SEX DIFFERENCE IN ACHIEVEMENT IN VCE MATHEMATICS

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In 1991 all Victorian year 12 students undertook the new Victorian Certificate of Education Mathematics Study designed by the Victorian Curriculum and Assessment Board. This paper presents the results of a study into sex difference in achievement in the new VCE Mathematics study in Victoria. An important goal of the study designers was to encourage more equal participation in senior secondary mathematics by females and males and to include assessment of mathematical skills previously not assessed in a year 12 course in Victoria. These new tasks could conceivably change the degree and direction of sex difference in achievement in senior secondary mathematics.

THE VCE MATHEMATICS STUDY

In 1991 year 12 students were able to choose from six mathematics blocks: Space and Number (SN), Change and Approximation (CA), Reasoning and Data (RD), Extensions Space and Number (ESN), Extensions Change and Approximation (ECA) and Extensions Reasoning and Data (ERD), though they were limited to taking only one Extensions block. The mathematics study is defined in terms of areas of study, work requirements and, for year 12 units (level 3 and 4), common assessment tasks (CATs). Each CAT addressed the content of the respective block.

There were four CATs for each block in 1991: CAT1, an investigative project based on a set theme; CAT2, a challenging problem selected from four set problems completed in a specified period of time; CAT3, facts and skills task, a multiple choice test involving 49 questions and CAT4, an analysis task, a test composed of structured questions designed to assess interpretative and analytical skills (VCAB, 1990, p. 53.)

LITERATURE REVIEW

A recent study into sex differences in mathematical achievement found that the difference in favour of males is very small and reducing over time (Friedman, 1989), however sex differences in favour of males are more likely to occur in senior secondary schooling (Friedman, 1989 and Hyde, et al., 1990.) Willis (1989) reviewed the studies of year 12 mathematics results and concluded that "girls do very well in mathematics examinations at the end of year 12 (p.9.)" In South Australia girls had higher percentages of pass rates and higher grades for two mathematics subjects and in Western Australia significant differences have favoured girls. Willis argues that these results may be because "girls enrol in mathematics courses which are easier than their ability would indicate (p.9.)" In Victoria, for HSC group 1, though there has not been a consistent pattern of sex difference in favour of males, males have consistently been more highly represented in the top grade levels than females (Leder, 1980) and have been found to perform better on examination questions which are unfamiliar, require interpretation, and are imbedded in a real world context (Pattison, Holton and Gordon, 1986.) Fennema (1980) argued that observed sex difference in mathematical achievement in the senior secondary levels in favour of males could be explained by the difference in the amount of mathematics studied. This argument was confirmed by Hyde et al (1990.)

Sentry and Money (1990a and 1990b) reported on the results of the trial of the common assessment tasks conducted in 1989 by VCAB using nine non-randomly selected schools. There were 623 students in the trial of which 41% were females, however their participation was not evenly distributed across the five blocks in the trial. They found that for each CAT, there was a difference in the mean score which favoured males. The lowest mean difference was CAT1: Investigative project and the highest mean difference was for CAT2: Challenging problem. The difference in the proportion of males and females achieving the highest grades was also most marked for CAT2: Challenging problem.

METHODOLOGY

This study of the 1991 population of year 12 VCE students involved an analysis of the grades of the all students completing CATs for mathematics. The analysis included comparisons between males and females overall and for each of the six mathematics blocks at the year 12 level, for each CAT and for total mathematics score.

Data for this study was provided by the Victorian Curriculum and Assessment Board (VCAB). For each 1991 VCE student they provided an anonymous identification number, sex, mathematics block(s) taken and grade for each CAT for each mathematics block taken. VCAB used a system of 12 grades for assessment: A+, A, B+,..., E as well as UG (un-graded) and NA (not assessed). For this analysis numerical equivalents were used: A+=10, A=9,....E=1, UG=0 and NA=0.

RESULTS

Almost 39,000 year 12 students enrolled in Mathematics in 1991. About the same number of females (18,122) and males (18,630), but a higher proportion of males studied mathematics. This higher proportion was for mathematics overall (72% compared to 60%), for students studying two mathematics blocks (22.5% compared to 9.1%) and for students taking each mathematics option. The proportion of females and males studying only one mathematics was almost equal (51.1% compared to 49.8%.) Males also outnumbered females in each mathematics block with the exception of CA. RD and SN were the most popular blocks for both females and males and ESN the least popular. Participation in ERD was negligible.

The total mathematics score for a student was calculated by adding together the student's CAT scores for the mathematics block taken, hence they could score between 0 and 40 for mathematics. All students who commenced the year are included in the analysis. Scores for students who took two mathematics blocks were averaged.

The mean total scores are recorded in table 1 and show that there was no significant difference between the total mathematics score for females and males, though the mean is slightly higher for females. There was also no significant difference in the total mathematics score between females and males for SN and ECA, but females performed significantly better than males in ESN and CA whilst males performed significantly better than females in RD.

Table 1 shows that the much larger proportion of males than females taking two mathematics blocks (22% compared to 9%) had the effect of increasing the achievement of males relative to females. For students taking only one mathematics block females have scored significantly better than males overall and for each block. For students taking two mathematics blocks there is no significant difference in mean total scores between females and males except in RD where males performed significantly better (at the 5% level) than females and in CA where females performed significantly better than males (at the 1% level.)

Table 1
Mean scores for total mathematics score[(a)] overall and for each block and by the number of blocks taken.

block	female			male			t test	
	N	M	SD	N	M	SD	t-value	p[(e)]
all[(b)]	18,122	17.53	9.5	18,630	17.46	10.4	0.70	0.48
1[(c)]	15,377	16.27	9.2	12,814	14.37	9.6	**16.92**	**0.00**
2[(d)]	2,739	24.61	8.1	5,802	24.29	8.8	1.61	0.11
SN	5,702	14.33	8.8	5,747	14.09	10.0	1.38	0.14
ESN	1,676	10.94	7.2	1,788	9.41	7.6	**6.04**	**0.00**
CA	2,722	24.20	9.1	2,461	22.69	10.0	**5.70**	**0.00**
ECA	3,230	23.91	8.5	5,653	23.70	9.2	1.06	0.28
RD	7,512	18.86	9.1	8,798	20.33	10.1	**-9.73**	**0.00**

Note: (a) Total mathematics score for a student is calculated by adding together the score for each CAT. The range therefore is from 0 to 40. (b) The results for all students. (c) The results for students taking only one mathematics block in year 12. (d) The results for students taking two mathematics blocks in year 12. (e) Significant differences in mean scores are in bold type.

Table 1 also shows that overall and in each block the standard deviation for total scores of males is greater than females. This indicates a greater spread of scores for males than females. More males than females achieved the highest total score, 40. The ratio of females to males achieving a total score of 40 is 1:1.3 overall and 1:3.5 for ECA, 1:3 for RD and 1:2.5 for SN. The lower ratio for all students is probably because total scores for students taking two blocks have been averaged.

Table 2 below shows the mean scores for each CAT for females and males overall and according to the number of blocks taken. It shows that overall females have scored significantly better than males on CAT1: Investigative Project and CAT2: Challenging Problem and that there is a significant difference in mean scores in favour of males for both CAT3: Facts and Skills Task and for CAT4: Analysis Task. For students doing only one block females score significantly better than males in each CAT and for students taking two blocks there is no significant difference in mean scores between females and males for CAT3, but a significant difference in favour of females for CAT1 and CAT2 and in favour of males for CAT4. Therefore male superiority for CAT3 and in part for CAT4, can be explained by the amount of mathematics studied.

Table 2
Comparison of mean scores for each CAT.

CAT	female N	M	SD	male N	M	SD	t test t-value	p
CAT1								
all	18,122	4.70	2.7	18,360	4.32	2.8	**12.93**	**0.00**
1	15,377	4.44	2.7	12,814	3.66	2.7	**24.20**	**0.00**
2	2,739	6.14	2.2	5,802	5.80	2.4	**6.13**	**0.00**
CAT2								
all	18,122	4.65	2.8	18,630	4.43	3.0	**7.13**	**0.00**
1	15,377	4.34	2.7	12,814	3.64	2.8	**21.17**	**0.00**
2	2,739	6.40	2.2	5,802	6.20	2.5	**3.65**	**0.00**
CAT3								
all	18,122	4.51	2.8	18,630	4.67	2.9	**-5.38**	**0.00**
1	15,377	4.15	2.7	12,814	3.84	2.7	**9.38**	**0.00**
2	2,739	6.53	2.3	5,802	6.49	2.4	0.70	0.49
CAT4								
all	18,122	3.68	2.6	18,630	4.03	2.9	**-12.1**	**0.00**
1	15,377	3.35	2.5	12,814	3.23	2.7	**3.74**	**0.00**
2	2,739	5.55	2.4	5,802	5.80	2.6	**-4.34**	**0.00**

For students taking only one mathematics block there was a significantly higher proportion of 0 scores awarded to male students for each CAT. Males may not have submitted work for assessment in greater proportions since students could still be awarded satisfactory for the completion of work requirements. This may in part explain the superior performance of females among students taking one block.

Table 3
The number of females and males achieving an A^+ or an average greater than A for each CAT.

CAT	CAT	female N	%	male N	%	c^2 test c^2	p
CAT1	all	478	1.6	518	2.8	0.71	0.40
	1	311	2.0	154	1.2	**29.02**	**0.00**
	2	166	6.1	364	6.2	0.15	0.70
CAT2	all	499	2.8	711	3.8	**31.69**	**0.00**
	1	293	1.9	165	1.3	**16.69**	**0.00**
	2	205	7.5	546	9.4	**8.61**	**0.00**
CAT3	all	524	2.9	774	4.3	**43.02**	**0.00**
	1	294	1.9	209	1.6	3.15	0.08
	2	229	8.4	562	9.7	3.89	0.05
CAT4	all	295	1.6	604	3.2	**100.3**	**0.00**
	1	170	1.1	182	1.4	**5.62**	**0.02**
	2	124	4.5	420	7.2	**22.94**	**0.00**

Note: Discrepancies in the number for all, that is the total for 1 and 2 can be explained by the small number of students taking 3 blocks of mathematics in year 12.

The proportions of females and males achieving the top grade, A^+ or an average greater than A, for each CAT is shown in table 3. It shows that a higher proportion of males were awarded the top grade for each CAT, overall and for students taking two blocks. This was significant for CAT2 and CAT4. However, for students taking one block a significantly higher proportion of females achieved the top grade for CAT1 and CAT2, but males still dominated CAT4 and there was no difference for CAT3.

DISCUSSION

This is the first Australian study to establish such a consistent pattern of higher average achievement in mathematics by females. However, males still remain the most likely sex to achieve the best results. This study has also established that the amount of mathematics studied at year 12 accounts for some but not all of the sex difference in achievement for those components which favour males. It is likely that the sex differences in favour of females, especially for students taking only one block, can be expalined by participation rates, that is, that females are more likely to choose to study one mathematics block rather than two. Evidence for this explanation is found in the significantly higher proportion of females who were represented in the top group of scores for students doing only one block and a higher proportion of males scoring 0. This finding supports the view of Willis (1989.)

It is also likely that the nature of the assessment tasks have suited females. Females have performed better than males on the "take home" CATs but there are other factors which may have contributed to their relative success such as better interpretative, research and communcation skills. Annice et al. (1988) and Cheung (1991) observed that a sex difference in favour of males is more likely for routine problems than for non-routine problems. This study support those findings in terms of the results for CAT2 and CAT4. A complementary study of 1991 VCE students who gained entry to university by Vale (1992) examines other reasons such as the context of problems in CAT2 and sex differences in importance attached to CATs.

Reasoning and Data (RD) was the odd one out. This is possibly due to the pattern of course taking by females and or some peculiar characteristics of the curriculum and teaching of the course. Perhaps the more able females doing only one mathematics chose CA or ECA rather than RD, but this doesn't explain the sex difference in achievement for students taking two mathematics and indicates a superiority for males in achievement for the particular content areas of the course: probability, statistics and logic. However the correlation rates between CATs were lowest for RD indicating an inconsistency of performance by both females and males across the CATs for RD. The teaching of the course may have been problematical, either because of inexperienced staff, or lack of familiarity with the content by the staff. It is therefore possible that females have been disadvantaged relative to males (Vale, 1992.)

Since the introduction of the VCE in 1991, modifications and changes have occurred to both the structure and arrangement of content in the mathematics offerings and the assessment tasks. CAT2 has been dropped and Reasoning and Data has also been dropped but the content of Reasoning and Data has been included in other offerings within a new structure of blocks. The dropping of CAT2 is unlikely to have an effect on sex difference in achievement in total score for mathematics, since it is presumed that females will continue to perform better than males on CAT1 and CAT3 for students doing the same number of mathematics courses at year 12. The inclusion of Reasoning and Data content in other courses may have the effect of closing the gap between females and males in the reason for the sex difference was to do with content areas rather than participation rates or pedagogy.

In conclusion, this study of 1991 VCE Mathematics results has found that the amount of mathematics studied in year 12 is a crucial factor when testing for sex difference in achievement in mathematics. The pattern of participation for both females and males has been shown to influence the results of sex difference tests both of the mean scores and the distribution of scores. The study has also found that females are more likely to perform better than males on investigative projects, non-routine problem solving and multiple choice tests of basic skills and that males are mores likely to perform better than females on routine analysis problems. It is likely that the nature and conditions of the assessment tasks have been important factors in the sex differences in achievement. It remains to be shown whether the superiority of females shown in this study will be maintained over time and with changes and modifications to the VCE Mathematics Study.

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