3. Gender Issues and Mathematical Performance at the Secondary Level: A Mauritian Experience

Hemant Bessoondyal
Mauritius Institute of Education, Mauritius
John Malone
Curtin University of Technology, Australia

Abstract

Mathematics plays a fundamental role in the life of human beings. It promotes logical and rational thinking and enhances one's ability to analyze and to solve problems. Life without mathematics is almost an impossibility and it would be difficult "to live a normal life in very many parts of the world" without it (Cockcroft, 1982, p.1). Its importance is also highlighted in the document entitled *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000, p. 5) where the following appears: "those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their future". Mathematics has been seen to act as a 'critical filter' in the social, economic and professional development of individuals. Mauritius relies, to a great extent, on its human resource power to meet the challenges of the technological developments and a substantial core of mathematics is needed to prepare students for their involvements in these challenges. An analysis of the performance of boys and girls in mathematics in Mauritius proved to be important in view of equal participation of both sexes in the developments of the country and also achievement of gender equity.

Background

Mauritius is a small island, having an area of 1 865 square kilometres. It is found in the Indian Ocean in a group of islands called the Mascarene islands and is about 2000 kilometres off the south east coast of Africa. Following independence in 1968, the country became a Republic in 1992. Its educational system based on the traditional 6-5-2 system of the UK, that is six years of primary education, five years of secondary education and a further two years of higher secondary education.

Gender has been a matter of great concern in Mauritius for quite some time. In a study, Bunwaree (1996) highlighted the following concerning gender and education in the country:

> Mauritius has an official policy of equality of educational opportunity for boys and girls but this policy does not get translated into reality. Equality of opportunity does not only mean access to schools. Outcomes of schooling too are important in measuring equality (Bunwaree, 1996, p. viii).

It should be noted that much is being done in the country to ensure that gender equity and social justice exist. Several bills such as The Protection of the Child (Miscellaneous Provisions) Act (1998), The Sex Discrimination Act (2002) and The Protection from Domestic Violence (Amendment) Act (2004) have been passed in our Legislative Assembly in the recent years to deal with this issue. The concern of the government in the educational field can be felt through the following words of the Prime Minister of Mauritius in his message to secondary school students at the 34th Anniversary of the Independence, and at the 10th Anniversary of the Republic in March 2002.

> We are specially committed to promoting gender equity. We want more and more women to study science and technology so that they may equally contribute to the welfare of Mauritius.

Gender and Mathematics

Gender related differences in mathematics achievement have been reported in many studies where boys were performing better in mathematics than girls (Hanna, Kundiger, & Larouche, 1990; Köller, Baumert, & Schnabel, 2001; Leder, 1992; Seegers & Boekaerts, 1996).

A summary of the gender analysis of three studies conducted within the space of 30 years by the International Association for the Evaluation of Educational Achievement (IEA), namely the FIMS, the SIMS and the TIMSS is provided in Hanna (2003, p. 210) and shown in Table 1.

Table 1: Decreasing Gender Gap in Mathematics

	Age 13	Ages 17-18
FIMS (1964)	1. Differences in boys' favor in 10 out of 12 countries. 2. Considerable variation between countries in the extent of gender differences.	1. Differences in boys' favor in all 10 countries. 2. Considerable variation between countries in the extent of gender differences.
SIMS (1980-82)	1. No difference in 5 out of 20 countries on all subjects. 2. Differences in boys favor in 10 countries, in up to 2 out of 5 subtests. 3. Differences in girls' favor in 5 countries in up to 2 out of 5 subtests.	1. No differences in 3 out of 15 countries on 6 out of 7 subtests. 2. Differences in boys' favor in 12 countries on 2 to 6 subtests.
TIMSS (1995)	1. No differences in overall achievement in 37 out of 39 countries. 2. Slight differences in girls' favor in Algebra in 12 countries (in Grade 8).	1. No differences in 5 out of 16 countries. 2. Differences in boys' favor in 4 countries on up to 2 content areas and in 7 countries on each of the 3 content areas.

As a result of these studies, different forums were constituted, conferences organized and consciousness raised concerning equity in mathematics education around the world. Different intervention programmes were developed in view of increasing females' enrolment and attainment in mathematics and mathematics oriented courses (Fennema, 2000; Hanna, 2003; Leder, 1992). A number of studies conducted afterwards showed that in many countries the gender differences in enrolment, and even performance, have decreased and are now quite small (Elwood, 1999; Fennema, 1996; Friedmann, 1989; Hanna, 2003). However other studies did find that even if the gender differences gap in mathematics achievement have been shrinking over time, gender differences favouring males still existed in areas related to high-level cognitive skills (Casey, Nuttall, & Pezaris, 2001; Fennema, 2000; Hyde, Fennema, & Lamon, 1990; Leder, 1992). There are also claims that now the boys are at the disadvantageous position (Boaler, 1997; Hanna, 2003; Matters, Allen, Gray, & Pitman, 1999; Vale, Forgasz, & Horne, 2004).

Achievement of Boys and Girls in Mauritius

The results of boys and girls at the first national examinations (end of primary schooling, average 10-11 years old) are provided in Tables 2 and 3

Table 2: Percentage Passes in Certificate of Primary Education Examination (CPE) in Mauritius 1995- 2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Boys	60.4	60.0	59.4	59.9	57.5	58.5	56.6	57.7	53.8	54.7
Girls	67.7	67.7	67.3	67.3	67.4	69.9	68.9	69.3	66.9	65.8

Source: Mauritius Examination Syndicate (2005)

It can be noted that girls consistently performed better than boys in the end of primary national examinations. To gain an insight of the situation in mathematics at the level, the percentage passes of boys and girls in mathematics are presented in Table 3.

Table 3: Percentage Passes in Mathematics in CPE Examination in Mauritius 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Boys	69.6	70.1	70.5	71.4	69.5	69.9	68.8	71.2	69.9	70.3
Girls	74.3	74.5	75.1	76.9	75.7	77.4	77.2	78.3	78.8	77.8

Source: Mauritius Examination Syndicate (2005)

Girls are still performing better than boys in the subject of mathematics at the primary school level. What is the situation at the School Certificate level? Table 4 shows the result of boys and girls in the School Certificate Examination for the past ten years.

Table 4: Percentage Passes in School Certificate Examination in Mauritius 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Boys	69.2	72.8	74.2	77.6	76.3	75.3	75.1	72.8	73.5	75.9
Girls	72.0	77.6	77.8	78.1	78.6	79.4	79.8	77.3	78.4	80.1

Source: Mauritius Examination Syndicate (2005)

Based on the data in Table 4, one can observe that for the School Certificate Examinations, the tendency is for girls to perform better than boys at the secondary level are. What is the situation concerning mathematics? The percentage passes in mathematics for the past ten years are displayed in Table 5.

Table 5: Percentage Passes in Mathematics in School Certificate Examination in Mauritius 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Boys	75.8	76.7	75.1	73.0	73.5	79.3	79.1	70.3	71.9	74.8
Girls	69.3	72.0	71.6	68.9	66.2	70.5	71.5	66.9	68.6	70.6

Source: Mauritius Examination Syndicate (2005)

The difference and the trend in these data can be easily read from the line graphs in Figure 1.

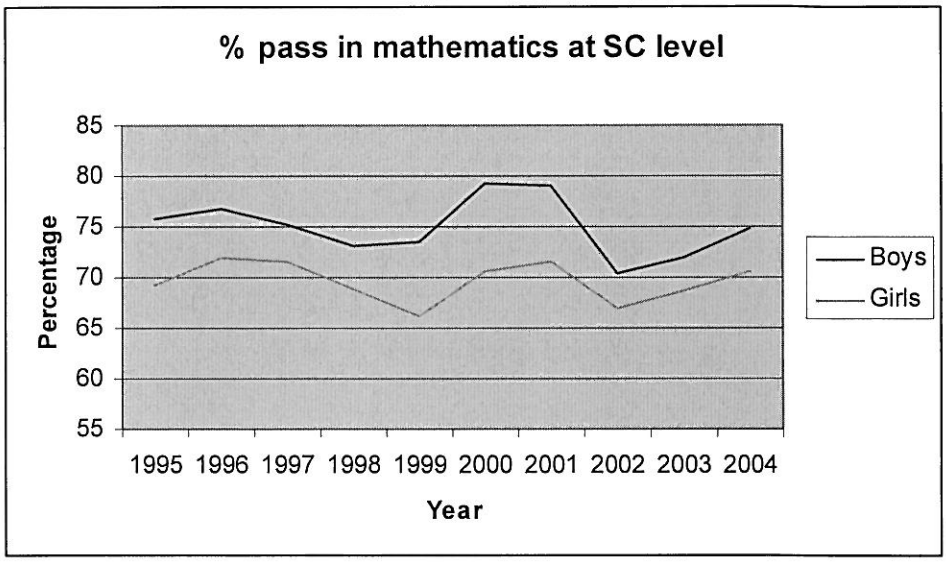

Figure 1: Percentage Passes in Mathematics at SC Level

It is very clear that in Mauritius the performance of secondary girls in mathematics is poorer than that of boys. The same trend can be observed when the grade distribution is analyzed.

Table 6: Percentage of Students Scoring Grades 1-3 in Mathematics in the School Certificate Examination 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Boys	29.6	31.0	30.3	27.2	27.9	27.8	25.7	24.6	23.8	27
Girls	20.9	21.7	22.7	19.2	20.8	20.7	20.4	21.3	21.4	23.8

Source: Mauritius Examination Syndicate (2005)

A graphical presentation of the data is provided in Figure 2.

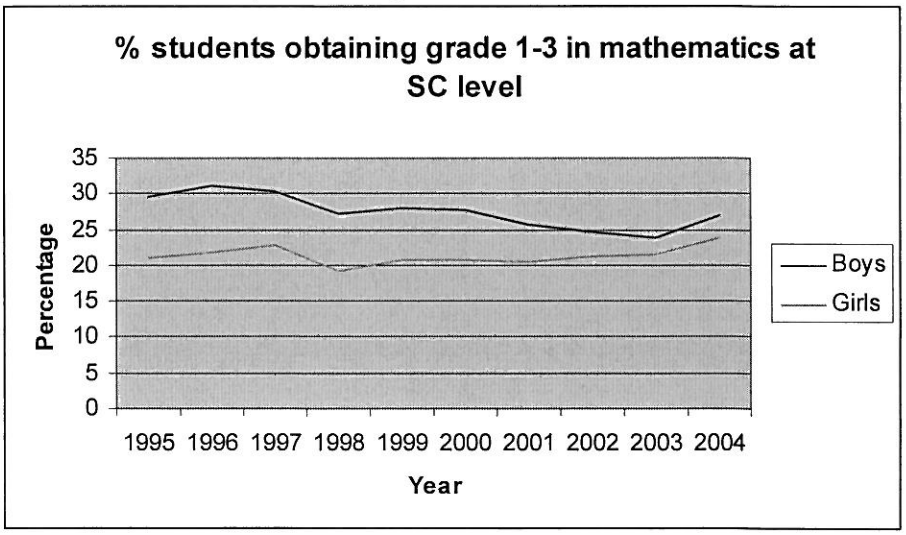

Figure 2: Percentage of Students Scoring Grades 1-3 in Mathematics at SC level

In the (1995-2004) achievement data there is a significant difference in the performance of boys and girls in mathematics at the secondary level (though there is a tendency recently that the gap is diminishing). An extensive review of the literature has revealed that little research has been carried out in relation to gender differences in mathematics in Mauritius except for a few dissertations at the PGCE or B.Ed level. It was necessary to probe deeper into this research problem.

Methodology

In order to assess and compare the students' achievement in mathematics in the different schools, a questionnaire was specially designed for the study. In the first instance, the syllabi of mathematics for Form I, II and III were analysed and the different objectives that need to be met by students of these forms were identified. The main aim in designing the questionnaire was to find out how much, and to what extent, the concepts of mathematics of the lower secondary level the students of Form IV had acquired. The strands chosen were Number and Operations, Algebra, Geometry and Data Analysis and Probability. These are four of the five strands advocated by the NCTM Standards (1989). It should be pointed out that more emphasis was given to Algebra in this questionnaire as the students in Mauritius are introduced to Algebra only at lower secondary level and it can be said to be the backbone of mathematics learning. In fact, the place and importance of Algebra in the secondary school curriculum has been emphasized by NCTM (1989). Items based on these strands were written, but in a somewhat different way to the manner students were familiar with in their regular examinations. Items were designed to test the conceptual understanding of the students.

This questionnaire was administered to the students of one Form IV class in seventeen different schools across the island. Table 7 shows the number of each category of school that formed part of the sample.

Table 7: Type of school in each region for the sample

Region	State	Confessional	Other private
Zone 1	1	0	1
Zone 2	2	2	1
Zone 3	2	0	3
Zone 4	1	2	1
Rodrigues		1	

The number of students involved in this study was 607, that is 288 boys and 318 girls.

Findings and Discussions

The findings of this study are analysed by first discussing the results of a few selected items from the mathematics questionnaire.

Question 3: The probability that a boy is late for school in a given day is $\frac{1}{5}$. The probability that the boy is late for school in two consecutive days is:

Results:

Possibilities		% response
A	equal to $\frac{2}{5}$	57.2
B	equal to 0.2	2.3
C*	less than $\frac{1}{5}$	24.8
D	more than $\frac{2}{5}$	12.0
No response		3.7

Note that approximately two third of the sample of students could not answer this question correctly. The most common answer to be found was "$\frac{2}{5}$", indicating a misconception concerning probability: these students have added the two probabilities instead of multiplying them.

A Mann-Whitney U test yielded a p-value of 0.001 which showed that a significant difference exists in the responses of students regarding gender.

Question 6: If X and Y are two non-empty sets (X, Y $\subset \xi$) such that X $\cap$ Y = Y, then

Results:

Possibilities		% response
A	X = Y	9.4
B*	Y $\subset$ X	38.2
C	X $\subset$ Y	19.2
D	X $\cup$ Y = ξ	20.2
No response		13.0

Approximately 38 % of the students were able to provide the correct answer to this item. Sets form part of the curriculum of mathematics from primary level and students are very much at ease with this chapter of the textbook as far as the usual questions set in the examinations are concerned. Note that 20.2 % of the students identified the answer "X $\cup$ Y = ξ" showing that they did not pay attention to the fact that it was specified in the question that the two sets X and Y are proper subsets of the universal set.

An analysis revealed that there was no significant difference between the responses of boys and girls for this question. (p-value = 0.158 for the Mann- Whitney U test).

Question.12: Without using calculator evaluate $6.27^2 - 3.73^2$

40.0% of students scored full marks for this question while 46.6% scored zero marks. It should also be noted that many students have carried out the actual multiplication and then the subtraction. Another interesting finding in the responses of the students is the answer " 2.54^2 "showing the misconception
" $a^2 - b^2 = (a-b)^2$ "

An analysis gender wise showed that the responses of boys and girls to this question were not significantly different (a p-value of 0.331 for the Mann-Whitney U test).

Question 13: A quantity is increased by 20% but later decreased by 10%. What is the overall percentage change?

This question can be considered to be amongst the most difficult ones in this mathematics questionnaire as only 4.6% of the students could score the total marks and 89.6% scored zero. Almost all the students who were incorrect gave the answer "10%", showing that they did not really understand the concept of percentage. They calculated "20% – 10%= 10%". Note that students are working with the concept of percentage since upper primary level.

Considering this question from a gender perspective there was a statistical difference between the responses of boys and girls. A Mann-Whitney U test yielded a p-value of 0.000 was obtained which showed that there is a significant difference in the responses of students regarding gender.

Question 17: The internal dimensions of a box are 10 cm by 8 cm by 5 cm. What is the maximum number of cubes of side 2 cm that can be stacked in the box?

This question was amongst the most difficult in this questionnaire, with a mean score of 0.50. 12.0% of the students scored full marks while the vast majority (87.3%) scored zero.

The common mistake that could be noted was:

$$\text{Number of cubes} = \frac{\text{volume of cuboid}}{\text{volume of cube}}$$

$$= \frac{400}{8}$$

$$= 50.$$

Considering this question from a gender perspective, there was a significant difference between the responses of boys and girls (p= 0.000 for the Mann-Whitney U test). This outcome reflects other research which asserts that girls experience difficulties in spatial visualization. In fact, a study by Battista (1990) concluded that males scored significantly higher than females on spatial visualization, geometry achievement and geometric problem solving.

It can be noted that in some of the items discussed above there were significant differences between the responses of boys and girls while in others there was not any significant difference. Such an analysis was carried out for each of the items in the questionnaire together with the total performance in the teat and in the different strands.

A summary of the analysis of the questions gender wise using Mann- Whitney U test is provided in Table 8.

Table 8: Summary of results from Mann-Whiney U tests

Question	p-value	Significant Difference
1	0.152	No
2	0.854	No
3	0.001	Yes
4	0.026	Yes
5	0.158	No
6	0.260	No
7	0.002	Yes
8	0.269	No
9	0.000	Yes
10	0.706	No
11(i)	0.234	No
11(ii)	0.885	No
12	0.331	No
13	0.000	Yes
14	0.014	Yes
15	0.000	Yes
16	0.000	Yes
17	0.000	Yes
18(i)	0.153	No
18(ii)	0.001	Yes
19	0.000	Yes
20	0.000	Yes
21(a)	0.082	No
21(b)	0.003	Yes
22	0.000	Yes
23	0.000	Yes
Total	0.000	Yes
Number	0.000	Yes
Algebra	0.000	Yes
Geometry	0.000	Yes
Probability	0.000	Yes

Note that out of 26 items in the mathematics questionnaire, there was a significant difference between the performance of boys and girls on 15 items, with boys outperforming girls on these items. The same could be noted when the overall performance of boys and girls in the mathematics test were compared as well as the performance in the different strands. These analyses provide further evidence that boys are still performing better than girls in mathematics at the secondary level in Mauritius and this agrees with studies conducted in other parts of Africa (Afrassa, 2002; Githua & Mwangi, 2003).

Chi square tests were also conducted to establish possible associations between certain factors and performance in the mathematics test. A summary of the results obtained for these analyses is given in Table 9.

Table 9: Summary of Chi square tests conducted

First variable	Second variable	Pearson Chi-Square	Significance
Total Grade	Sex	27.302	0.000
Total Grade	Ethnic Community	88.524	0.000
Total Grade	Zone	61.211	0.000
Total Grade	Private Tuition in FI	1.396	0.707
Total Grade	Private Tuition in FII	5.787	0.448
Total Grade	Private Tuition in FIII	4.075	0.253
Total Grade	Private Tuition in FIV	18.836	0.027
Total Grade	Hours of home study I	33.758	0.000
Total Grade	Hours of home study II	44.768	0.000
Total Grade	Hours of home study III	41.386	0.000
Total Grade	Hours of home study IV	44.721	0.000
Total Grade	Performance in Form I	214.965	0.000
Total Grade	Performance in Form II	272.654	0.000
Total Grade	Performance in Form III	295.842	0.000
Total Grade	Performance in Form IV	171.384	0.000
Total Grade	CPE English Grade	94.957	0.000
Total Grade	CPE Maths Grade	124.105	0.000
Total Grade	CPE French Grade	62.216	0.000
Total Grade	CPE EVS Grade	70.002	0.000
Total Grade	CPE Oriental Grade	15.705	0.402
Total Grade	Father Education	92.467	0.000
Total Grade	Mother Education	80.548	0.000
Total Grade	Father's profession	109.566	0.000
Total Grade	Mother's profession	65.415	0.000

Note that the number of hours of study at home had an influence in the performance in the mathematics test. The amount of time devoted to study at home is very important to review the concepts dealt in the classroom and consolidate the conceptual understanding. Moreover, tackling problems plays an important role in the learning of mathematics. The more time is devoted to mathematics the better tends to be the achievement in the subject.

In the same way, the prior performances of students in mathematics in classes were found to play an important role in their achievement in the test. Mathematics is a hierarchical subject and one has to master the prerequisite concepts and skills before moving onto other concepts. This view was verified through informal interviews with past students who have not performed well in mathematics at the School Certificate level. Many attributed their non-success in mathematics to some instances of failure, or problems experienced at the lower secondary level. Those who did remedy the situation could move forward, but those who could not do much to review the situation (or did not have enough opportunities provided) continued with this 'handicap' and consequently experienced further difficulties in mathematics later on.

Another important factor influencing performance in the mathematics test was parents' education and profession. This finding is in keeping with other research highlighting the contribution of parents in the educational achievement of their children (Carr, Jessup, & Fuller, 1999; Kratsios & Fisher, 2003; Monitoring Learning Achievement, 2003). Parents spend a considerable amount of time with their children, helping them in their academic endeavors. The way parents support the children can motivate them, and can also provide logistic and other facilities to make a difference when it comes to the achievement. Parents who themselves have experienced difficulties in mathematics may convey negative messages to their children and this may, in some way or another, influence the attitude of the child towards the subject and eventually his/her performance in the subject.

Conclusion

Preliminary analysis of results at the School Certificate examinations showed that boys are outperforming girls in mathematics at secondary level in Mauritius. Further evidence of this situation was obtained through the analysis of the performance of a sample of 607 students in a mathematics questionnaire specifically designed for this study. It was found that boys were performing better than the girls not only in the overall test but also in each of the strands Number and Operations, Algebra, Geometry and Data Analysis and Probability. Further statistical analysis were carried out to analyse possible relationship between the performance in the mathematics test and other factors. It was found that prior performance in mathematics, hours of home study, parents' profession and education, amongst others, had an influence in the students' performance in the test.

After having obtained further evidence that boys are performing better than girls in mathematics at the secondary level in Mauritius, it is important to identify factors that are responsible for such a situation and develop strategies to help in enhancing students' performance in mathematics and in developing conceptual understanding in mathematics. These are dealt with in the second and third phase of the study.

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