SELF-MOTIVATION IN MATHEMATICS LEARNING: ARE THERE DIFFERENCES BETWEEN GIRLS AND BOYS?

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ABSTRACT

This paper examines students' self-motivation in mathematics learning between girls and boys using secondary analysis of the Third International Mathematics and Science Study (TIMSS) conducted in 2003 by the International Association for the Evaluation of Educational Achievement (IEA) involving eighth graders. Components of self-motivation include students' self-confidence in learning mathematics, attitudes towards mathematics, the value students place on mathematics, students' initiative in looking up for information concerning mathematics topics and extra mathematics classes outside of classroom hours. The paper also examines the relationships between these components and mathematics average achievement between girls and boys.

Keywords: Self-Motivation, Mathematics learning, gender differences, average achievement

INTRODUCTION

Mathematics is undoubtedly a subject that has received considerable attention in school because of its importance as a prerequisite for admission into institutions of higher learning in most disciplines. The need to have a strong foundation in mathematics from younger age is overwhelmingly accepted by both parents and teachers, that it has become a subject taught in every tuition centre outside the school system across all levels of schooling.

Achievement in mathematics is affected by numerous factors ranging from individual student's thinking ability to instructional strategies in learning the subject. In turn mathematics learning and achievement vary across nations, regions, and a variety of socio-economic and demographic characteristics. One of the most discussed among educators and researchers are gender differences with regard to mathematics learning and achievement. For example, previous studies found that females generally scored lower than males on standardized test of mathematics (Gallagher and Kaufman, 2005; Cleary, 1992; Beller and Gafni, 1996), and that there are more males than females scoring in the two extreme ends (Willingham and Cole, 1997; Wang and Maxey, 1995). Similar result was obtained by Engelhard (1990) where boys performed better with changing level of complexity in mathematics content. However, a recent study by Alkhateeb (2001) found that among high school students in the United Arab Emirates, females scored higher Mathematics achievement than males.

As students' performance in examination is greatly associated with learning, it is expected that variations in mathematics achievement between girls and boys may be attributed to differences in the way students learn mathematics. One key component in learning is, students' self-motivation, as measured by a number of variables including their attitude and self-confidence in learning mathematics, the value they place on the subject and the time students spend on practising mathematics related homework and problems outside the school hours. It is the interest of this paper to examine the differences between girls and boys in terms of these variables and their influence on mathematics achievement.

Methods

This study uses data from the Third International Mathematics and Science Study (TIMSS) 2003 conducted by the International Association for the Evaluation of Educational Achievement (IEA). The study was designed to provide trends in eighth-grade mathematics and science achievement in an international context involving participation of 46 countries including Malaysia. The data contains information on average overall

mathematics scores as well as average scores in each of the five content areas namely, fractions and number sense; measurement; data representation, analysis, and probability; geometry; and algebra. It also contains information on students' background including parents' socio-economic status, students' self-confidence in mathematics ability, the value students place on mathematics and extra classes in mathematics that could affect differences in mathematics learning and achievement between girls and boys. Chi-Squared tests and t-tests are used to examine the associations between variables and to assess the differences in the average achievement between the two sexes, respectively. The analyses are based on 5314 students comprising 3071 girls and 2243 boys.

Results

The overall average mathematics score of 508 ranks Malaysia at number 10 and one of the 26 countries with an average achievement that was significantly higher than the international average of 467 from the 46 participating countries. The country's average achievement for girls of 512, is slightly higher than score of 504 for the boys while there is no difference between the two sexes for the international average scores.

Examining achievement in the mathematics content areas, Table 1 shows that Malaysian girls scored relatively higher than boys in number sense, algebra, measurement and data. However, the international data shows similar performance for both girls and boys in number sense, geometry and data. International average also shows that girls outperformed boys in algebra while the reverse is true of the achievement in measurement.

Table 2 presents the results of the t-tests which suggest that the overall average achievement for girls is significantly higher than for boys and although the average achievement for girls is greater than that for the boys in all five content areas, the difference is significant in three of them namely, algebra, data and number sense.

Mathematics Content Areas	Country Average Achievement			International Average Scale Scores		
	Total	Girls	Boys	Total	Girls	Boys
Overall	508	512	504	467	486	485
Number	524	529	518	467	467	467
Algebra	495	501	488	467	471	462
Measurement	504	505	502	467	464	470
Geometry	495	495	494	467	466	467
Data	505	507	503	467	467	467

Table 1: Average Achievement in Mathematics Content Areas by Gender

	Sex	N	Mean	Standard Deviation	p-value
Overall Score	Girl	3071	512	70.73	0.000
	Boy	2243	504	74.20	
Number	Girl	3071	529	67.60	0.000
	Boy	2243	518	72.56	
Algebra	Girl	3071	501	68.54	0.000
	Boy	2243	488	72.77	
Measurement	Girl	3071	505	76.99	0.157
	Boy	2243	502	81.50	
Geometry	Girl	3071	495	75.06	0.867
	Boy	2243	494	80.38	
Data	Girl	3071	507	56.61	0.008
	Boy	2243	503	60.15	

Table 2: Comparison of Average Achievement in Mathematics Content Areas between Girls and Boys

Statements	Gender	Agree a lot	Agree a a little	Disagree a a little	Disagree a lot	P-value
I usually do well in Mathematics	Girls	11.5	46.2	40.9	1.4	0.001
	Boys	15.1	45.1	38.0	1.8	
Mathematics is more difficult for me than for many of my class mates	Girls	7.8	34.6	45.3	12.2	0.003
	Boys	9.4	35.0	41.1	14.5	
Mathematics is not one of my strengths	Girls	5.7	29.4	44.4	20.5	0.032
	Boys	7.1	30.5	40.9	21.4	
I learn things quickly in mathematics	Girls	9.3	49.1	39.0	2.6	0.000
	Boys	13.1	46.3	37.2	3.4	

Table 3: Self-Confidence in Mathematics Ability by Gender

Further investigation examines the gender differences in terms of students' self-confidence in learning mathematics. The Chi-square test based on four statements about their confidence in mathematics ability is shown in Table 3, which indicates significant differences between girls and boys and their level of agreement. More boys tend to really agree that they usually do well in mathematics and that they learn things quickly in mathematics. On the other hand there was a lot of agreement among boys that mathematics is not one of their strengths and that the subject is more difficult for them compared with many of their classmates.

To obtain the overall confidence measure of mathematics ability among students, TIMSS used three levels of index, that is, high, medium and low. High level of index were assigned to students who agreed a little or agreed a lot with the four statements, on average, while low level of index were assigned to students who disagreed a little or disagreed a lot with all four, on average. All other combinations of responses were assigned medium level of index (Mullis et. al, 2004). It should be noted that the computation of index is reversed for the two negative statements in Table 3.

For Malaysia, 39 percent of the students scored a high index, 45 percent medium and 16 percent low index. It can be observed in Table 4 that the average achievement decreases substantially with decreasing level of index of students' self- confidence in learning

	High Index	Medium Index	Low Index
Malaysia:			
Percent of Students	39	45	16
Average Achievement	546	490	471
Girls:			
Percent of Students	38	46	16
Average Achievement	549	493	479
Boys			
Percent of Students	39	44	17
Average Achievement	542	486	462
International:			
Percent of Students	40	38	22
Average Achievement	504	453	433

Table 4: Average Achievement by Index of Students' Self-Confidence in Learning Mathematics

mathematics. Table 4 also shows that Malaysia's average achievement is much higher than the international average for all three levels of index of self-confidence. A slightly higher proportion of the boys than girls are in the high index and low index category. Comparing the average achievement within the same level of index of self-confidence, it can be observed that girls outperformed boys at every level.

Table 5 presents seven statements which attempts to provide some measure of how students value the importance of mathematics and the need to learn the subject. The Chi-square statistics suggests that with the exception of the statement that learning mathematics will help them in their daily lives, there is significant difference between students' responses and gender for the remaining six statements. It is interesting to note that 95 over percent of both girls and boys agree that learning mathematics will help them in their daily lives.

The result clearly shows that interest to take more mathematics in school is higher among girls than boys as

agreed by 94 percent and 90 percent of them, respectively. Similarly, the proportion of students who agreed that they enjoy learning mathematics is higher among girls (90 percent) compared with the boys (85 percent).

The proportion of girls who agreed that they need mathematics to learn other school subjects is also higher than that of the boys, with 85 percent and 81 percent, respectively while the need for students to do well in mathematics to get them into university of their choice and get the job they want is agreed by 93 and 88 percent of the girls compared with 90 and 86 percent of the boys, respectively. It would be reasonable to argue that since girls generally tend to mature earlier than boys, there is greater tendency for girls to appreciate the learning of mathematics. This appreciation is not just for the sake of learning mathematics as a subject but extends to a wider context in terms of its need in relation to other subjects in school as well as life after high school and beyond.

Statements	Gender	Agree a lot	Agree a little	Disagree a little	Disagree a lot	P-Value
I would like to take more mathematics in school	Girls	54.3	39.3	5.9	0.5	0.000
	Boys	46.8	43.3	9.4	0.6	
I enjoy learning mathematics	Girls	43.9	43.1	11.8	1.2	0.000
	Boys	37.7	47.1	13.9	1.3	
I think learning mathematics will help me in my daily life	Girls	58.0	38.3	3.5	0.1	0.071
	Boys	54.9	40.5	4.5	0.1	
I need mathematics to learn other school subjects	Girls	28.8	55.9	14.6	0.8	0.001
	Boys	24.9	56.4	17.7	1.0	
I need to do well in mathematics to get into the university of my choice	Girls	58.8	34.2	6.6	0.5	0.000
	Boys	54.3	36.0	8.6	1.1	
I would like a job that involved using mathematics	Girls	17.6	46.5	33.3	2.5	0.738
	Boys	17.3	47.3	32.5	2.9	
I need to do well in mathematics to get the job i want	Girls	48.1	40.0	11.4	0.5	0.009
	Boys	45.2	41.0	12.6	1.2	

Table 5: Attitude and Value Students Place on Mathematics by Gender

The seven statements relating to the value students place on mathematics is again converted into index of Students' Valuing Mathematics using the same computation as for the index of Self-Confidence in Learning Mathematics (Mullis et. al, 2004). The result in Table 6 shows that more than three-quarters of the Malaysian students scored a high index, followed by over twenty percent medium index. The average achievement decreases substantially from a high to medium level of index of students' valuing mathematics, and Malaysia's average achievement is much higher than the international average for the two levels of index. Girls also tend to have a more positive attitude towards learning mathematics as indicated by 21 percent of them, who agreed that they will never really understand a new topic if they do not initially understand it compared with 28 percent of the boys. This may suggest the difference in the level of perseverance and will lead to learn something new between girls and boys.

	High Index	Medium Index	Low Index
Malaysia:			
Percent of Students	78	21	1
Average Achievement	515	486	--
Girls:			
Percent of Students	80	20	1
Average Achievement	517	494	456
Boys			
Percent of Students	75	24	1
Average Achievement	512	478	455
International:			
Percent of Students	55	35	10
Average Achievement	479	458	458

Table 6: Average Achievement by Index of Students' Valuing Mathematics

Table 6 also shows that a higher proportion of the girls than boys are in the high index category, although there is no difference for those having low index of students' valuing mathematics. Similar pattern of performance is observed where girls scored higher than boys for each level of index. Gender difference is also examined in terms of how often the students look up for ideas and information related to mathematics. More boys than girls reported that they do this on a daily basis or at least once a week (Table 7). While there is a difference in the average score in the former category where boys performed relatively better, there is no difference in the average score between girls and boys among those who look for information at least once a week. It is interesting to note that for students who reported that they only look up for information concerning mathematics less often or never, the average achievement for girls are found to be much higher than for boys. Another self-motivation component shown in Table 7 is the amount of extra classes or tutoring in mathematics students attend outside of the regular school classes. A slightly higher proportion of the boys (5%) reported having extra classes almost everyday compared with the girls (4%) and that their average achievement is also much higher (520 for boys and 513 for girls). Interestingly, a greater proportion of the boys (39%) than girls (37%) reported never attended extra tutoring in mathematics and that the boys' average scores (502) is much lower the girls' average (509). For the two middle categories, the result shows girls outperformed boys by quite a big margin.

		Total		Girls		Boys	
	Frequency	Percent	Mean Score	Percent	Mean Score	Percent	Mean Score
Look up for ideas and information mathematics	Every Day	2.9	498	2.4	496	3.6	500
	At Least Once a week	20.5	501	18.2	500	23.5	501
	Once Or twice a month	24.0	519	24.8	521	22.9	517
	A Few Times A Year	18.6	524	19.6	531	17.2	515
	Never	34.1	514	35.1	519	32.7	506
Extra lessons or tutoring in mathematics outside of regular classes	Almost every day	4.1	516	3.6	513	4.7	520
	Once Or Twice a week	31.1	529	31.5	532	30.5	525
	Sometimes	27.3	489	28.3	495	26.0	479
	Never or almost never	37.5	506	36.6	509		502

Table 7: Extra Information and Extra Classes in Mathematics

Discussion

The result from this study shows that girls performed significantly higher in the overall average mathematics achievement as well as in three areas of mathematics content namely, number, algebra and data. This finding is similar to that found by Alkhateeb (2001) but in contrast with the general result of several other studies in which boys usually outperformed girls (Gallagher and Kaufman, 2005; Cleary, 1992; Beller and Gafni, 1996; Engelhard, 1990). A number of dimensions pertaining to students' level of self-confidence in mathematics ability, the value of mathematics as perceived by them, the amount of time students spend looking up for information in mathematics as well as the amount of extra mathematics classes were explored as possible factors affecting this differences. Average achievement seems to increase with increasing level of index of self-confidence and the index of students' valuing mathematics for the total sample as well as for both girls and boys. Within each index level of each of the dimensions mentioned, girls outperformed boys although the difference is quite small for a couple of categories.

It is not surprising that among the five mathematics content areas, both sexes scored highest in number because students were introduced to number sense much earlier than other content areas. And it is also not surprising that despite having lower average achievement than girls in almost all the mathematics content areas, the boys portrayed higher self-confidence level as perceived by them. They seemed to think that they tend to do well in mathematics and that they understand quickly in learning the subject. In terms of extra mathematics classes, the study revealed greater proportion of the boys than girls at the two extreme ends. However, girls scored much higher than boys in terms of enjoyment in mathematics learning, interests in taking up more mathematics subject, the importance of mathematics in relation to other school subjects, university education and employment. Girls also seemed to have a better and wider scope of the need to seriously learn mathematics because of the value they place on it.

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