Title: Mathematics and the gender gap: The Singapore perspective
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MATHEMATICS AND THE GENDER GAP -
THE SINGAPORE PERSPECTIVE

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Mathematics and the gender gap - the Singapore perspective

by

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Synopsis:

In the last two decades one major area of mathematics education research has been the investigation of sex-related differences in the learning of mathematics and achievement in mathematics. However, only a few studies (Kaur, 1987; MOE, 1988; Tan, 1990) done to date on Singapore pupils contribute to research in the area of gender and mathematics.

As sex differences in mathematics - claimed to be complex and influenced by the interaction of many societal factors - have not been consistent across countries (Ethington, 1990; Hanna, Kundiger and Larouche, 1990) this paper attempts to review and discuss the research done to date which contributes in one way or another to the area of gender and mathematics in the Singapore context.

Kaur (1987) in her study examined sex differences in mathematical attainment of Singapore students at the 'Ordinary' Level standard. She found that on the whole the boys were superior in performance.

MOE (1988) in its study from 1977 to 1987 found that at Primary 3, girls performed better than boys in mathematics but at the PSLE, while girls continued to out-perform boys in the languages, boys did better in mathematics and science.

Tan (1990) in his study on secondary school students found no significant sex differences in mathematics achievement, mathematics anxiety and locus of control.

Despite the dearth of research in the area gender and mathematics on Singapore pupils it may be claimed that the findings are in agreement with the trend of known results in the corpus of related literature.

It is evident that the gender gap in Mathematics achievement does exist in Singapore. However it is not possible to ascertain the relative width of the gap in comparison with other countries in the world as Singapore has not participated in any of the IEA's studies in Mathematics.
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Introduction

In the last two decades one major area of mathematics education research has been the investigation of sex-related differences in the learning of mathematics and achievement in mathematics. However, only a few studies (Kaur, 1987; MOE, 1988; Tan, 1990) done to date on Singapore pupils contribute to research in the area of gender and mathematics.

As sex differences in mathematics - claimed to be complex and influenced by the interaction of many societal factors - have not been consistent across countries (Ethington, 1990; Hanna, Kundiger and Larouche, 1990) this paper attempts to review and discuss the research done to date which contributes in one way or another to the area of gender and mathematics in the Singapore context.

Review of Studies

Kaur (1987) in her study examined sex differences in mathematical attainment of Singapore students at the 'Ordinary' Level standard. The Singapore-Cambridge General Certificate of Education Ordinary Level Examination in Mathematics Syllabus D(4024) for November/December 1986 was used as the basis for the study. The examination consisted of two papers. Both papers were based on the syllabus which demands understanding of basic mathematical concepts and their applications, together with an ability to show this by clear expression and careful reasoning in writing. Both papers were of 2½ hours duration. Each of the two papers carried an equal weighting.

Out of a population of 42,627 Singapore candidates (21,037 boys and 21,590 girls) who took the mathematics examination, a random sample of 176 (88 boys and 88 girls) was used for the study. The examination scripts were selected at random with equal numbers for the two sexes in each of the 6 achievement grades A to F (A being the top and F being the bottom of the range).

The questions were classified by topic, level of cognitive complexity (computational skill, knowledge of concepts and problem solving ability) and test of spatial ability. Marks gained for every part of a question on both papers were recorded and used for data analysis.
The two-way analysis of variance test was used extensively in the study. The means and standard deviations to all parts of the questions in both papers were worked. The Pearson product-moment correlation coefficients for the sample’s performance in mathematics and other subjects taken in the examination were also worked.

Boys performed better than girls on paper I questions on the whole. (Paper I had 28 compulsory short questions.) For the compulsory questions on both papers boys did significantly better than the girls on the following topics: mensuration, statistics, arithmetic, geometry and probability while the girls outperformed the boys on algebra and graphs. Boys also surpassed the girls on the compulsory questions which tested spatial ability and the cognitive complexity-knowledge of concepts. In Paper II, Section B where candidates were to answer 4 out of the given 7 Questions girls showed a marked preference for questions on algebra and graphs, and vectors in 2-dimensions while the boys only marked preference was the question on mensuration.

The pupils grades in mathematics were also compared with those of the other subjects they took in the English medium examination and it was found the grades in physics, science (chemistry, physics) and metalwork the so called mathematics - related subjects - did not correlate to the same degree for the two sexes.

The mathematics results of the Singapore candidature (42,627 students) in Ordinary Level mathematics examination (November/December 1986) revealed that on the whole boys performed significantly better than the girls. MOE (1988) in its study from 1977-1987 on the relationship of examination performance with sex and birth-month found that, at Primary Three level (9 years of age), girls performed better than boys in the First language i.e. English language, the Second language usually the mother tongue, and Mathematics. Students born earlier in the year also performed better than those born later in the same year. At the Primary School Leaving Examination level (12 years of age), girls did better in the two languages while the boys did better in Mathematics and Science. By birth-month, students born earlier in the year continued to perform better than those born later in the same year.

Tan (1990) in his study examined the relationship between mathematics anxiety, locus of control and mathematics achievement, and looked at the differences in mathematics achievement, mathematics anxiety and locus of control between male and female Singapore students, and between Arts (students who have little aptitude for mathematics and science) and Science Singapore students. The subjects were 558 (16 year olds) students from six secondary schools in Singapore. The sex by stream distribution of the sample was as follows:
Gender and Mathematics

<table>
<thead>
<tr>
<th>Stream</th>
<th>Sex</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts</td>
<td></td>
<td>136</td>
<td>133</td>
<td>269</td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>140</td>
<td>149</td>
<td>289</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>276</td>
<td>282</td>
<td>558</td>
</tr>
</tbody>
</table>

The instruments used in the study were the Fennema-Sherman Mathematics Anxiety Scale (MAS), the Mathematics Achievement Locus of Control (MALOC) Scale and a Mathematics Achievement Test. The MALOC Scale and the Mathematics Achievement Test were developed by the researcher Tan as part of his study.

The data was analysed by means of Pearson's product-moment correlations, z-tests, two-way Analysis of Variance (ANOVA) and post hoc multiple comparison using Scheffe's test.

The two-way ANOVA show no significant interactions between sex and stream for each of the dependent variables, mathematics achievement, mathematics anxiety and locus of control.

No significant differences in mathematics achievement were found between males and females. This result is not in line with studies such as that of Kaur (1987), Benbow and Stanley (1980) which say that for this age group, boys, performed significantly better than girls.

No significant sex differences were found in Mathematics anxiety in the study. This result agrees with those of Richardson and Suinn (1972) and Resnick et al. (1982) but not Dew et al. (1983) which found that on the Fennema-Sherman Mathematics Anxiety Scale, females reported higher anxiety.

No significant sex differences in locus of control were found in the study. As Dyal (1984, p. 268) observed in his review, although a number of studies across various cultures appear to show that females are somewhat more external, "this fragile effect varies substantially (and capriciously) with the particular culture and sample characteristics". The results in this study indicate that in the Singapore culture, males and females do not differ significantly in their perception of control in the domain related to mathematics.

There was a significant difference in mathematics achievement between Arts students and Science students. Significant differences in mathematics anxiety were also found between Arts students and Science students which supports the finding of Foong (1985).
The ANOVA results revealed that significant differences in locus of control exist between Arts and Science students. Science students were significantly more internal than Arts students. The correlation between locus of control and mathematics achievement was found in the study to be significantly stronger for Arts students than for Science students. It appears that for the Arts students, locus of control is an important variable.

A stepwise multiple regression analysis with sex, stream, mathematics anxiety and locus of control as independent variables and mathematics achievement as dependent variable showed that stream was the best regressor, followed by locus of control and mathematics anxiety. Sex was not a significant regressor.

Discussion

Empirical studies indicate that few consistent sex-related differences are found in Mathematics achievement at the primary level. However, at the secondary level, it is well researched that boys perform better than girls in Mathematics. The IEA's (International Association for the Evaluation of Educational Achievement) First International Study of Achievement in Mathematics (Husen, 1967) reported that boys performed better than girls, at the age of 13 in all the 12 developed countries surveyed, and their performance was ahead of their female counterparts on verbal mathematical problems. However, sex differences in Mathematics performance varied among the countries surveyed. It was greatest in Belgium and Japan and least in U.S.A.

Recently, Hanna, Kundiger and Larouche (1990) investigated sex differences in Mathematics achievement among students in the last grade of secondary school in a number of North American, European and East Asian countries. The investigation made use of data collected in 1982 and 1983 by the Second International Mathematics Study (SIMS) conducted by IEA. The modal student age was 18 and a very large stratified random sample (25,606 boys and 15,349 girls) was used. On the whole boys did better than girls in 6 out of 7 subtests. Multivariate analysis of variance showed that both sex and country were significant in predicting achievement. Country-by-sex interaction was found to be significant for all except one sub-test. This shows that sex differences are not consistent across countries.

Since it is very unlikely that biological differences between the sexes vary from one country to another, the SIMS data tend to contradict those theories that attempt to explain boys' superiority in mathematics on the basis of biological factors. Hence the issue of gender differences in Mathematics is very complex and should be explored from many different perspectives.
Hilton (1974) in his longitudinal study did not find any sex difference in Mathematics achievement at Grade 5 (10 years of age) but at Grades 7 (12 years of age), 9 (14 years of age) and 11 (16 years of age) male students did better than female students in this subject.

Marshall, S.P. and Smith, J. D. (1987) in their longitudinal study of elementary school mathematics performance over a 3 year period, found that girls in Grade 3 (8 years of age) performed better than boys in all the areas evaluated, namely, computation, counting, visual problems, geometry, measurement, traditional word and non-traditional word problems. Girls however, lost ground to boys by the time they reached Grade 6 (11 years of age) where their performance declined in all other areas except for computation and non-traditional problems.

There is a dearth of research in the area gender and mathematics on Singapore pupils. In terms of overall mathematics achievement, Kaur (1987) found that boys as a group performed better than girls in the 1986 GCE 'O' Level mathematics examination and MOE (1988) in its study from 1977-1987 found that at Primary 3, girls performed better than boys in mathematics but at the PSLE, while girls continued to out-perform boys in the languages, boys did better in mathematics and science. The findings of both these studies are in agreement with the trend of known results in the corpus of related literature.

Kaur (1987) found no significant differences in computational and problem solving skills, but boys had higher levels of achievement in the skill-knowledge of concepts/mathematics application questions. It is interesting to note that there is no significant difference between the sexes in the area of computation and problem solving, contrary to research findings elsewhere (Sabers, Cushing & Sabers, 1987; Martin & Hoover, 1987). This may be due to differences in pedagogy of teaching adopted by Singapore teachers compared to their counterparts elsewhere. Considering the fact that practice on past year examination papers form a substantial part of preparation for the GCE 'O' level examinations for Singapore pupils, coupled with the fact that the type of 'problem solving' questions in the examination papers are routine in nature it is not surprising that no significant differences were detected between the sexes as such skills could be honed through drill and practice.

What cannot be achieved equally through drill and practice is understanding of mathematical concepts. This lack of firm grasp of mathematical concepts may be the cue to the girls lower level of achievement in mathematics.

Tan (1990) in his study found no significant sex differences in mathematics achievement, mathematics anxiety and locus of control. Tan suggests that in view of the rapid
modernization of the Singapore society and the complete emancipation of women in Singapore, differences among the affective variables in relation to achievement seemed to be tenuous.

Tan's sample may not have been representative of the Singapore pupils at the level studied. Both Kaur (1987) and MOE (1988) made use of the entire cohort of Singapore pupils at the desired levels and hence it may be claimed that their findings are representative of the Singapore pupils.

It is evident that the gender gap in Mathematics achievement does exist in Singapore. However it is not possible to ascertain the relative width of the gap in comparison with other countries in the world as Singapore has not participated in any of the IEA's studies in Mathematics.

References:


