skills.

In a recent study, mathematics teachers in Victoria were found to be confident about the effects that the introduction of the CAS calculator would have on their teaching, on student learning, and on the curriculum [28]. Yet, the introduction of new technologies has been associated with declining enrolment numbers. When the enrolments and results of the Western Australian Calculus Tertiary Entrance Examinations [Calculus TEE] for the years 1995-2000 were examined (ie. three years before and three years after the graphics calculator was introduced for the subject), it was noted that male enrolment numbers had decreased by 3% while female enrolments had dropped by 22%. The researchers suggested increased technology use as one of three explanations for the enrolment decline, particularly for girls [29].

The trends noted in the more recent literature focussing on school-level implications of technology use reviewed above suggest that males might derive greater benefit than females from the use of technology for learning mathematics, and that female enrolments in mathematics may decrease as a result. To determine whether evidence from Victoria would support these directions was the main focus of the two studies undertaken and reported here.

3. The studies

3.1 Study 1.
Enrolments and performance in Mathematical Methods and Mathematical Methods CAS

Enrolment and performance data in the VCE (Victorian Certificate of Education) grade 12 mathematics subjects, Mathematical Methods and Mathematical Methods CAS, are publicly available on the VCAA (Victorian Curriculum and Assessment Authority) website (http://vcaa.vic.edu.au). Data for the years 2002 (the first year in which the two subjects were offered) to 2008 were downloaded and analysed.

The enrolments for Mathematical Methods and Mathematical Methods CAS, and for the combined cohorts in the two subjects, are shown in Figures1 to 3 respectively. It should be noted that the graphs have been drawn with the same axes to allow the comparisons discussed below to be seen by eye. The data are shown by gender within cohort. The percentages illustrated in the figures were calculated as follows: the number of males/females enrolled in the subject was expressed as a percentage of the total male/female cohort enrolled in the Victorian Certificate of Education [VCE] at the grade 12 level. The calculations were done this way in order to compare like quantities as there are more females than males enrolled in VCE. In 2008, for example, the VCE numbers were: 27,400 females and 23,223 males, that is, females comprised 54% of the entire cohort. Using within subject percentages would not appropriately represent the gender imbalance in total VCE enrolments, and could have lead to incorrect interpretations.

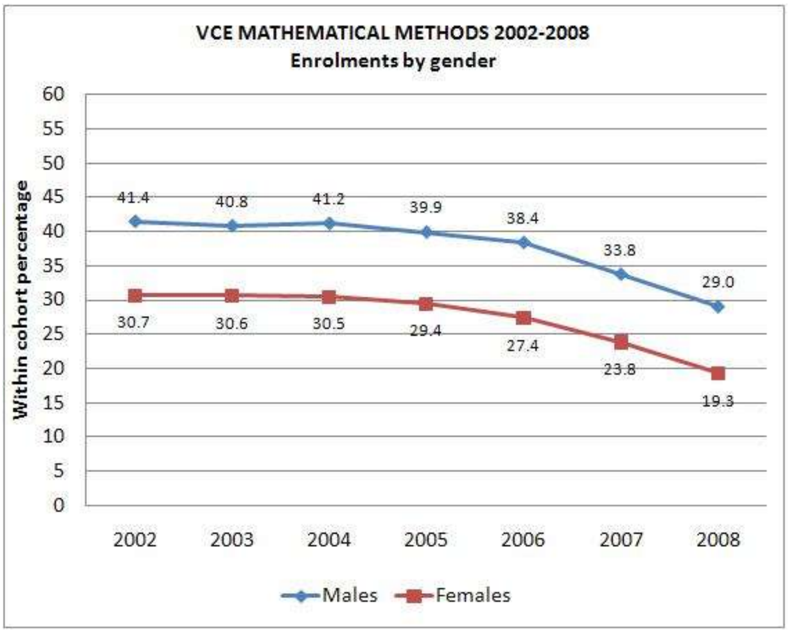

Figure 1. Mathematical Methods enrolments by gender, 2002-2008.

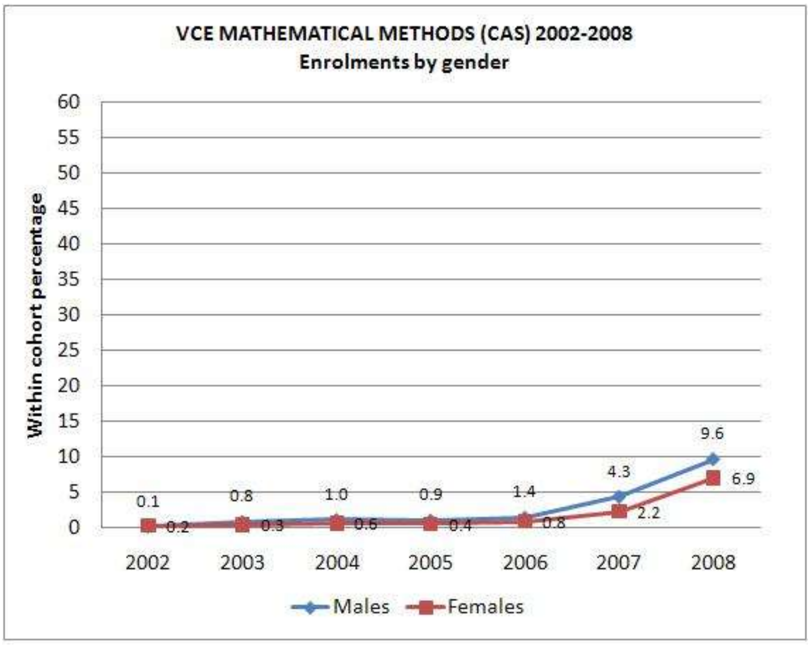

Figure 2. Mathematical Methods CAS enrolments by gender, 2002-2008.

Figures 1 and 2 clearly reveal schools' gradual migration from offering Mathematical Methods to Mathematical Methods CAS, particularly in the last few years. That there are higher proportions of males than females enrolled in both subjects is also apparent from the data illustrated in Figures 1 and 2.

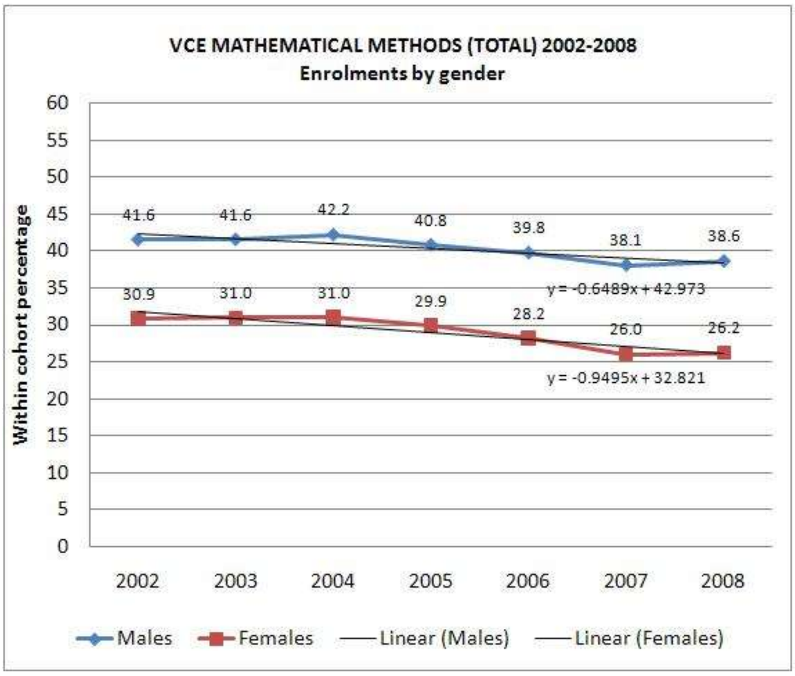

Figure 3. Combined enrolments for Mathematical Methods and Mathematical Methods CAS by gender, 2002-2008 with trend lines (and equations)

In Figure 3, linear trend lines (with equations), generated by the Excel spreadsheet package, have been added. A slight downward trend in the combined enrolments in the two Mathematical Methods subjects for both males and females is evident. When the proportions of male and female enrolments were considered, the gender gap favouring males was 10.7% (41.6% – 30.9%) in favour of males in 2002. In 2008, the gender gap in favour of males was larger at 12.4% (38.6% - 26.2%). The magnitudes of the negative gradients of the two trend lines (0.65 for males and 0.95 for females) confirm a slightly greater decline in female enrolments over time. The explanation for the increased gender gap in enrolments is not known. However, an examination of the achievement data in the two subjects suggests that technology use may be implicated, as was found in Western Australia when the graphics calculator was introduced for grade 12 examinations [29].

Performance data

Mathematical Methods and Mathematical Methods CAS each have three assessment tasks: a school-based assessment, and two examinations – one that is technology-free and the other requiring the use of the graphics calculator (Mathematical Methods) or CAS calculator (Mathematical Methods CAS).

The results for each VCE subject can be downloaded from the VCAA website (www.vcaa.vic.edu.au). For assessment task in each subject, the results are reported as grades (A+, A, B+, B, C+, C, D+, D, E+, E, and UG – ungraded) and the percentage of students receiving each grade is recorded; the results are also disaggregated by gender. The percentages of males and females receiving the highest grades, A+ and A, in Mathematical Methods and Mathematical Methods CAS for Examination 2, the examination requiring the use of the graphics/CAS calculator, are illustrated in Figures 4 to 7. The A+ and A grades were selected for analysis as previous research has revealed that it is at the highest achievement levels that males frequently outperform females [see 10, 12]. It should be noted that the same scales have been used for each graph.

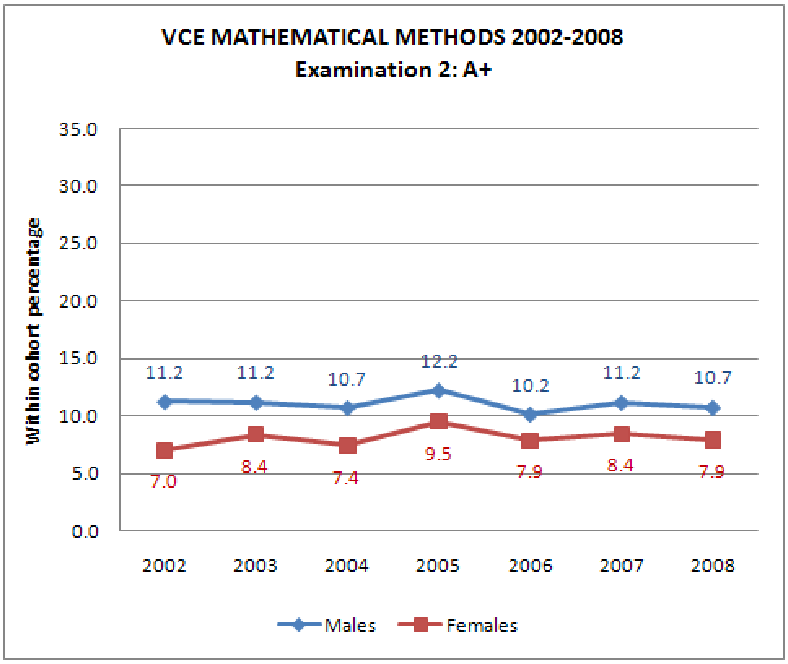

Figure 4. Percentages of male and female students awarded A+ for Mathematical Methods on Examination 2 (graphics calculator required), 2002-2008

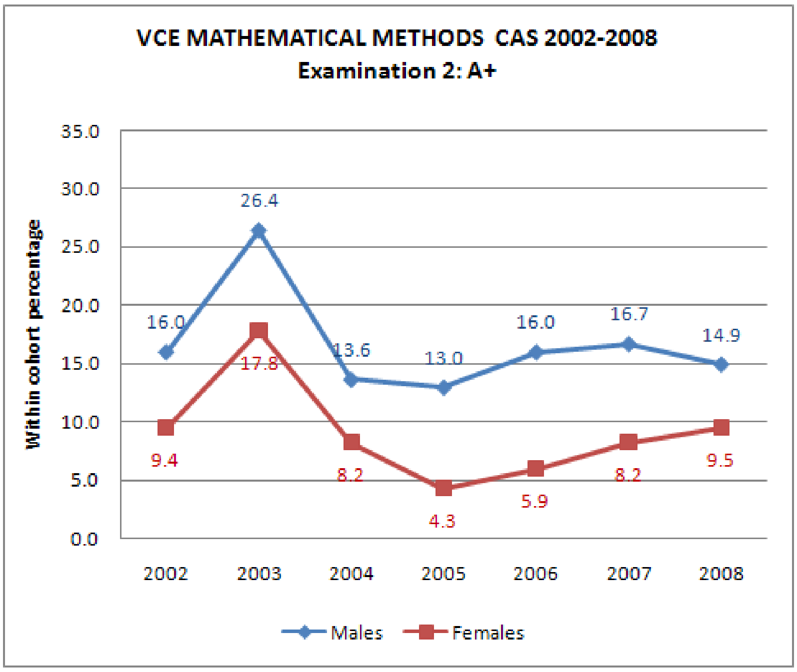

Figure 5. Percentages of male and female students awarded A+ for Mathematical Methods CAS on Examination 2 (CAS calculator required), 2002-2008

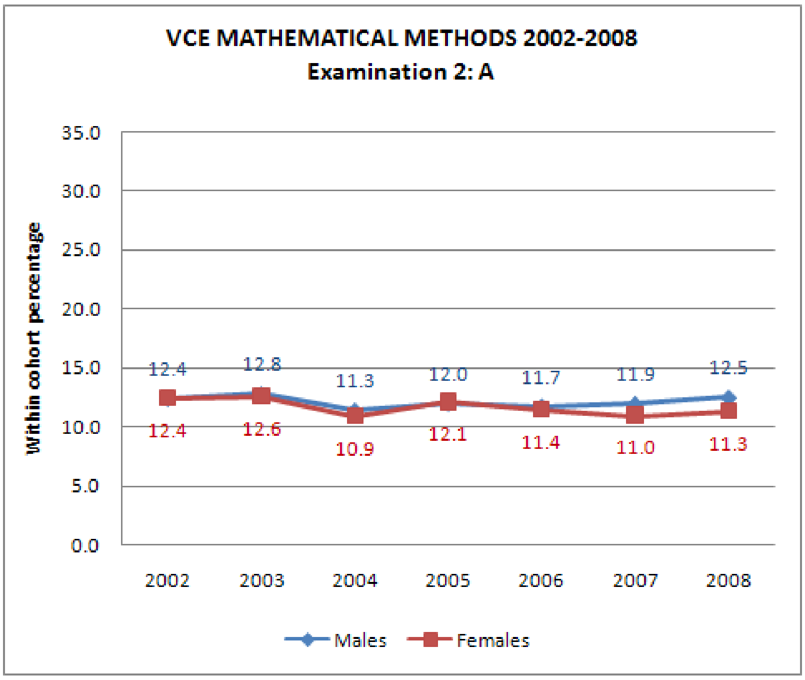

Figure 6. Percentages of male and female students awarded A for Mathematical Methods on Examination 2 (graphics calculator required), 2002-2008

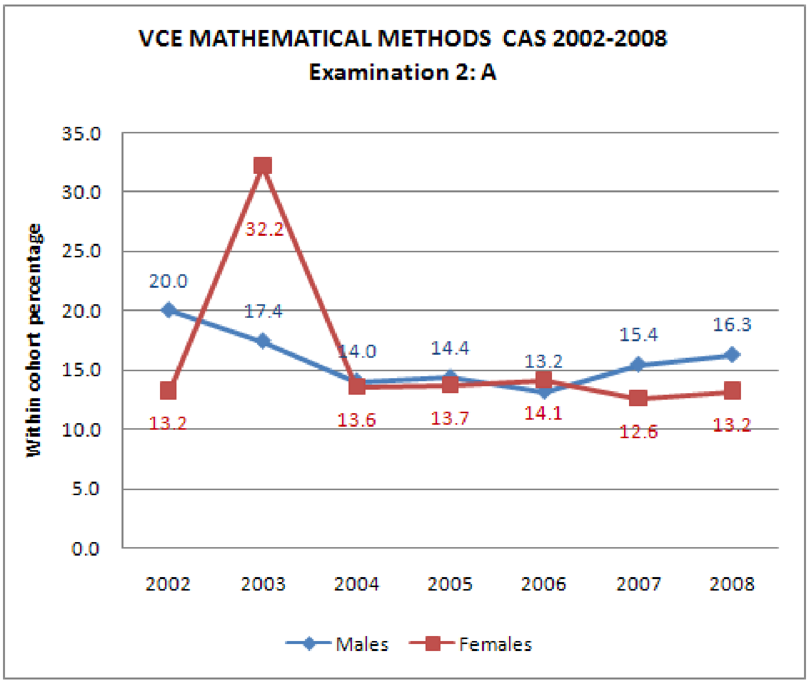

Figure 7. Percentages of male and female students awarded A for Mathematical Methods CAS on Examination 2 (CAS calculator required), 2002-2008.

Close inspection of Figures 4, 5, 6, and 7 reveals that:

- For both A+ and A, there was less variation in the patterns of males' and females' achievement in Mathematical Methods than in Mathematical Methods CAS; the much larger cohorts studying Mathematical Methods is likely to be a major contributor to this trend
- For both subjects, a higher proportion of males than females received the grade A+ for Examination 2 in each year from 2002-2008
- For the grade A, the pattern of gender difference was more variable. [It should be remembered that enrolment numbers in Mathematical Methods CAS were very small in the earlier years of the seven year period examined – see Figure 2]
- For the grade A+, the gender gap (ie. the difference in the percentage of male and female students achieving the grade A+) was greater for Mathematical Methods CAS than for Mathematical Methods.

In summary, males outperformed females at the highest level of achievement, A+, on Examination 2 in both subjects. However, the gender gap in favour of males was consistently larger for Mathematical Methods CAS than for Mathematical Methods, that is, in each year 2002-2008. While it cannot be said with certainty that the CAS calculator is the reason for the larger gender gap in performance for Mathematical Methods CAS, it is not unreasonable, however, to suggest that it may be implicated, particularly considering that there has also been a greater decline in female than male enrolments in Mathematical Methods (see Figure 3). The greater enrolment decrease for females than for males is of a smaller magnitude than that reported earlier by Forster and Mueller [29] in Western Australia for the grade 12 calculus subject in that state. But the explanation may be the same. Forster and Mueller [29] suggested that the introduction of the graphics calculator for use in the grade 12 Calculus examinations might explain the larger fall in female than male enrolments over the six year period they examined.

3.2 Study 2.
Attitudes towards computers for mathematics learning

In a three year project, quantitative and qualitative data were gathered to examine Victorian grade 7-10 students', and their teachers', beliefs about the effects of computers on mathematics learning, and to identify factors contributing to any gender differences in the patterns of belief found. As part of that study, a survey was conducted and large samples of students in the years 2001 and 2003.

In 2001, 96 (52F, 44M) grade 7-10 mathematics teachers participated. They were drawn from 28 coeducational secondary schools, representative of the three educational sectors in Victoria: government (18 schools), Catholic (4 schools) and independent (6 schools); 15 schools were located in metropolitan Melbourne, and the others were in Victorian regional cities and small towns. The schools were located in areas in which people across the socio-economic spectrum would be found. To avoid school or grade level bias, not more than one teacher from each grade level per school was involved. The same schools were invited to participate again in 2003. The 2003 teacher sample size was reduced to 75 (41F, 34M); for a variety of reasons, five schools declined the invitation to participate again in 2003.

The participating students were those taught by the surveyed teachers. In 2001, 2140 (1015F, 1112M) students were surveyed; in 2003, there were 1613 (810F, 796M). There were approximately the same numbers of students from each grade level (7-10).

On the survey, students were asked if computers helped their mathematics learning. Their teachers were asked if they believed computers helped students' learning of mathematics. The students' responses and the results of chi-square tests to explore if there were gender differences in the frequency distributions of the Yes/Unsure/No responses are shown in Table 1. Similar data for the teachers are shown in Table 2.

From the data in Table 1, it can be seen that the males believed more strongly than the females that computers helped their mathematics learning. Table 2 reveals no gender difference in the teachers' beliefs about computers assisting students' mathematics learning. However, the students (2001: 26% and 2003: 29%) were much less convinced than their teachers (61% in both years) that computers contributed positively to the understanding of mathematics.

Table 1.
Students' beliefs about computers helping mathematics learning, 2001 and 2003

2001: N=2140						**2003: N=1613**					
F (n=1015)			**M (n=1112)**			**F (n=810)**			**M (n=796)**		
Yes	*Unsure*	*No*	*Yes*	*Unsure*	*No*	*Yes*	*Unsure*	*No*	*Yes*	*Unsure*	*No*
194	334	429	326	331	384	185	269	300	239	237	256
20%	35%	45%	31%	32%	37%	25%	36%	40%	33%	32%	35%
Gender difference: χ^2 = 32.5, df=2, p<.001						Gender difference: χ^2 = 12.1, df = 2, p<.01					

Table 2.
Teachers' beliefs about computers helping students' mathematics learning, 2001 and 2003

	2001 (N=96; F=52, M=44)			**2003 (N=75; F=41, M=34)**		
	Yes	*No*	*Unsure*	*Yes*	*No*	*Unsure*
All teachers	50	7	22	43	4	23
	63%	9%	28%	61%	6%	33%
Female	25	4	12	21	4	15
	61%	10%	29%	53%	10%	38%
Male	25	3	10	22	0	8
	66%	8%	26%	73%	0%	27%
	Gender difference: not significant			Gender difference: not significant		

A partial explanation for this discrepancy in student and teacher beliefs emerged in the qualitative dimension of the study conducted in 2002. When software which was very visual (e.g., *Geometers' Sketchpad* and *Graphmatica*) was used, a large proportion of students, both male and female, reported that their mathematical understanding had been enhanced - see [30] for more details.

The qualitative component of the study involved six grade 10 mathematics classrooms, two in each of three schools. Mathematics lessons were observed when the students used computers, a number of self-report instruments were completed, and the six teachers (3F, 3M) and four students from each class (2F, 2M) were interviewed. Two of the schools, one government and one Independent, were located in Metropolitan Melbourne; the third school was a government school in a small town in Victoria.

On the self-report instrument, and at interview, the six teachers were asked if there were differences in the ways boys and girls worked with computers in mathematics classes. The teachers' behaviours towards boys and girls during the observed lessons were also monitored. From their comments and from observations – see [31] for more details – it was apparent that the teachers believed that it was students who were competent with computers, rather than necessarily mathematically strong, who gained most from computer use, and boys were identified as having more computer competence than girls. Representative teachers' comments in response to an interview question in which their views on any differences in boys' and girls' engagement with computers during mathematics lessons included:

> Boys in this class appear to be the more confident and competent. I'm conscious of it. I feel the girls have less confidence and competence in using computers. I can think of two or three girls – Kate who struggles in using computers and Lyn who's very quiet – so you don't know whether they're asking or needing help or whether they're getting it from others. [There are] two or three girls that seem to hang back, they just idle through things, so you're not too sure whether that's slowing them down in computers... I probably noticed the boys more than the girls. It was just that a few of the boys stood out more as being able to do things with computers. (Male teacher)

> Some of the girls in that class are just sort of helpless types and they don't seem to want to take initiative. Not all of them. Some girls who are very independent learners get on with it. The back row girls, they tend to just put their heads down and do it, and the others seem to lack the confidence just to do it. I'm just thinking of the girls that always seem to lag behind and always seem to be not sure of where to go next.
> [Probed further, she added:] I think the girls tend to be more reticent, but I'm generalising again. I think the boys tend to be a bit more vocal in sharing some of their ideas [and] to be a bit physically bigger, there's more of a presence of them. I think girls tend to fade that little bit into the background. I can think of counter examples where the girls dominate and are vocal and tend to volunteer what they know, maybe more in the junior classes. But I think, maybe in the senior classes, perhaps the girls tend to be a bit more quiet. (Female teacher)

In summary, the data from this study indicated that boys were more likely than girls to believe that computer use would improve their mathematical understanding – even though a majority of the students did not believe that computers helped their mathematical understanding (see Table 1). The teachers interviewed and observed believed that boys and girls interacted differently with computers for mathematics learning and that boys were more competent users of the technology. The findings echo those reported by Vale [15].

In 2001 and 2003, large samples of grade 11 students were also administered a survey questionnaire, but the questions were different from those asked of grade 7-10 students. Grade 11 is the first year of the two-year VCE program and mathematics is not a compulsory study at that level. However, the vast majority of grade 11 students in Victoria are enrolled in at least one of the three subjects on offer at the grade 11 level. The subjects vary in degree of difficulty, and future mathematical pathways into grade 12 and beyond school are dependent on the choices made at grade 11. Among a range of questions, the grade 11 students were asked if prior computer use for mathematics in grades 7-10 had helped their mathematical understanding, made mathematics learning more enjoyable, if prior computer use in grades 7-10 had influenced their grade 11 mathematics subjects choices, and if mathematics was likely to be included in their post-secondary school studies. The frequencies and percentages of students providing the Yes/No/Unsure responses, and chi-square results to explore if there were gender differences in the frequency distributions, are shown in Table 3.

Table 3.
Frequencies of response by gender on three questions, 2001 and 2003

	Computers helped mathematics understanding		**Computers made mathematics more enjoyable**		**Computer use influenced gr 11 mathematics subject choice**		**Maths likely in postsecondary studies**	
	F	**M**	**F**	**M**	**F**	**M**	**F**	**M**
2001	N=178	N=203	N=180	N=205	N=185	N=208	N=191	N=208
Yes	53 (30%)	69 (34%)	107 (59%)	128 (62%)	25 (14%)	43 (21%)	87 (46%)	146 (70%)
No	87 (49%)	74 (37%)	73 (41%)	77 (38%)	160 (87%)	165 (79%)	104 (55%)	62 (30%)
Unsure	38 (21%)	60 (30%)						
Gender difference	$\chi^2 = 6.47$, df = 2, $p<.05$		ns		ns		$\chi^2 = 24.89$, df = 2, $p<.001$	
2003	N=134	N=161	N=135	N=160	N=138	N=166	N=145	N=174
Yes	35 (26%)	69 (43%)	68 (50%)	112 (70%)	15 (11%)	28 (17%)	78 (54%)	129 (74%)
No	63 (47%)	54 (34%)	67 (50%)	48 (30%)	123 (89%)	138 (83%)	67 (46%)	45 (26%)
Unsure	36 (27%)	38 (24%)						
Gender difference	$\chi^2 = 9.47$, df = 2, $p<.01$		$\chi^2 = 11.86$, df = 1, $p<.01$		ns		$\chi^2 = 14.37$, df = 1, $p<.001$	

The statistically significant gender differences found in Table 3 reveal that compared to males:

- larger proportions of females believed computers had not helped them understand mathematics better (2001 and 2003);
- a smaller proportion of females believed that computers made mathematics learning more enjoyable (2003 only); and

- smaller proportions of females indicated that mathematics was likely to be included in their post-secondary studies (2001 and 2003).

Although not statistically significant in either year, a smaller proportion of females indicated that prior computer use for mathematics had influenced grade 11 mathematics subject choices.

Summary
For the grade 7-10 students, the data presented reveal that the boys viewed the effects of computers on their mathematics learning more positively than did the girls, and the teachers saw the boys as more computer competent than girls. Among the grade 11 students, higher proportions of males than females indicated that they gained mathematically and enjoyed mathematics as a result of using computers in earlier grades, and were likely to pursue mathematics beyond school. Taken together, these data suggest that the effects of computer use in grades 7-10 are more likely to be beneficial to boys' learning of mathematics and on their attitudes towards future studies in the field. That is, computer use may be implicated in the lower proportions of females than males studying mathematics at the grade 12 level and beyond.

4. Final words

Based on the findings from the two studies reported here, it appears that technology use for mathematics learning may be implicated in the various patterns of gender difference noted, with girls losing out. This is not to say that computer and CAS calculator use for mathematics learning should be abandoned – that would be a very retrograde step. However, as found in this study and in previous research [see 12], the mathematics education community needs to be aware that some girls may be less confident than boys in using computers. As a consequence of the demands and expectations to master the use of computers and the sophisticated CAS calculator as integral components of their mathematics learning, girls may also be dissuaded from pursuing mathematics subjects at the grade 12 level and beyond.

Girls' flight from Mathematical Methods may be partially explained if they have learnt that in the VCE examinations girls are not achieving as well with the CAS calculator as with the graphics calculator. Clearly more research is needed to determine if the impact of the CAS calculator is a partial explanation for the decline in female enrolments.

Nonetheless, the findings from the two studies sound a warning that should not be ignored. Girls may well be disadvantaged by the use of computers and the CAS calculator for mathematics learning. It will, of course, be interesting to see if the trends reported here for the VCE Mathematical Methods and Mathematical Methods CAS enrolments and achievements persist into 2009, the last year in which the graphics calculator version of Mathematical Methods will be offered in Victoria. Close monitoring of enrolment and achievement data are invaluable in identifying patterns and trends requiring explanation, and researchers are urged to continue this work. Classroom-based research and case studies are also needed to try to unpack what is happening at the *chalk face* as students engage with technology in mathematics classes. Can exemplary practices in the use of technologies for furthering all students' mathematics learning be identified? For the longer term benefit of all students, it is imperative to identify such practices in order to provide equitable opportunities for all students' mathematics learning to flourish.

5. Acknowledgements

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