Single-sex mathematics classes: Who benefits?

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A co-educational high school in Melbourne, Australia, introduced an innovative program of single-sex mathematics classes for grade 10 students. Of particular concern to the school was the impact of the program on enrolments in mathematics courses in grade 11. The requested evaluation of the program is reported in this paper. Students' and parents' reactions, the effects on students' achievements and their beliefs about themselves as learners of mathematics are presented. Implications of the findings and recommendations to the school for future action are discussed.

Background information

Early in 1991 the authors were asked by the staff of a co-educational high school in the metropolitan area of Melbourne, Australia, to help them monitor the effects of an organisational initiative introduced that year; to teach mathematics at the grade 10 level in a single-sex setting. At all other grade levels mathematics continued to be taught in mixed-sex groups. (In Australia, the academic year runs from January to December. Secondary schools in Victoria are from grades 7 to 12.) By selecting grade 10 for this intervention, the staff hoped that more females would choose the more rigorous and demanding mathematics subjects when they become optional in grades 11, 12, and beyond. No plans were made, formally or informally, to modify instructional strategies or curriculum materials used in the school, nor to examine the prevailing culture of the school.

Participation

In Australia, statistics indicate that more females than males now complete secondary schooling (Castles, 1993). Females' overall

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* Academic performance as measured by completion rates; that is, the number of students certificated with completing the final year of schooling as a proportion of the population that could attend grade 12.

academic performance* at the grade 12 level is better than males' (Ministerial Council on Education, Employment, Training and Youth Affairs, 1994). In Sweden "girls have higher marks than boys in almost every subject in both compulsory and upper secondary school" (Ministry of Education and Science, 1993, p.72). Yet, in both countries, patterns of participation in mathematics and performance on tasks involving timed tests favour males.

The participation rates of females and males in higher education and in the most demanding mathematics courses at school level are remarkably similar in Australia and Sweden (see Table 1). Careful inspection of the statistics shows that enrolments in science-related courses do not reflect the fact that females constitute a larger proportion of higher education students than males. In both countries, more males than females are found to study the most demanding mathematics courses at school.

	Australia[1]	Sweden[2]
Higher education enrolments	1994: commencing students 54.7% female	Over last decade: commencing students 60% female
Higher education enrolments in science-related courses	1991: 39.4% in science	1992: 45% in natural science
Enrolments in education/teaching courses	1991: 73% females	1989/90 80% females
Enrolments in most demanding mathematics courses at school level	1989: M: 30617 F: 18867 Ratio (M:F) 1.6:1 1993 (Victorian[3] data): M: 6157 F: 3788 females Ratio (M:F) 1.62:1	1990: M: 13600 F: 6900 Ratio (M:F) = 2.0:1

Table 1. Participation rates: Comparisons between Australia and Sweden

1 Sources: Castles (1993), Dekkers, De Laeter, & Malone (1991), Australian College of Education News (1994), Board of Studies (1994)
2 Sources: Ministry of Education and Science (1993), Grevholm & Nilsson (1994) Grevholm (personal communication, February 26, 1995)
3 Victoria is one of the Australian states. Education is state-controlled in Australia.

Participation rates for the more demanding mathematics subjects at the school involved in the study mirrored the Victorian data included in Table 1.

Performance

The education systems, the organisation of schools, and testing programs in Australia and Sweden are quite different. Yet some parallels are evident in the patterns of performance of males and females in mathematics courses. Grevholm and Nilsson (1994) discussed the results of standardised testing in mathematics for the two mathematics courses (General and Advanced) for students in grades 7-9 that are conducted at the end of grade 9. When test performance was compared to class grades assigned by teachers, it was found that:

> the boys score higher in tests, but the girls are given higher grades by their teachers although the difference is small. (p. 244)

For diagnostic testing conducted for students in Upper Secondary School taking the Advanced course in mathematics, the males scored higher than the females (40.4 compared to 36.7).

In Victoria, recent performance data from students in their final year of schooling show similar trends to the Swedish data. In 1992, there were four mathematics tasks separately assessed and reported. Two of these tasks were undertaken in class-time and at home and assessed by teachers. The other two were timed examinations. For the most demanding subject offered at this level (Extensions Change and Approximation), the females outperformed the males on the two teacher-assessed tasks (higher mean scores, and more females obtained top grades of A+ and A). This pattern was reversed for the examinations tasks (Cox, 1993; Forgasz, 1994; Leder, 1994; Victorian Curriculum and Assessment Board, 1993). Performance data for 1993 showed similar trends to those in 1992.

Explaining gender differences in mathematics learning

A number of theoretical models have been put forward to explain gender differences in mathematics learning. There are many common features:

- the emphasis on the social environment
- the influence of significant others in the environment
- students' reactions to the cultural and immediate context in which learning takes place
- the cultural and personal values placed on learning
- the inclusion of learner-related as well as cognitive variables

The re-organisation of co-educational classes to single-sex classes changes the environment in which learning occurs: the social environment is different; with the possible exception of the teacher, the significant others in the classroom are now only girls; and the different peer group inside the mathematics classroom may place different personal values on learning.

Parents also have great influence on their offspring. Home support for the learning of mathematics can affect achievement levels. Findings from the Second International Mathematics Study [SIMS] revealed that lower levels of home support were found in countries with substantial gender differences in achievement (Hanna, Kündiger and Larouche, 1990). Home support, it was argued, compensated for society's greater encouragement of males in traditionally male-dominated spheres including mathematics. In Australia, Ainley and Sheret (1992) reported that "among background factors parental expectations of continued education stands out as the most influential on school attainment" (p.170)

Single-sex settings in Australia

Unlike Sweden, Australia has a long history of single-sex schooling which stems from the times of British colonisation (Leder, 1992). While the majority of public schools in Australia are co-educational, many private schools are single-sex. Findings on the relative benefits of single-sex or co-educational schools are inconclusive and the issue remains unresolved (Gill, 1988). To make meaningful comparisons of the educational outcomes of students from the two school settings, societal factors must be considered. Gill (1988) pointed out that in Australia:

> the distinction between single sex and co-educational schools is interwoven with the division between private and public schooling which has been the site of a long and at times particularly acrimonious debate in the history of Australian education. (p.3)

For some time, single-sex education has been viewed as anachronistic reflecting a time when it was believed that males and females had different educational needs related to their (gender-stereotyped) future societal roles. It has been assumed that coeducation was the means for achieving equality (Leder, 1992). More recently, there have been strong calls to re-examine the equity assumptions underpinning arguments in favour of coeducation.

Participation and performance data such as those presented earlier indicate that equity in mathematics education has not been achieved in systems dominated by co-educational learning settings for

mathematics. Examined next are Australian studies which have compared the mathematics learning outcomes of students from mixed and single-sex settings.

Australian research on single-sex and mixed settings for mathematics

Gill (1988) reported that comparisons of the academic performance and attitudes to various aspects of schooling of students attending single-sex and co-educational schools have yielded inconsistent results.

Victorian enrolment data for students from the three sectors of education: government, Catholic, and non-Catholic independent, were compared by Teese (1989). In each sector female participation in mathematics was lower than for males at the grade 12 level. Jones (1990) found that mathematics enrolment patterns were affected by gender and school type (Government or Catholic) in New South Wales. School setting (single-sex or co-educational) was a factor influencing participation and performance in a range of school subjects including mathematics.

Several studies have examined affective variables. During the four year transition when two single-sex Government high schools in Sydney merged to form one co-educational school, Marsh, Smith, Marsh and Owens (1988) found that mathematics achievement differences favouring males were unaffected. Multidimensional self concept measures, however, increased for both males and females. Foon's (1988) study of grade 10 students from non Catholic independent schools reported that males rated their mathematics achievement higher than did females, and females in single-sex schools rated their mathematics achievement higher than their co-educational counterparts. Using a number of affective variables incorporated in models explaining gender differences in mathematics learning outcomes (see Leder, 1992), Forgasz (1993) found gender differences among grade 7 students from co-educational schools irrespective of whether the students were in single-sex or mixed classes. Males from the single-sex setting viewed mathematics as a stereotyped domain to a greater extent than did the males from the mixed settings. Bornholt, Goodnow and Cooney (1988) reported that males in grades 7 to 10 made higher estimates of their mathematics achievements than did females. Differences in estimated achievement levels were smaller between males and females in co-educational settings than for males and females in single-sex schools.

Studies of student/teacher interaction patterns often report that males interact more frequently with the teacher than do females (see Leder, 1992). For example, Leder (1993) reported that more time and a greater number of high cognitive questions in particular were directed to boys. Gender differences in attitudes towards mathematics and in beliefs about themselves as learners of mathematics were also found.

Some schools have tried single-sex settings within co-educational schools. In one study, students in grades 7 and 8 were randomly allocated to single-sex or co-educational mathematics classes. No gender differences in achievement were found over the two year monitoring period but there were significantly higher gains in confidence for students in the single-sex classes than in the mixed classes; the most notable gains being found for girls (Rowe, 1988). Grade 9 students' attitudes towards single-sex or mixed classes in mathematics and science were reported by Regan (c1992). Descriptive data revealed that females from single-sex classes believed that students of both sexes benefited from the single-sex learning setting and that they should continue into the next year; males from single-sex settings expressed opposing views equally strongly.

In 1992 a comprehensive evaluation five years after the implementation of the National policy for the education of girls in Australian schools (Commonwealth Schools Commission, 1987) was conducted by Milligan, Thompson, and Ashenden and Associates (1992). Their findings on single-sex education were mixed although generally supportive. They reported that many girls, teachers and parents were supportive of single-sex environments because:

> Girls are free from sex-based harassment from boys, they participate more, are more on task, and feel freer to be themselves. (p.18)

Some girls disliked single-sex classes because of missed social opportunities and a sense of false protection against the realities of the world. Opposition to single-sex classes was also found among some teachers who believed that:

> single-sex learning should not be widespread, because boys do better in co-educational environments where girls moderate the disruptive behaviour. Other teachers believe that single-sex classes are the lazy way out, discouraging teachers from developing their skills to teach effectively in co-educational classes. (p.18)

Milligan et al. (1992) concluded that:

> there is no doubt that the benefits of single-sex teaching are being recognized more. Increasingly co-educational schools are using strategically selected single-sex classes to improve the education of girls. (p.18)

The study

Aims

The school was anxious to know if the introduction of single-sex mathematics classes at the grade 10 level would result in equal numbers of males and females enrolling in the most demanding mathematics courses at the grade 11 level. The mathematics department staff also requested recommendations with respect to the continuation of the program in future. To meet these objectives two of the issues explored are reported in this paper: the level of support for the program from students and parents; and the effects of the program on students' achievements (using achievement data available in the school), their beliefs about themselves as learners of mathematics, and their choices of mathematics options for the following year.

Methods and techniques

Quantitative and qualitative research techniques were used for data gathering. An overview of the instruments which met the specific objectives of the project described above and the time line for data gathering is given in the next section.

Data sources

There were three periods of data gathering: early in the school year (Time 1), seven-eight months into the program (Time 2), and just before the end of the school year (Time 3). Self-report, pen-and-paper instruments were the primary sources for Times 1 and 3. The second data collection phase relied primarily on interviews. Performance data were gathered from teachers, and parents of grade 10 students responded to questionnaires.

A. Self report measures

Several self-report measures were administered.

1. Students were asked to respond to a number of items on five point scales (5 = excellent to 1 = weak). Questions asked included: 'How good are you at maths?', 'How good at maths would you like to be?', 'How good at maths does your teacher believe you are?', and 'How good at maths would your parents like you to be?'
2. Students were asked to complete various open ended questions, e.g., 'If you could change your mathematics classes, what would you change? Explain why you want these changes', 'Do you like maths? Explain why'.

B. Interviews

The interviews covered the following main issues:

- Students' response to their single-sex class
- The effects of single-sex classes on mathematics learning
- Working with the opposite sex.
- Students' perceptions of and their attitudes towards their teachers
- Relevance of mathematics for the future

Follow up questions were asked as appropriate.

C. Performance data

Teachers were asked to provide a rating of students' performance in mathematics at the beginning, middle, and end of the year. These ratings relied primarily on data obtained through the school's regular assessment program.

D. Parent questionnaire

The questionnaire contained 15 questions. Eight required a yes/no response. There were opportunities for the parents to elaborate on their views in the remaining seven questions. Items included 'Are you aware that your child is currently in a single-sex class for mathematics?', 'To what extent do you support this scheme?' and 'Have you discussed with your child what it is like to be in a single sex class for mathematics?'

Results

A. Perceived achievement in mathematics and teachers' ratings

Male and female students' perceptions of their mathematics achievement levels at the beginning and the end of the year were compared. Comparisons were also made between their perceptions and their teachers' ratings of achievement at the end of the year. Selected results are shown on Table 2.

The results indicate that:

- males' perceptions of their achievement levels increased over the year; the females' ratings remained the same
- the males and the females believed their teachers would rate their achievements higher at the end of the year than at the beginning. For males, the extent of improvement was greater than for the females

	MALES				FEMALES			
	End of year (76)[1]	Beginning of year (81)	sd[2]	ES[3]	End of year (75)	Beginning of year (83)	sd[1]	ES
Self-rating	4.08[4]	3.65	1.29	.33	3.23	3.22	1.07	.01
Perceived teacher rating	3.78	3.17	1.32	.46	3.38	3.10	1.15	.24
Perceived parent rating	4.04	3.76	1.14	.24	3.54	3.55	1.19	-.00
Teachers' ratings	3.81					4.01		

Table 2. Repeated measures of perceived achievement levels in mathematics, effect sizes, and teacher's ratings of students' achievements, by gender.

NB.
1 The number of participants
2 Standard deviations for 'beginning of the year' data
3 ES = Effect size
4 T-test comparing end of the year rating with beginning of the year rating: t72=-1.68, p<.1

- the males, but not the females, believed their parents would rate their achievements higher at the end of the year than at the beginning
- the teachers rated the females' achievement slightly higher than the males' (not statistically significant)
- the males rated their achievements higher than did the females
- the males overestimated their achievements at the end of the year (higher than teachers' ratings)
- the females underestimated their achievements at the end of the year (lower than teachers' ratings)

At interview students were also asked about their mathematics achievements.

Females: Half of the girls said that their mathematics achievements had not changed over the year. Of the remaining girls, most believed that their mathematics had improved. Reasons given for improvement included:

- single-sex class
- working harder
- the teacher

Examples: More work was done because of 'a better teacher', or because the teacher was 'explaining it better'. This was often said in conjunction with 'no interruptions from the boys'.

Males: Of the boys interviewed, just over 10% considered that they were having greater difficulty with mathematics than in previous years. They cited not working well and the teacher as reasons. Just over 50% considered they were doing better. Reasons given for improvement:

- the teacher
- improved concentration.

B. Students' views on their single-sex mathematics classes

Students' views about their single-sex mathematics classes were derived from two sources: interviews (25M, 29F) and questionnaires at the end of the year (76M, 75F). A synopsis of these views is presented below under several headings.

Beliefs about the introduction of single-sex classes

At interview, students were asked why they thought the school had introduced single-sex classes. Their responses are summarised in next page, Table 3.

Descriptions of grade 10 mathematics classes

The most frequently mentioned characteristics of mathematics classes are summarised on the next page, Table 4.

How single-sex classes differed from co-educational classes

Males: At interview some said that with no girls there they could ask more questions in single-sex classes. Several commented that there was not much difference between single-sex and co-educational classes. Examples:

a When the girls were there 'you tried to impress them'.

b Now 'the guys act more like guys and you talk about the girls ... If you got the answer wrong it didn't really matter because the girls can't say anything'.

c There are 'just no girls'.

Females: Many commented that they were able to get more work done in single-sex settings. The teacher's manner and a more acceptable rate of instruction also attracted favourable comments.

MALES	**FEMALES**
Reasons: • emphasis on academic concerns *Examples*: a to make people work harder b so students can concentrate a lot better c because girls would work better in a single-sex class' • the negative effect the boys had on the girls *Examples*: The boys thought girls were 'distracted' by boys; boys 'intimidated' girls or 'stopped girls from learning'; and that teachers thought boys 'got more attention'.	*Reasons*: • the negative effect the presence of boys had as agents of embarrassment and/or inhibition. *Examples*: In coeducational classes, girls said they were too 'embarrassed' to ask questions, were 'harassed' by the boys, felt they were 'being made fun of'. Some felt pressured and annoyed by boys. • the 'distraction' associated with boys' behaviour towards girls or their 'distraction of the class'. • whether or not girls would work better if not 'distracted' by boys.

Table 3. Beliefs about the introduction of single-sex classes.

MALES	**FEMALES**
disruptive (43) boring (10) good (9) fun (6) hard (5) comments about the teacher – some positive, some negative (7) *Examples*: a. Noisy, disruptive, could talk when wanted b. The classes were boring; we didn't learn much from the teacher. c. Chaos but usually entertaining	negative effects of a change in teacher (17) boring (6) quiet (6) good (5) noisy (5) fairly traditional (5). *Examples*: a. Noisy, but you were left to work at your own pace and get help when needed. b. Fun, easy, wanted to go, but not any more with new teacher. c. Very boring

Table 4. Descriptions of grade 10 mathematics classes.

Examples:

a 'Girls were more into working [this year] than impressing the boys'.

b The teacher 'was nicer'.

Changes to mathematics classes wanted

The most frequent changes males and females would like to have made to their mathematics classes included:

MALES	**FEMALES**
change the teacher (21) have girls return to the class (20) remove disruptive students (14) no change at all (5) *Examples* a The teacher. Some teachers are better and you learn more b Single-sex to co-ed. More enjoyable and disciplined with girls present c Get rid of the losers in our class	**FEMALES** nothing (23) not to have had changes in teacher (20) have the males back (6). *Examples* a I wouldn't change anything. It was pretty good overall b I would have changed the teacher because I have a lot of trouble understanding her c I would have a mixed class because I work better with boys and girls in one

Table 5. Changes to mathematics classes wanted.

Views on teachers

At interview, most students said they believed their teachers enjoyed teaching single-sex classes; they were more certain about same gender teachers. The vast majority of boys (84%) and girls (79%) expressed no preference for being taught by a man or a woman. They made it clear that teaching proficiency was a more important factor than the sex of the teacher. Examples:

Male: 'A teacher is a teacher. If you have a teacher that is good, if its a female teacher or a male teacher it doesn't matter'
Female: 'I have had female teachers and I have had male teachers, and it doesn't matter why as long as they teach you, because they are going to teach the same thing anyway'

Liking of single-sex classes

Students' responses were classified into four broad categories: yes, no, makes no difference, and unsure. The noteworthy results were as follows:

- A considerably larger proportion of females (73%) than males (25%) enjoyed their single-sex classes
- A much larger proportion of males (54%) than females (12%) did not like their single-sex classes

The reasons students gave in Table 6.

MALES		FEMALES	
Liked	**Disliked**	**Liked**	**Disliked**
• less pressured without females around and could concentrate on their work • freer to 'muck around'.	• classes were less disciplined without girls • girls were needed to moderate their behaviour Other comments were along sexist lines.	• felt free of the intimidation they had experienced from males in mixed classes • free of the pressure to conform to some sort of stereotype • could work better	• missed the boys' assistance • missed the boys' presence
Examples: a Yes, because I got my work done b Yes 'cause we stuffed around	*Examples*: a all guys talk too much. We need girls in the class. b because girls make you behave and work harder c No-one to look at	*Examples*: a you don't have the guys to annoy you and tease you. b you could do your work and actually understand the subject c you didn't have to worry much about what people thought of you and the class was pretty under standing	*Examples*: a Not really, mainly because we got their [boys'] help last year and they could help us like they did in grade 9

Table 6. Liking of single-sex classes.

DID YOU LIKE YOUR SINGLE-SEX CLASSES?	Yes		No		Unsure	
WHAT WOULD YOU PREFER IN GRADE 11?	M%	F%	M%	F%	M%	F%
single-sex	5	40	1	0	0	0
co-educational	1	7	50	8	0	1
don't mind either way	15	23	3	1	21	11
not sure	4	3	0	3	0	3

Table 7. Preferred mathematics class settings for grade 11.

Preferred learning setting for grade 11

The results for this question were categorised according to how students had responded about their enjoyment of single-sex classes. The results are shown on Table 7.

The results indicated that:

- A considerably greater proportion of females (40%) than males (6%) would choose single-sex classes
- A much larger proportion of males (51%) than females (16%) would choose co-educational classes
- Approximately one third of the males (39%) and of the females (35%) would not mind single-sex or co-educational classes

C. Parents' questionnaire

The parents' questionnaires were distributed by the teachers. The parents of 59 students (i.e. approximately one third of the households) responded. More mothers (55) than fathers (39) replied.

For ease of presentation the thrust of the questionnaire items, and a summary of the answers, are presented in table form (Table 8). Items included to check on consistency of replies are omitted from the table.

D. Subject choice

The school offers two mathematics streams at grade 11: general mathematics, i.e., one unit of mathematics and general mathematics taken with mathematics methods, i.e., two units of mathematics. Table 9 shows students' mathematics intentions for grade 11, gathered by the researchers towards the end of 1993, as well as the actual enrolments in grade 11 mathematics subjects for 1994.

It can be seen that there is a reasonably close match between the anticipated and actual enrolment data. For both females and males, more enrolled for the two mathematics units than for the one unit course.

Discussion

The findings from each of the various data sources are discussed separately.

Achievement

Teachers' ratings indicated very little difference between males' and females' end-of-year achievement levels. Males were found to have overestimated and females to have underestimated their end-of-year performance levels. Students' self-ratings and their responses about

Aware child is in a single sex mathematics (SSM) class?	Almost all the mothers who replied (91%) and approximately half of the fathers (54%) knew that such classes had been introduced
Why do you think SSM classes were introduced?	The major reasons given were: • To benefit the girls, e.g., to avoid distracting and intimidatory behaviour from boys (40%) • To benefit both sexes, e.g., to avoid being distracted by the opposite sex; as a trial to see if students' attitudes or performance improved (47%) • No response or no idea (10%) • Mothers of daughters were most likely to support the SSM classes (70%); fathers of sons least likely (13%)
Do you support the scheme? (Fully/partly/ unsure/not at all)	• More than half the parents (58%) fully supported the SSM classes, few (6%) indicated no support • Mothers with daughters were more supportive than fathers of daughters (73% v. 41% indicated full support) • 52% of mothers and 59% of fathers with a son fully supported the scheme
Has your child's attitude to mathematics changed since the introduction of SSM?	Almost have the parents (43%) indicated that they had noticed a change: E.g. child seems more relaxed, enjoys maths more and gets higher marks And (mothers of sons) less work is done, SSM class is disruptive
Do you support extension of this scheme into other grade levels? (Yes/may be/no)	• Mothers of daughters were most in favour of extending the scheme (72%) • Overall, 57% of parents firmly supported extension of the SSM classes scheme, another 29% were uncertain (checked maybe). Parents did not mind whether the SSM classes scheme were extended into higher or lower grades
Did parents of the same child agree about the advantages/disadvantages of SSM classes?	• Half the parents did not differ in their opinion about the scheme • Where differences occurred, the father of a daughter was less likely to support the scheme than her mother

Table 8. The parents' questionnaire: items and responses.

	MALES (N=78)		FEMALES (N=73)	
Maths units	**Anticipated enrolments**	**Actual enrolments**	**Anticipated enrolments**	**Actual enrolments**
0	4%	5%	4%	8%
1	23%	31%	36%	33%
2	58%	64%	57%	59%
Missing data	15%		3%	

Table 9. Intended and actual mathematics courses enrolments in grade 11.

their mathematics performance levels at interview were consistent. More males than females believed their achievements had improved over the year. Both females and males, though fewer of the latter, mentioned the absence of members of the opposite sex as a contributing factor. More females than males considered that there had been no difference in their performance levels.

Since the males' but not the females' mean self-ratings of mathematics achievement increased over the year, it could be argued that males' confidence levels were boosted more than females' as a consequence of being in single-sex classes. That is, males benefited from the program to a greater extent than females. The single-sex classes did not challenge the frequently reported finding that males overestimate and females underestimate their mathematics achievement.

Students' reactions to the single-sex program

The interview data suggested that females more so than males enjoyed and benefited from the single-sex mathematics classes. Females who liked the classes felt they could work better, and were free of the intimidation and pressure to conform to stereotypes which they had experienced from males in mixed classes. Several males made similar comments. Of those who did not like single-sex classes, many males felt that classes were more disruptive without girls; the girls missed the presence of boys in lessons.

Students believed that their teachers enjoyed teaching single-sex classes. A telling finding was their conviction that teaching proficiency was a more important factor for them than the sex of the teacher.

Outcomes of the program

The enrolment data indicated that the school's aim to have more equal participation in the most demanding mathematics subjects at grade 11 was achieved. Whether single-sex classes were entirely responsible for this result was unknown. It was recommended that the school pursue the single-sex program for at least two more years to gauge whether this apparently positive outcome became the norm.

Teachers' ratings of students' end-of-year performance levels showed no significant gender differences. It would appear that there has also been no detrimental effect on either males' or females' mathematics performance outcomes as a result of the single-sex program.

Support for the program of single-sex classes

More mothers than fathers completed the questionnaire. More mothers than fathers seemed to know about, and approve of, the introduction of the single sex mathematics classes and to have discussed the scheme with their child. Parents' opinions about the worth of single sex mathematics classes seemed linked to the sex of their child: mothers of daughters were most likely, and fathers of sons least likely, to support the introduction of single sex mathematics classes. Among the students more females than males enjoyed the single-sex classes and, given the choice, would prefer single-sex classes for grade 11 mathematics.

The reasons parents (mothers and fathers) and students (males and females) believed that the single-sex classes had been introduced were very similar: to benefit females' learning of mathematics was the dominant response.

Final words

Students suggested a number of avenues worthy of further research. For example, several believed that single-sex mathematics classes should be introduced at earlier grade levels, such as grade 9. Some students alluded to differences in male and female teachers' attitudes towards single-sex classes and to their differing teaching styles. The significance of parents' attitudes and whether single-sex classes should be compulsory or voluntary are additional questions deserving of research attention. The extent to which this complexity of factors contributed to the effects on student learning outcomes we did document is unknown.

We did not investigate all the factors which may have contributed to the success or failure of the single-sex grade 10 mathematics program. For example, we did not explore the school's mathematics curriculum nor its program of assessment of student learning.

In view of the factors we did not examine, and from inferences drawn from students' and parents' comments, we recommended to the school that the curriculum and its mode of delivery, and the assessment procedures and means by which student outcomes are reported be reviewed in relation to gender equity issues. We also suggested that teachers involved in the single-sex program meet regularly to exchange views and share experiences, and that professional development on gender issues in mathematics learning be supported. Since parents indicated a wish to be informed of the outcomes

of the single-sex mathematics program, it was also recommended that in future parents be better informed about the program at the commencement of the school year.

This study has not provided unequivocal evidence that single-sex mathematics classes per se address well-documented gender differences in mathematics learning outcomes. The program evaluated did not appear to have been damaging to the majority of grade 10 students in the school investigated, and may well have benefited many. Although the school's aims for the program, and the students' and the parents' beliefs were that females would benefit most from single-sex classes, there were signs that males derived equal, if not more, benefit from the program than the females.

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Enkönade matematikklasser: Vem tjänar på det?

Sammanfattning
En skola med årskurserna 7-12 i Melbourne i Australien införde ett nyskapat program med enkönade matematikgrupper för elever i årskurs 10. Av särskild betydelse för skolan var den påverkan programmet hade på elevernas val av matematikkurser i årskurs 11. Den utvärdering av programmet, som skolan begärde, rapporteras i denna artikel. Här presenteras reaktionerna hos eleverna och deras föräldrar, effekterna på eleverna och deras resultat och deras uppfattningar om sig själva, som personer som lär sig matematik. Vidare diskuteras slutsatserna av resultaten och rekommendationerna till skolan beträffande framtida åtgärder.

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