Trends in Factors Affecting Iranian Eighth Graders' Mathematics Achievement by Gender (TIMSS 1999, 2003 & 2007)

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Abstract

In the present study, the changes observed in the mathematics achievement of Iranian eighth graders across three consecutive TIMSS studies were investigated by gender. The data obtained from Iranian eighth graders in TIMSS 1999, 2003 and 2007 were analyzed. A number of 5301 (2096 girls and 3205 boys), 4942 (2059 girl and 2883 boys), and 3881 (1786 girls and 2195 boys) Iranian students participated in TIMSS 1999, 2003 and 2007, respectively.

Using the data from the Student Questionnaire and factor analysis, four factors were extracted for each of the studies. Due to the fact that the items in the Student Questionnaire in the three different studies were not the same, the indicators for some of these factors in the three different studies were not identical. The factors were identified as attitudes towards math, socio-economic status, mathematics self-concept, and school climate. The criterion variable was defined using five mathematics plausible values. The key methodologies used in this study were the effect sizes and the Linear Structural Model. Diverse fit statistics were used to assess the goodness of fit, and the model fit was acceptable for all the models. The data from each study were analyzed for boys and girls, separately. Trends in influential factors for the boy and girl participants in these three studies and the direct and indirect effects of the factors on mathematics achievement were also analyzed and discussed.

Key words: *trend, mathematics achievement, eighth graders, factors*

Introduction

The question of gender differences in mathematics achievement has a long history of research with different or contradictory results. Different theories have different explanations for the gender gap in mathematics. The biological theories argue that innate differences in spatial ability, higher order thinking, or brain development produce a gap in achievement. Societal explanations focus on how girls are socialized into believing that math is not important, useful, doable, or part of the identity of a girl (Wilder & Powell, 1989). In addition to the above-mentioned theories, gender similarities hypothesis argues that boys and girls are similar in most, but not all, psychological variables (Hyde, 2005). The gender stratification hypothesis proposes that in a society with more societal stratification based on gender, and more inequality of opportunity, girls will report less positive attitudes and more negative affect and will perform less well on mathematics achievement tests than will their boy peers.

Penner (2008) analyzed TIMSS 1995 data and showed that the proportion of girls scoring above the 95th percentile was linked to the national gender equity (cited in Else-Quest, Hyde, and Linn, 2010). Gender stratification hypothesis is consistent with Eccles's expectancy-value theoretical model (1994). According to this model, cultural inequities in educational or career opportunities have an adverse impact on girls' performance.

Fryer and Levitt (2009) found a high correlation between the gender gap in mathematics and gender equality in 17 countries participated in PISA (Program for International Student Assessment) and TIMSS. They argued that gender equality is sensitive to the inclusion of Muslim countries. They also stated that in spite of women's low status in Muslim courtiers (mentioning Iran and Bahrain), girls actually outperformed boys in math, and this is due to relatively strong performance by the girls, not an unusually bad showing among the boys.

Previous research in the area of mathematics achievement has shown that boys' superiority in the mathematics subject area is a universal phenomenon (Janson, 1996; Mullis, et al., 2000). While early research (Fennema & Sherman, 1977) indicated that boys outperformed girls in math at junior and senior high school levels, there were also significant differences in attitudes toward math between the two groups. Through a survey, Armstrong (1979) found strong stereotypical parents, peers, and teachers' expectations that influenced girls' lack of positive attitude toward and participation in mathematics. Researchers have shown that gender differences in math achievement become apparent at the secondary level (O'Connor-Petruso, Schiering, Hayes and Serrano, 2004). Two studies conducted by the IEA at the eighth grade, i.e., TIMSS 1995 and TIMSS 1999, also showed that on average across all participant countries, boys performed better than girls (Mullis et al., 2000).

In spite of research evidence of boys' superiority in math achievement, some research findings do not support the difference between the two genders in math achievement. For instance, one of the international studies conducted by the IEA (TIMSS 2003) showed that on average across all studied countries, there was essentially no difference in math achievement between boys and girls at either eighth or fourth grade (Mullis, Martin, Gonzalez, & Chrostowski, 2004). Findings from a longitudinal study on gender differences in mathematics indicated that there was no difference among boys and girls

in mathematics achievement (Ding, Song, & Richardson, 2007). According to a recent IEA study (TIMSS 2007), there was no difference in average mathematics achievement between boys and girls at the fourth grade, and on average, girls had higher achievement than boys at the eighth grade (Martin, Mullis, & Foy, 2008).

In order to estimate the magnitude of the gender differences in mathematics achievement, attitudes, and affect across 69 nations throughout the world, Else-Quest, Hyde, and Linn (2010) conducted a Meta analysis based on two international data sources, i.e., TIMSS 2003 and PISA 2003. Their analysis showed that the mean effect sizes were small. According to their analysis of TIMSS 2003 data, the effect sizes in 27 countries showed the superiority of girls and in 18 countries the superiority of boys in mathematics achievement. In general, they came to the conclusion that even though the gender gap in mathematics achievement persisted in some nations, the overall mean effect sizes, consistent with the gender similarities hypothesis, were very small, ($d < 0.15$). The data analysis of 40 countries participated in PISA 2003 indicated that boys performed slightly better than girls overall. The effect sizes demonstrated that the majority (50%) of the effect sizes favored boys, 2.5% favored girls, and 45% were negligible ($d< 0.10$).

Research findings show that students' performance in mathematics is influenced by factors such as attitude towards mathematics (Hammouri, 2004), math self-concept (Bryen & Shavelson, 1987; Campbell, Connolly & Piezo, 1986), home environment (Fullarton, 2004), parental education (Alomar, 2006; Robitialle & Garden, 1989; Engheta, 2004), schools climate and culture (Fullan, 2001), home educational resources (Mullis, et al. 2000), socioeconomic status of the family (Marjoribanks, 2002), and home background (Fullarton, 2004).

The relation between math attitude and mathematics achievement has been extensively investigated. Schreiber (2000) found that students who performed better on a mathematics test tended to have positive attitude toward math. Alrwais (2000) referred to the students' attitude toward learning mathematics as the best predictor of mathematics achievement. A direct relation between math attitude and mathematics achievement was also reported by Papanastasiou based on TIMSS data (2002).

According to Bulach, Malone, and Castleman (1995), student achievement and school climate are significantly correlated. Freiberg (1998) points out that a positive school climate can promote higher morale and improve student achievement. Research conducted by Papanastasiou (2002) showed that school climate was influenced by the educational background of students.

Ismail and Awang (2008) conducted a study based on TIMSS 2003 data in which they compared the mathematics performance of students in Malaysia and Singapore. This study indicated that girls in both countries achieved significantly higher scores than boys. It also showed that achievement significantly increased with increasing parents' educational level, and the indexes of students' attitudes towards mathematics and self-concept in learning math. Roslyn and Anthony (2006), cited in Hsiao-Fang Lin and Ming-Ning Yu (2008), investigated the sources of gender variations in African American middle school students' academic performance and indicated that girls obtain

higher grades than boys in middle school, and boys' test scores are more likely to be affected by peers, educational attitudes, school structure, and school climate.

Significance of the Study

Findings from the three consecutive TIMSS studies (TIMSS 1999, 2003 & 2007) in Iran show that there are no significant differences between boys and girls in mathematics achievement at grade eight. The superiority of Iranian boys over girls in TIMSS 1999 changed to no significant differences between girls and boys in TIMSS 2003 and 2007. The important point is that the fluctuation in the average achievement for the girls in these studies is almost negligible (1999 across 2007 is -1 point), but for the boys it is quite high (-32 points). The patterns of Iranian students' mathematics achievement in the three consecutive IEA studies are especially striking when one considers the fact that girls' performance in mathematics is more or less consistent over the years, but boys have suffered a great loss in almost all measured mathematics content domains. Considering the highly centralized educational system and the Iranian culture that directly or indirectly favors boys, the obtained results especially boys' performance in mathematics have occupied the mind of many educators, policy makers as well as politicians.

Purpose of the Study

The present study aims to explore the trends that might exist in mathematics achievement and factors such as socio-economic status, school climate, mathematics self-concept, and attitudes towards math for both genders. In general, this study was designed: 1) to investigate the changes observed in Iranian boy and girl eighth graders' overall mathematics achievement as well as their achievement in different math content domains across TIMSS 1999, 2003 and 2007, and 2) to identify and explain the trends in the direct and indirect effects of the above-mentioned factors on the gender differences observed in mathematics achievement. Table 1 shows the sample size and average mathematic scores for Iranian students by gender in the three consecutive TIMSS studies.

Please take in Table 1 about here

Methodology

The data obtained from eighth grade Iranian students in TIMSS 1999, 2003 and 2007 were analyzed in this study. The data were related to the students who participated in the mathematics achievement test and completed the entire required items from the Student Questionnaire. The selected items were subjected to factor analysis. The Varimax Factor Analysis Method was used in order to categorize the items into factors due to the fact that there were various parameters that could determine the socio-economic status, school climate, mathematics self-concept, and attitude towards math. After checking the Bartlett's test of sphericity, based on the Scree test and Eigen values over

one, four identical factors were accepted for girls and boys in the three studies. It is worth mentioning that as a result of factor analysis, the number of items for TIMSS 1999, 2003 and 2007 decreased to 18, 17 and 16, respectively. On account of the fact that the Student Questionnaire items in the three studies (especially in 1999 compared to the other two studies) changed, the indicators used for the factors in the three consecutive studies were not the same.

The description of the items used for defining the four factors is as follows:

1. "Socio-economic status" factor including 3 items related to: "number of books at home, father and mother's level of education". Cronbach's alpha indices for girls in the three studies were 0.672, 0.624 and 0.714, and for boys 0.718, 0.633 and 0.714, respectively.

2. "School climate" factor including 6 items for 1999 study related to: "friend had something stolen, student had something stolen, student skipped a class, friend thought might get hurt, friend skipped a class, and student thought might get hurt", and 5 items for 2003 and 2007 studies related to: "made fun of or called name, hit or hurt by other students, made to do things by other students, something was stolen by others, and was left out of activities". Cronbach's alpha indices for girls were 0.672, 0.518 and 0.503, and for boys 0.720, 0.582 and 0.549, respectively.

3. "Mathematics self-concept" factor including 5 items for 1999 study related to: "math is more difficult for me, like math more if not so difficult, usually do well in math, never really understand it, and math is not one of my strength", and 4 items for 2003 and 2007 studies related to: "math is more difficult for me, learn things quickly in math, usually do well in math, and math is not one of my strength". Cronbach's alpha indices for girls were 0.726, 0.627 and 0.771, and for boys 0.706, 0.548 and 0.733, respectively.

4. "Attitude towards math" factor including 4 items for 1999 study related to: "need math to get a job, need math to enter desired school, like a job involving math, and math is more important in life", 5 items for 2003 study related to: "need math to get a job, need math to get into university, need math to learn other subjects, would like a job that involves math, and math will help in daily life", and 4 items for 2007 study including 4 out of the 5 items for 2003 except the item "would like a job that involves math". Cronbach's alpha indices for girls were 0.657, 0.736 and 0.645, and for boys 0.685, 0.72 and 0.653, respectively

It is noteworthy that these four factors accounted for 55.08 and 50.61 percent of the variances in girls and boys' model in 1999 study, respectively. The cumulative variances accounted by the four factors in girls and boys' model in 2003 study were 47.89 and 48.03, and in 2007 study 56.46 and 49.83, respectively. In addition, 5 mathematics plausible values were used as the indicator of the criterion variable. The key methodology used in this study was calculating the effect sizes as well as the Linear Structural Model.

Results of the Study

The magnitude of gender differences in mathematics achievement is defined as the differences between means of boys and girls divided by the pooled within-gender standard deviation. All the analyses were conducted using weighted data from TIMSS 1999, 2003 and 2007. The means as well as the effect sizes (d) for scores in the overall mathematics test, 5 different content domains, mathematics self-concept, school climate, and attitude towards math are presented in Tables 2 and 3, respectively. Table 2 demonstrates that boys are losing ground in every math category from 1999 to 2007. In Table 3, positive values showed that the means for boys were higher than those of girls. The negative values indicated that the means for girls were higher than those of boys. The effect sizes between -0.10 and +0.10 were considered to be indicative of no differences between genders. The Cohen criteria (Howell, 2002) for the effect sizes interpretation, i.e., d=0.20, small effect; d= 0.50, medium effect; and d = 0.80, large effects, were used for overall mathematics scores, the five mathematics content domains as well as the three factors.

Please take in Tables 2 & 3 about here

All the effect sizes in 1999 study were positive. Even though 2 out of the 6 comparisons (Algebra and Data) were negligible (0.05), four others especially the means for the overall mathematics scores were above 0.20. In 2003 study, 5 out of the 6 comparisons were negative; among these, the ds for Algebra, Geometry and the total test are worth mentioning. The change from d=0.29 for the total test in 1999 study to d=-0.13 in 2003 study not only showed the inverse trend in girls' and boys' math achievement scores (+9 points for girls and -24 points for boys), it was also an indication of low performance of boys in 2003 study compared to 1999 study. The 35-point drop in the mean achievement of the boys in Algebra domain, compared to the 2-point decrease in the girls' mean in this content domain from 1999 to 2003, was a clear indication of outperformance of boys, and almost stable performance of the girls. For Geometry, the change from d=0.23 to d=-0.18 can be interpreted as the reverse direction of the performance of both genders, i.e., higher mean for girls (+13 points) and lower mean for boys (-25 points) during four years. This was also the case for Measurement domain (+8 points for girls and -8 points for boys) even though the ds were positive in both studies. The average performances of both genders in the Data and Number content domains decreased from 1999 to 2003 studies; however, the amount of decrease for boys was much higher than that of girls.

Trends from 2003 to 2007 studies are not the same as the trends from 1999 to 2003 studies. The important reason for trends from 1999 to 2003 studies, as mentioned above, was the low performance of boys compared to the girls' performance. Nevertheless, in 2007 study, means for the overall math test, as well as Geometry and Number content domains for both genders were lower than their counterpart means in 2003 study. In other words, trends for both genders in the overall math test as well as the above-mentioned content domains were negative. Almost all changes in the magnitude of the d's from 2003 to 2007 studies were negligible. Both genders gained 10 points in the Data domain from 2003 to 2007 studies. The only change that might be considered as the lower performance of girls and higher performance of boys in 2007

compared to 2003 study was the change in the means for the Algebra content domain. In this content domain, girls lost 12 points and boys gained 1 point.

The effect sizes in 2007 study clearly indicated that in general girls performed better than boys in the overall math test as well as other content domains except the Number domain. Regardless of these results, both genders' performances in 2007 were lower than 1999 study. The significant fact here is the differences in the magnitude of negative directions of the performances of both genders.

Trends in the mathematics self-concept in 1999 and 2003 studies demonstrated that boys tended to hold more positive mathematics self-concept, though the gap is small (d=0.03 and 0.06). In 2007, the gap changed and girls inclined to hold positive mathematics self-concept, though this amount of gap was also small (-0.06). Girls tended to have better feelings about their school climate during the three studies. The effect size for 1999 study was quite high (d=-0.62); however, this gap shrank to -0.39 and -0.22 in 2003 and 2007 studies, respectively. Attitudes towards math were the same for both genders in 1999 and 2007 studies, but the attitude of the girls toward math was more positive than that of boys in 2003 study (d= -0.15).

In general, the only important trend in the effect sizes can be observed in the school climate variable, with girls tending to report more positive school climate, a gap that shrank little by little.

One of the aims of the present study was to develop a conceptual model for predicting math achievement by examining different factors that have had an impact on the Iranian girl and boy eighth graders' mathematics achievement during three consecutive TIMSS studies. Figure 1 demonstrates the proposed model for this study.

Please take in Figure 1 about here

Six different models were tested for girls and boys from the three studies and the model fit was acceptable for all the models. Indices for goodness of fit for the six models are given in Table 4. All the indices supported the proposed model fit for both genders in the three studies.

Please take in Table 4 about here

Trends in influential factors for both genders in the three studies indicated that mathematics self-concept was the most influential factor in mathematics achievement (Tables 5 and 6). The direct impacts of this factor in the three studies for girls were 0.61, 0.69 and 0.53 and for boys 0.53, 0.67 and 0.50, respectively. All the indirect impacts of this factor through attitude towards math on mathematics achievement were negative for both genders in the three studies. The indirect effects of mathematics self-concept on math achievement for both genders in 2007 study were higher than the other two studies. A comparison of the total effects of β's for mathematics self-concept on math achievement showed that the effects of this factor for girls in each study were slightly higher than boys.

After mathematics self-concept, SES was the most influential factor in mathematics achievement. The direct and indirect impacts of SES on mathematics achievement for both genders in 2007 were higher than 1999 and 2003 studies. The total effects of SES on mathematics achievement for both genders in each of the three studies were almost the same. School climate was also a better predictor of girls' and boys' mathematics achievement in 2007 compared to 1999 and 2003 studies. The direct effects of this factor on math achievement in 1999 and 2003 studies were not significant. The direct impact of attitude towards math on mathematics achievement was negative for both genders in the three studies. The negative effects of this factor on math achievement for both genders from 2003 to 2007 studies changed from -0.29 to -0.07.

Please take in Tables 5 and 6 about here

The four investigated factors, explained 0.43, 0.45 and 0.47 percent of the girls' mathematics scores in 1999, 2003 and 2007 studies, respectively. These factors also explained 0.35, 0.36 and 0.42 percent of the boys' mathematics scores in TIMSS 1999, 2003 and 2007, respectively (See Table 7).

Please take in Table 7 about here

Conclusion

The data analysis of overall mathematics test scores, mathematics content domains as well as the three factors under study indicated that the magnitude of 13 out of 25 investigated effect sizes was between +0.10 and –0.10. Among these, 8 of the effect sizes favored girls and 5 other favored boys. Boys performed better than girls in overall math test, Geometry, Measurement and Number domains in 1999 study as well Measurement domain in 2003 study. Girls performed better than boys in overall math test and Geometry domain in 2003 and 2007 studies. They also considered the school climate much safer than boys in the three studies and had less negative attitude towards math than boys in 2003 study.

Like many other research studies (Bryen & Shavelson, 1987; Campbell, Connolly & Piezo, 1986; Roslyn & Anthony, 2006, cited in Hsiao-Fang Lin & Ming-Ning Yu 2008; and Ismail & Awang 2008), the present study indicated that math self-concept is a strong predictor of math achievement for both genders. Similar to other research (Alomar, 2006; Fullarton, 2004; Engheta, 2004; Marjoribanks, 2002; and Mullis, et al. 2000), findings from this study showed that SES is one of the influential factors which has significant direct and indirect effects on math achievement of both genders.

Trends analysis showed that attitude towards math had direct and negative effects on math achievement in 1999 and 2003 studies for both genders. The negative direct effects of attitude towards math in 2007 for both genders were not significant. The negative effects of attitude towards math is consistent with previous national studies in Iran (Kiamanesh, 2004; Kiamanesh & Mahdavi-Hezaveh, 2008) and inconsistent with international studies (such as Hammouri, 2004; Papanastasius, 2002; Schreiber, 2000; and Alrwais, 2000) which show a positive relationship between math achievement and attitude towards math.

The results of trends analysis for the impact of school climate on math achievement in 2007 study are consistent with the findings from other research studies such as Bulach, Malone, and Castleman (1995), Freiberg (1998), and Papanastasiou (2002). But the effects of school climate on math achievement for both genders in 1999 and 2003 studies are not consistent with 2007 results and the research findings from the literature.

Findings of this study showed that the means of mathematics self-concept, attitude towards mathematics, and school climate, as well as the variances accounted for mathematics achievement by the four factors are almost the same in the three studies for both genders. In general, findings from trends analysis of students' math performances in the three consecutive TIMSS studies from 1999 to 2007: 1) do not support the idea that girls outperformed boys, 2) do not provide a clear trend in factors affecting mathematics achievement, and 3) do not clearly explain the reasons for the decline in the average performance of the boys in the three international studies.

What can be concluded from this study is that the achievement gap in math scores at the eighth grade has been shrinking over time and a pattern of declining scores in mathematics from 1999 to 2007 is more tangible among boys than girls. These findings are against Fryer and Levitt (2009) finding. In fact, Iranian girls are actually outperforming boys in math; however, this is due to the unusual shrinkage of boys' math achievement and not the better and stronger performance of girls.

As a result, it can be argued that the better performances of girls compared to boys in the three studies are not related to the improvement of girls situation in the educational system or even in the society. Hence, regardless of the narrowing gap between mathematics achievement of girls and boys in Iran, these findings are somehow consistent with the gender stratification hypothesis, Eccles's expectancy-value theoretical model (1994), and the gender similarities hypothesis (Hyde, 2005).

Further studies are needed to be carried out on male and female teachers' qualifications, pedagogical knowledge, and attitudes toward teaching, as well as the pedagogical knowledge of school principals and their administrative strategies for defining the differences between girls and boys' mathematics learning and achievement in Iran.

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Table 1
Average Scores for Iranian Eighth-Graders on Mathematics Test Items in TIMSS 2007, 2003, 1999

Study	Both Genders		Girls		Boys	
	N	Mean	N	Mean	N	Mean
TIMSS 2007	3881	403	1786	407	2195	400
TIMSS 2003	4942	411	2059	417	2883	408
TIMSS 1999	5301	422	2096	408	3205	432

Table 2
Mean for Overall Achievement Test, 5 Content Areas and Three Variables by Gender and Study

Study	Gender	Overall Math	Algebra	Geometry	Measure-ment	Data (a)	Number (b)	MSC (c)	SC (d)	ATM (e)
1999	Girl	408	431	433	385	421	425	2.56	3.61	3.27
	Boy	432	435	457	411	435	445	2.58	3.3	3.27
2003	Girl	417	429	446	393	407	420	2.74	1.87	3.08
	Boy	408	400	432	403	403	414	2.78	1.78	3.18
2007	Girl	407	417	429	-	417	392	2.89	1.86	3.38
	Boy	400	401	418	-	413	397	2.85	1.78	3.39

Note. (a): for 1999 and 2003 is Data Representation, Analysis, and Probability; (b): for 1999 and 2003 is Fraction and Number Sense; for 2007 is Data and Chance (c): MSC: Math Self-Concept; (d): SC: School Climate; (e): ATM: Attitude towards math.

Table 3
Sample Sizes and Effect Sizes (d) for Gender Differences in Math Achievement, Math Self-Concept, School Climate and Attitude towards Math in Different Studies [a]

Study	N Girls	N Boys	Math	Algebra	Geometry	Measure-ment	Data (b)	Number (C)	MSC (d)	SC (e)	ATM (f)
1999	2096	3205	0.29	0.05	0.23	o.26	0.05	0.24	0.03	-0.62	0.00
2003	1977	2965	-0.13	-0.38	-0.18	0.12	-0.05	-0.09	0.06	-0.39	-0.15
2007	1786	2195	-0.08	-.195	-0.12	-	-0.05	0.06	-0.06	-0.22	0.02

Note. (a) Positive values of d represent higher scores for boys than girls, whereas negative values represent higher scores for girls; (b): for 1999 and 2003 is Data Representation, Analysis, and Probability; (c): for 1999 and 2003 is Fraction and Number Sense; for 2007 is Data and Chance (d): MSC: Math Self-Concept; (e): SC: School Climate; (f): ATM: Attitude towards math.

Fig. 1. The Proposed Model for the Girls and Boys in Three Studies

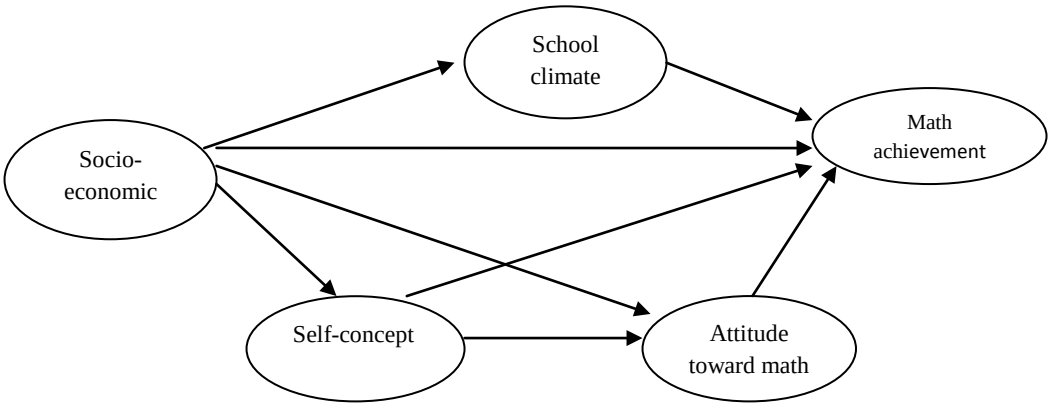

Table 4
Indices for Goodness of Fit for Both Genders in the Three Studies

Study	1999		2003		2007	
gender	Girls	Boys	Girls	Boys	Girls	Boys
χ^2	468.11	743.44	541.37	781.62	275.11	354.07
df	222	222	201	201	181	181
RMSEA	0.071	0.062	0.030	0.034	0.019	0.024
GFI	0.89	0.92	0.91	0.92	0.93	0.93
AGFI	0.86	0.90	0.89	0.90	0.91	0.91

Table5
Tested Path in SEM for Girls' Model

Path	Direct Effect			Indirect Effect			Total Effect		
	99	2003	2007	99	2003	2007	99	2003	2007
SES									
School climate	0.00	0.04	0.08	-	-	-	0.00	0.04	0.08
Self-concept	0.15*	0.12**	0.28**	-	-	-	0.15*	0.12**	0.28**
Attitude	-0.11**	-0.04	-0.04	-0.06*	0.06**	0.12	-0.05	0.02	0.08
Achievement	0.24**	0.20**	0.31**	0.10**	0.08**	0.15**	0. 34**	0.28**	0.46**
School climate									
Achievement	0.05	0.06**	0.15	-	-	-	0.05	0.06**	0.15
Self-concept									
Attitude	0.39**	0.46**	0.44**	-	-	-	0.39**	0.46**	0.44**
Achievement	0.61**	0.69**	0.53**	-0.08**	-0.13**	-0.03	0.53**	0.56**	0.50**
Attitude towards math									
Achievement	-0.21**	-0.29**	-0.07	-	-	-	-0.21**	-0.29**	-0.07

*p<0.05 ** p<0.01

Table 6
Tested Path in SEM for Boys' Model

Path	Direct Effect			Indirect Effect			Total Effect		
	99	2003	2007	99	2003	2007	99	2003	2007
SES									
School climate	-0.12**	0.00	0.03	-	-	-	-0.12**	0.00	0.03
Self-concept	0.27**	0.12	0.21**	-	-	-	0.27**	0.12	0.21**
Attitude	0.01	-0.06*	-0.05	0.12**	0.08	0.10	0.13**	0.02	0.05
Achievement	0.21**	0.19**	0.33**	0.14**	0.08**	0.11**	0. 35**	0.27**	0.44**
School climate									
Achievement	-0.02	0.01	0.11*	-	-	-	-0.02	0.01	0.11*
Self-concept									
Attitude	0.42**	0.62**	0.49**	-	-	-	0.42**	0.62**	0.49**
Achievement	0.53**	0.67**	0.50**	-0.03**	-0.18**	-0.04	0.50**	0.49**	0.46**
Attitude towards math									
Achievement	-0.08**	-0.29**	-0.07	-	-	-	-0.08**	-0.29**	-0.07

*p<0.05 ** p<0.01

Table7
R^2 for the Six Model

Predictor factors	Predicted variables	R^2					
		1999		2003		2007	
		Girl	Boy	Girl	Boy	Girl	Boy
SES , Attitude towards math, Self-concept & School climate	Math achievement	0.43	0.35	0.45	0.36	0.47	0.42
SES & Self-concept	Attitude towards math	0.15	0.18	0.21	0.38	0.18	0.23
SES	Self-concept	0.02	0.07	0.01	0.02	0.08	0.05
SES	School climate	0.00	0.01	0.00	0.00	0.01	0.00