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Singapore's Higher Social Gender Equality and Girls' Higher Mathematics Achievement in TIMSS 2011

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I. Introduction

Guiso, Monte, Sapienza and Zingales (2008) observed that countries of higher gender equality typically have higher gender equality in mathematics achievement. Among Asian countries, Singapore represents a country of higher gender equality. In 2016, Singapore′s gender parity level, represented by the Global Gender Gap Index (GGGI), was 55th in the world which is higher than many other Asian countries. In comparison to Singapore, Indonesia was rated at 88th, China at 99th; Malaysia at 106th; Japan at 111st, and Korea was rated at 116th in the world in 2016 (World Economic Forum, 2017).

Singaporean eighth grade girls have been performing at or higher in mathematics achievement than Singaporean eighth grade boys in international assessments such as TIMSS. The differences between Singaporean eighth grade boys′ and girls′ mathematics achievement scores were statistically significant from 2003 to 2011. Figure 1 represents the Singaporean eighth grade boys′ and girls′ average mathematics achievement scores from the first year that Singapore participated in 1995 to the assessment in 2011 (Mullis, Martin, Gonzalez, Gregory & Garden, 2000; Mullis, Martin, Gonzalez & Chrostowski, 2004; Mullis, Martin & Foy, 2008; Mullis, Martin, Foy & Arora, 2012; TIMSS International Study Center, 1996).

Halpern, Benbow, Geary, Gur, Hyde and Gernsbacher(2007) indicated that "although there are no simple answers to the complex questions about gender differences in mathematics, a wide range of sociocultural forces contribute to gender differences in mathematics achievement – including the effects of family, neighborhood, peer, and school influences, etc." Mullis et al. (2012) stated a positive relationship between parent′s expectation and involvement in education to student′s achievement levels. Park (2006) indicated that teacher efficacy has effect on student's attitudes towards mathematics and student's attitudes have positive effect on mathematics achievement. School climate and culture are also important factors for student's achievement (Blum & Libbey, 2004).

Although there are numerous studies focusing on countries with gender gap in mathematics achievement, there are limited studies on countries of higher gender equality and countries where girls perform higher in mathematics achievement than boys. This study focuses on Singapore, a country of higher gender equality and a country where girls perform higher in mathematics achievement than boys, and examines (1) if sociocultural factors that are known to influence gender gap in mathematics achievement are gender equitable in Singapore, (2) if there is a higher level of gender equitability in students′ attitudes towards mathematics and (3) how sociocultural factors influence mathematics achievement for Singaporean

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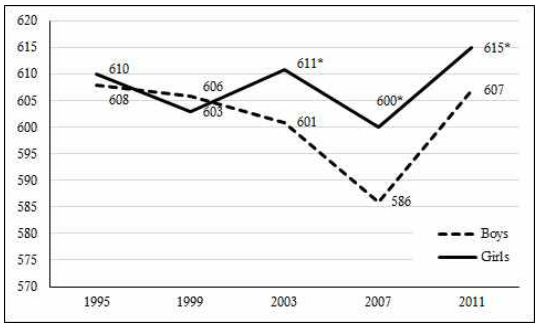
eighth grade students using TIMSS 2011 mathematics achievement data. The study findings can provide additional insight into the role of sociocultural factors in influencing mathematics achievement even in a higher gender equitable environment.



[Fig. 1] Singapore Boys' and Girls' Mathematics Achievement Scores from 1995 to 2011
Note: * Significant differences (Mullis et al., 2012)

II. Literature Review

1. Parent, Teacher and School Factors

Bleeker and Jacobs(2004) and Mullis et al.(2012) observed a positive relationship between parent's expectation and involvement in education to student's achievement levels. O'Connoer-Petruso and Miranda(2004) found that "Parental nurturing and pedagogical factors were key influences to high mathematics achievement. Similarly, parental expectations for their progeny's future careers mirrored gender typing. Male students were encouraged to pursue technical careers in the hard sciences while female students were directed towards fields in literature." The differences in parental expectation between boys and girls are also known to influence children's attitudes towards mathematics and the choice of profession (Geist & King, 2008). Between boys and girls, Whang(2006), based on the study of Korean eighth grade students, identified that parents have more significant influence on girls' mathematics achievement levels.

Related to teacher influence, House(2004) indicated that students who know that their teachers care about them and have clear and reasonable expectation can achieve better scores. Park(2006) indicated that teacher efficacy has effect on students' attitudes towards mathematics and students' attitudes have positive effect on mathematics achievement. Of the gender difference, Shin(2012), based on the PISA 2003 results for Korean students, found that boys showed higher appreciation of teacher's attitude and showed higher positive attitude towards mathematics than girls.

School climate and culture are also important factors for students' achievement (Blum & Libbey, 2004). Chung(2002), based on a study involving Korean fourth grade and eighth grade students, identified that peer relationship has an influence on students' achievement levels. Yoo(2014) found that Korean secondary school girls showed a significantly higher level of school affinity than boys. However, the result is different for high school students where Kye, Lee, Kim, Park, and Yoo(2001) observed that Korean high school boys had higher school affinity than the girls.

2. Students' Attitudes towards Mathematics

Mullis et al.(2012) discussed a strong positive relationship between students' attitudes toward mathematics (like learning mathematics; value learning mathematics; confident with mathematics) and mathematics achievement. Mullis et al.(2012) stated that "on average internationally, and in almost all TIMSS 2011 countries, students who liked learning mathematics had higher average mathematics achievement than those who only somewhat liked learning mathematics. In particular, those students who reported not liking learning mathematics had the lowest average mathematics achievement." Else-Quest, Hyde and Linn(2010) observed positive correlation between students' attitudes towards mathematics and

mathematics achievement. Shin(2012) observed that "boys are more positive about mathematics than girls from the perspective of individual psychological characteristics."

Else-Quest et al.(2010) observed that "gender difference in mathematics achievement were significantly correlated with gender difference in self-confidence in mathematics ($r = .54$, $p < .01$) and students' valuing mathematics ($r = .30$, $p < .05$)." If girls do not perceive value in mathematics education they will put less effort, and as a consequence their performances will be expected to be low (Bleeker & Jacobs, 2004). O'Connoer-Petruso and Miranda(2004) identified that "the strongest predictor for achievement for both males and female was mathematics self-concept."

3. Gender Gap Index and Mathematics Achievement

Guiso et al.(2008), using 2003 PISA data testing of fifteen year olds from forty countries, found that gender inequality as measured by the Global Gender Gap Index significantly correlated with the magnitude of the mean mathematics gender gap. Guiso et al.(2008) concluded that the nations with greater gender equality typically have a smaller mathematics gender gap. Halpern et al.(2007) indicated that "the magnitude of the gender difference correlates negatively with measures of gender equality in the country." The implication is that higher the gender equality of a country the lower the gender gap in mathematics is. These findings are consistent with gender stratification hypothesis of Baker and Jones(1993) which proposes that, where there is more societal stratification based on gender, and thus more inequality of opportunity, girls will report less positive attitudes and will perform less well on mathematics achievement tests than will their male peers.

Ⅲ. Methods

1. Data Source & Instrumentation

The TIMSS 2011 student questionnaire and achievement data were obtained from the TIMSS 2011 International Database(2013). The total numbers of Singaporean students participated in TIMSS 2011 were 5,923 (Table 1). The student questionnaire was structured in 4-point Likert scale: (1) agree a lot; (2) agree a little; (3) disagree a little; and (4) disagree a lot. For this study the scale was transposed so that a higher number represents stronger agreement and a higher frequency. The transposed scale was: (1) disagree a lot; (2) disagree a little; (3) agree a little; and (4) agree a lot. For the questions involving frequency, the transposed scale was: (1) never or almost never; (2) once or twice a month; (3) once or twice a week; and (4) every day or almost every day. The TIMSS achievement results were reported on a scale from 0 to 1,000.

[Table 1] Sample Size for the Study

Gender	No. of Students	%
Boys	2,991	50.5%
Girls	2,932	49.5%
Total	5,923	100%

2. Data Analysis Procedure

From the TIMSS 2011 student questionnaire, thirty two questions dealing with parents, teachers, school environment and students' attitudes towards mathematics were identified (Appendix 1). The questionnaire items ask students with questions such as "how often parents ask about what you learned in school," "interested in what teacher says," "like being in school," "like mathematics". etc.

The study conducted an exploratory factor analysis to identify underlying factors among student responses to these thirty two questionnaire items. The factors of Eigenvalues greater than one were selected as significant factors. Cronbach's alpha reliability coefficients were computed to determine internal

consistency of these factors. t-Test was conducted to identify significant statistical difference. A path analysis was conducted to compute the path coefficients to assess the degree of influence on mathematics achievement levels. The Variance Inflation Factors (VIF) were used to assess the multicollinearity and Comparative Fit Index (CFI) was computed to estimate the fit of the model. The models were reduced to achieve the CFI higher than 0.9 which is considered a reasonably good fit (Hong, 2000, Kim, 2008). The analysis were conducted with SPSS V.21 and SPSS-AMOS V.22.

Ⅳ. Results and Discussion

1. Gender Differences in Achievement Levels

The Singaporean students' average mathematics achievement score was 611. The girls had the higher average score of 615 than the boys' average score of 607 (Table 2). The differences between boys and girls were statistically significant ($p < .01$).

[Table 2] Mathematics Achievement and t-Test results

Category	Average Score	Std. Deviation	t	Sig.
Boys	607	2.9	4.92	0.001**
Girls	615	2.3		
Total	611	2.4		

Note: ** $p < .01$. t-Test for significant difference in boys' and girls' average scores.

2. Gender Differences in Sociocultural Factors and Students' Attitudes towards Mathematics

Based on exploratory factor analysis with Varimax Rotation with Kaiser normalization, the six factors with Eigenvalues of greater than one, which is the accepted criteria for a significant factor, were selected. Tables 3 and 4 provide factor structures for the rotated principal component solution matrix with

[Table 3] Exploratory Factor Analysis for Boys

TIMSS Student Questionnaire Items	1	2	3	4	5	6
Usually do well mathematics	**0.593**	0.282	0.117	0.085	0.035	0.021
Learn quickly in mathematics	**0.599**	0.280	0.154	0.107	0.043	0.069
Good at working out problems	**0.660**	0.261	0.115	0.054	0.047	0.064
Teacher thinks I can do well in mathematics	**0.705**	0.097	0.138	0.308	0.054	0.047
Teacher tells me I am good at mathematics	**0.703**	0.144	0.067	0.295	0.069	0.028
Wish I have not to study mathematics	0.098	**0.663**	0.146	0.086	0.016	0.057
Mathematics is boring	0.082	**0.713**	0.133	0.147	0.009	0.063
Need mathematics to get into university	0.088	-0.044	**0.820**	0.064	0.048	0.073
Need mathematics to get the job I want	0.089	0.040	**0.807**	0.066	0.024	0.028
Teacher is easy to understand	0.132	0.077	0.118	**0.821**	0.037	0.103
Interested in what teacher says	0.117	0.267	0.146	**0.788**	0.080	0.147
How often parents ask what you learned at school	0.060	0.040	0.047	0.026	**0.779**	0.088
How often talking about school work with parents	0.030	0.085	0.092	0.071	**0.748**	0.104
How often parents set aside time for homework	-0.021	-0.017	0.110	0.062	**0.770**	0.080
How often parents check if you do your homework	0.058	0.008	0.014	0.066	**0.739**	0.029
Like being in school	0.037	0.193	0.080	0.130	0.092	**0.806**
Feel safe at school	0.050	-0.009	0.066	0.174	0.125	**0.813**
Feel like belong at school	0.043	0.053	0.092	0.130	0.106	**0.843**

Note: numbers represent factor loadings.

factors loadings. The six factors accounted for 57.8% and 63.1% of the variances for boys and girls, respectively. The six factors are (1) confident with mathematics; (2) like learning mathematics; (3) value learning mathematics; (4) teacher efficacy; (5) parental involvement in education; and (6) school affinity.

Cronbach's alpha reliability coefficient was computed for internal consistency of questionnaire items for each factor. The Cronbach's alpha reliability coefficients for the six factors ranged from 0.862 to 0.941 (Table 5). The values are higher than the acceptable value for internal consistency which is greater than 0.8 (George & Mallery, 2003). As such the six factors identified from the exploratory factor analysis are acceptable for the study.

1) Parent, Teacher and School Factors

The factor of 'parental involvement in education' incorporates the students responses to such questions as how often parents ask about learning in school, how often parents making sure time is set aside for homework, how often parents check for homework, and how often students talk to parents about school. The scale for the parental involvement was: (1) never or almost never; (2) once or twice a month; (3) once or twice a week; and (4) every day or almost every day.

The Singaporean boys' mean response for 'parental involvement in education' was 2.59 and the girls' mean response of 2.58 (Table 6). There were no significant differences between boys and girls. The Singaporean parents exhibit gender equitability in their involvement in boys' and girls' education.

The factor of 'teacher efficacy' incorporates student responses to questionnaire items of teacher is easy to understand and interested in what teacher says. The boy's mean response to 'teacher efficacy' was 3.02 and the girls' mean response was 3.01 (Table 7).

[Table 4] Exploratory Factor Analysis for Girls

TIMSS Student Questionnaire Items	1	2	3	4	5	6
Usually do well mathematics	**0.809**	0.153	0.189	0.124	0.028	0.049
Learn quickly in mathematics	**0.753**	0.147	0.153	0.165	0.023	0.064
Good at working out problems	**0.755**	0.163	0.070	0.125	0.026	0.076
Teacher thinks I can do well in mathematics	**0.695**	0.189	-0.139	0.329	0.083	0.097
Teacher tells me I am good at mathematics	**0.703**	0.173	-0.068	0.335	0.103	0.041
Wish I have not to study mathematics	0.075	**0.787**	-0.082	0.051	0.086	0.056
Mathematics is boring	0.062	**0.800**	0.019	0.053	0.060	-0.018
Need mathematics to get into university	0.460	0.196	**0.642**	0.111	0.034	0.017
Need mathematics to get the job I want	0.401	0.172	**0.654**	0.175	0.020	0.059
Teacher is easy to understand	0.165	0.064	0.129	**0.818**	0.024	0.085
Interested in what teacher says	0.118	0.184	0.280	**0.789**	0.078	0.117
How often parents ask what you learned at school	0.064	0.076	0.005	0.035	**0.804**	0.085
How often talking about school work with parents	0.084	0.124	0.050	0.057	**0.759**	0.111
How often parents set aside time for homework	0.027	0.054	0.049	0.078	**0.783**	0.054
How often parents check if you do your homework	0.002	-0.006	0.056	0.054	**0.742**	0.029
Like being in school	0.048	0.080	0.158	0.113	0.092	**0.818**
Feel safe at school	0.071	0.056	0.013	0.116	0.109	**0.829**
Feel like belong at school	0.062	0.077	0.060	0.108	0.085	**0.854**

Note: numbers represent factor loadings.

There were no statistically significant differences between boys and girls (Table 6). The Singaporean teachers exhibit high levels of gender equitable influence on students.

The factor of 'school affinity' incorporates student responses to questionnaire items of like being in school, feeling safe at school, and feel like belong at school.

The boys' mean response to 'school affinity' was 3.12 and the girls' mean response was 3.24 (Table 6). The differences between boys and girls were statistically significant. The girls showed higher affinity to school than boys. The finding of girls having higher affinity to school and girls performing high achievement levels is consistent with the study of Blum and Libbey(2004) that student's affinity levels to school's climate are important factors for students' achievement levels.

2) Students' Attitudes towards Mathematics

The students' attitudes towards mathematics include 'like learning mathematics,' 'value learning mathematics,' and 'confident with mathematics.' For the attitude of 'like learning mathematics,' there were no statistically significant differences between boys and girls. The boys' mean response to 'like learning mathematics' was 2.86 and the girls' response was 2.85 (Table 7). The finding indicates that the eighth grade boys and girls have statistically equivalent liking of mathematics.

For the attitude of 'value learning mathematics' there were no statistically significant differences between boys and girls. The boys' mean response to 'value learning mathematics' was 3.41 and the girls'

[Table 5] Cronbach's Alpha Reliability Coefficients for Six Factors

Gender	Parental Involvement in Education	Teacher Efficacy	School Affinity	Like Learning Mathematics	Value Learning Mathematics	Confident with Mathematics
Boys	0.862	0.932	0.904	0.941	0.927	0.908
Girls	0.872	0.935	0.910	0.932	0.924	0.919

[Table 6] Boys' and Girls' Mean Responses for Parents, Teachers and School Related Questions

Factors	Boys		Girls			t	Sig.
	Mean	SD	Mean	SD	Difference		
Parental Involvement in Education	2.59	0.84	2.58	0.85	0.02	-1.05	0.298
Teacher Efficacy	3.02	0.79	3.01	0.77	0.01	-0.73	0.467
School Affinity	3.12	0.70	3.24	0.63	-0.12	6.87	0.001**

Note: ** $p < .01$

[Table 7] Boys' and Girls' Mean Responses to Students' Attitudes towards Mathematics

Factors	Boys		Girls			t	Sig.
	Mean	SD	Mean	SD	Difference		
Like Learning Mathematics	2.86	0.96	2.85	0.91	0.01	-0.60	0.551
Value Learning Mathematics	3.41	0.67	3.38	0.66	0.03	-1.71	0.088
Confident with Mathematics	2.74	0.72	2.56	0.72	0.18	-9.86	0.001**

Note: ** $p < .01$

response was 3.38. The result supports that a society with higher gender parity has less societal stratification based on gender and there is no gender difference in appreciation of the subject. For the attitude of 'confident with mathematics' there were statistically significant differences between boys and girls. The boys' mean response was higher than girls' mean response (2.74 and 2.56 for boys and girls, respectively in Table 7). The finding reflects study findings of Else-Quest et al.(2010), Lee(2013), Leung, Graf and Lopez-Real(2006) and Shin(2012) that boys tend to exhibit higher levels of confidence in mathematics than girls.

3. Path Analysis Model

To determine the effect size of factors on mathematics achievement a path analysis was conducted. For the assessment of multicollinearity, the variance inflation factors (VIF) were computed. The VIFs for individual factors were all between 1.0 and 1.6 within the acceptable level.

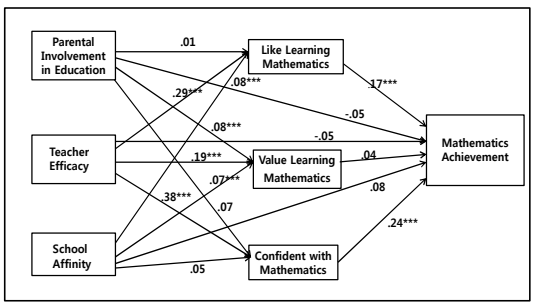
The initial path analysis model for boys and girls are provided in figures 2 and 3, respectively. The CFI for the initial models were 0.53 and 0.58 for the boys and girls, respectively. These CFI values are relatively low as CFI higher than 0.9 is considered a good fit (Hong, 2000, Kim, 2008). Given the relatively low CFI of the models, the reduced models with higher CFI were obtained through elimination of paths with low effects on mathematics achievement (figures 4 and 5). The reduced models achieved CFI values of 0.90 and 0.93 for boys and girls, respectively. The path coefficients for reduced models are provided in Tables 8 and 9.

1) Parent, Teacher and School Factors

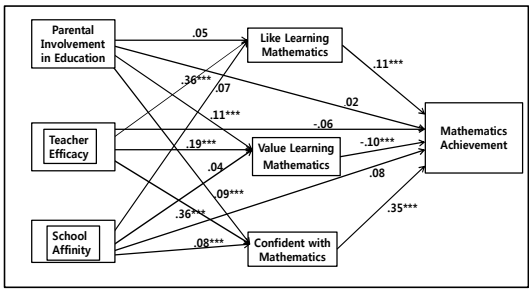
Parental involvement in education - The reduced models (figures 4 and 5) show that 'parental involvement in education' has significant indirect effect on mathematics achievement through influencing student's attitude of 'confident with mathematics.' The 'parental involvement in education' has stronger effect on girls than boys for the attitude of 'confident with mathematics' (path coefficients of 0.06 and 0.10 for boys and girls, respectively). The study finding is consistent with the finding of Whang(2006) that parents have a higher level of influence on girls than boys. Given the finding that girls' attitude towards mathematics is more influenced by parents, one can strive to improve girls' mathematics achievement by having more active involvement of parents in girls' mathematics education.

Teacher Efficacy - The reduced path analysis models (figures 4 and 5) show that 'teacher efficacy' has significant indirect effect on mathematics achievement through 'confident with mathematics' (path coefficients of 0.39 and 0.38 for boys and girls, respectively in figures 4 and 5). The effect size of 'teacher efficacy' on mathematics achievement is highly equivalent for boys and girls.

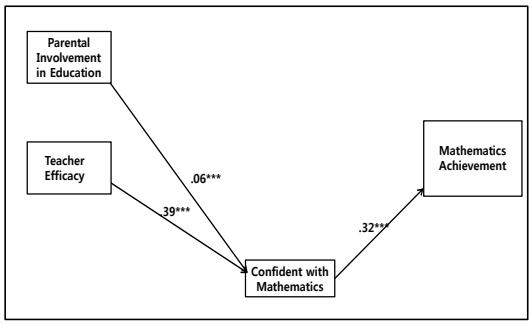
School Affinity - The initial path analysis models (figures 2 and 3) reveal that 'school affinity' although positive, has relatively weak effect on mathematics achievement (path coefficients < 0.1 for boys and girls). In the process to achieve an acceptable CFI for the reduced model, the factor of 'school affinity' was eliminated.



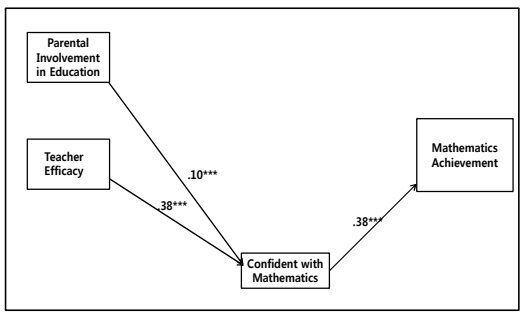
[Fig. 2] Initial Path Analysis Model: Boys
Note: numbers represent path coefficients. ***: p < .001



[Fig. 3] Initial Path Analysis Model: Girls
Note: numbers represent path coefficients. ***: p < .001



[Fig. 4] Reduced Path Analysis Model - Boys
Note: numbers represent path coefficients. ***: p < .001



[Fig. 5] Reduced Path Analysis Model - Girls
Note: numbers represent path coefficients. ***: p < .001

2) Students' Attitudes towards Mathematics

Like Learning Mathematics - The initial path analysis models (figures 2 and 3) reveal that the attitude of 'like learning mathematics' although has positive effect on mathematics achievements (path coefficients of 0.17 and 0.11 for boys and girls, respectively), it did not have as strong effect as other factors. It was eliminated during the process to achieve an acceptable CFI for the reduced models.

Value Learning Mathematics - The initial path analysis models show that the attitude of 'value learning mathematics' has no effect or even weak negative effect on mathematics achievement (path coefficients of 0.04 and -0.10 for boys and girls, respectively). It was also eliminated to achieve an acceptable CFI for the reduced models. According to Mullis et al.(2012), Singaporean students, although performing at high levels in mathematics, showed relatively low appreciation for mathematics. The Singaporean eighth grade students were rated 31st out of 42 countries in their appreciation of mathematics in the TIMSS 2011 assessment. The low appreciation for mathematics is consistent with the study finding that the 'value of learning mathematics' had no significant effect on Singaporean eighth grade students' mathematics achievement levels.

Confident with Mathematics - The reduced models show that 'confident with mathematics' had significant effect on mathematics achievement with path coefficients of 0.32 for boys and 0.38 for girls in figures 4 and 5. The finding supports O'Connoer-Petruso and Miranda(2004) that the most significant effect on mathematics achievement levels among Asian students is self-confidence. The reduced models (figures 4 and 5) reveal that having high levels of confidence in mathematics can have stronger effect on girls' mathematics achievement than boys in Singapore.

3) Total Effect on Mathematics Achievement

The total effect on mathematics achievement from each factor in the reduced model is provided in Table 10. The order of effect size on mathematics achievement is (1) 'confident with mathematics,' (2) 'teacher efficacy,' and (3) 'parental involvement in education.'

[Table 8] Path Coefficients for Boys in Reduced Model

Path			Standardized Estimate	S.E.	C.R.	P
Parental Involvement in Education	-->	Confident with Mathematics	0.063	0.014	3.76	***
Teacher Efficacy	-->	Confident with Mathematics	0.394	0.015	23.52	***
Confident with Mathematics	-->	Mathematics Achievement	0.323	2.116	18.68	***

Note: S.E: Standard Error, C.R.: Critical Ratio. ***: $p < 0.001$

[Table 9] Path Coefficients for Girls in Reduced Model

Path			Standardized Estimate	S.E.	C.R.	P
Parental Involvement in Education	-->	Confident with Mathematics	0.100	0.014	5.88	***
Teacher Efficacy	-->	Confident with Mathematics	0.380	0.016	22.39	***
Confident with Mathematics	-->	Mathematics Achievement	0.384	0.384	22.53	***

Note: Note: S.E: Standard Error, C.R.: Critical Ratio.***: $p < 0.001$

The student's attitude of 'confident with mathematics' had the most significant effect on mathematics achievement. The order of effect is same for boys and girls, although the effect is higher for girls than boys. For example, the attitude of 'confident with mathematics' had the effect size of 0.384 for girls which is higher than 0.323 for boys. The 'teacher efficacy' had the effect size of 0.146 for girls and 0.128 for boys. The parents also had stronger effect on girls' mathematics achievement with the effect size of 0.038 than the boys with the effect size of 0.020. Between boys and girls, sociocultural factors have greater influence on girls' mathematics achievement than boys.

[Table 10] Total Effect Size on Mathematics Achievement

Factors	Mathematics Achievement	
	Boys	Girls
Parental Involvement in Education	0.020	0.038
Teacher Efficacy	0.128	0.146
Confident with Mathematics	0.323	0.384

Note: numbers represent the effect size.

V. Conclusions and Implications

The Singaporean eighth grade girls are performing as well or higher than the eighth grade boys in international mathematics assessments such as TIMSS mathematics assessments. The trend has been consistent from TIMSS 2003 to TIMSS 2011 (Mullis et al., 2000; Mullis et al., 2004; Mullis et al., 2008; Mullis et al., 2012). Guiso et al.(2008) observed that countries of greater gender equality typically have a smaller mathematics gender gap. Singapore's gender parity level, represented by the Global Gender Gap Index, was rated 55th in the world which is higher than many other Asian countries in 2016. Compared to Singapore, China was rated at 99th, Japan at 111st and Korea at 116th in 2016 (World Economic Forum, 2017). Among Asian countries, Singapore represents a country of higher gender equality.

The objective of the study was to examine (1) if the sociocultural factors that can influence gender gap in mathematics achievement are gender equitable

in Singapore, (2) if there is a higher level of gender equitability in students' attitudes towards mathematics and (3) determine the degree of their influence on mathematics achievement for Singaporean eighth grade students using TIMSS 2011 mathematics assessment data. The study findings are as follows.

First, the study found that there were no statistically significant differences in 'parental involvement in education' between Singaporean eighth grade boys and girls. And, there were no significant difference in 'teacher efficacy' for the eighth grade boys and girls in Singapore. These findings are consistent with Singapore's high level of gender equality as represented in the Global Gender Gap Index. The Singaporean parents and teachers exhibit high levels of gender equitability in their involvement and influence in students' education.

Second, the study found no statistically significant gender differences in students' attitudes of 'like learning mathematics,' and 'value learning mathematics'. The Singaporean eighth grade students show high levels of gender equitability in their attitudes towards mathematics. However, a significant gender difference was identified for the attitude of 'confident with mathematics.' The boys displayed a higher level of confidence in mathematics than girls. This finding is consistent with various study findings that Asian boys tend to be more confident in mathematics than the girls. Third, related to the degree of sociocultural effect on mathematics achievement, the study found that 'confident with mathematics' had the most significant effect on mathematics achievement for boys and girls. And then, 'teacher efficacy,' and 'parental involvement in education.' The finding supports prior study findings that the most significant predictor for mathematics achievement is the attitude of 'confident with mathematics' for Asian students. The path analysis models show that 'teacher efficacy' and 'parental involvement in education' have significant indirect effect on mathematics achievement through 'confident with mathematics. The teachers have stronger effect on mathematics achievement than parents.

The degree of effect from sociocultural factors on mathematics achievement is stronger for girls than boys. The attitude of 'confident with mathematics' has the effect of 0.384 for girls vs. 0.323 for boys. The 'teacher efficacy' has the effect of 0.146 for girls vs. 0.128 for boys. The parents also have stronger effect on girls' mathematics achievement with the effect size of 0.038 vs. boys with the effect size of 0.020. The finding implies that girls' mathematics achievement can benefit more from having positive encouragement and involvement of teachers and parents and strengthening confidence in mathematics.

In conclusion, Singapore, reflecting its high gender parity status as reflected in Global Gender Gap Index, maintains highly gender equitable influence on students' mathematics education and achievement. Specifically there is gender equitability in parental and teacher influence on students' mathematics education as well as students' attitudes towards mathematics. The students showed gender equitability in like learning mathematics and value learning mathematics. The Singaporean eighth grade girls' mathematics achievement scores which are equivalent or higher than the eighth grade boys are reflecting this highly gender equitable environment. Future studies of gender difference in mathematics achievement can further validate the study findings with other country data or other mathematics achievement data such as PISA. It is hoped that the findings and the models developed in this study can provide additional insight into the importance of sociocultural influence in reducing gender gap in mathematics achievement.

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싱가포르의 높은 양성평등수준과 TIMSS 2011에 나타난 여학생의 높은 수학성취도

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The purpose of this study was to examine (1) if sociocultural factors that are known to influence gender gap in mathematics achievement are gender equitable for Singaporean eighth grade students, (2) if there is a higher level of gender equitability in students' attitudes towards mathematics and (3) how sociocultural factors influence mathematics achievement for Singaporean eighth grade students. This study is based on 5,923 Singaporean eighth grade students who participated in TIMSS 2011 assessment. The study found that there were no statistically significant gender differences in 'parental involvement in education' and 'teacher efficacy.' There were no statistically significant gender differences in students' attitudes of 'like learning mathematics,' and 'value learning mathematics'. A significant gender difference was identified for the attitude of 'confident with mathematics.' The boys displayed a higher level of confidence in mathematics than the girls consistent with other study findings for Asian students. The degree of effect from 'parental involvement in education,' 'teacher efficacy,' and 'confident with mathematics' on mathematics achievement are found to be stronger for girls than boys. The finding implies that girls' mathematics achievement can benefit from having more positive encouragement and involvement of parents and teachers and strengthening confidence in mathematics.

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Appendix 1: TIMSS 2011 Student Questionnaire Items for the Study

No.	TIMSS Variable Name	TIMSS Student Questionnaire Items
1	BSBG11A	How often parents ask about what you learned in school
2	BSBG11B	How often talking about school work with parents
3	BSBG11C	How often parents make sure time is set aside for homework
4	BSBG11D	How often parents check if you do your homework
5	BSBM15A	How much do you know what teacher expects you to do
6	BSBM15B	Think of things not related to lesson
7	BSBM15C	Teacher is easy to understand
8	BSBM15D	Interested in what teacher says
9	BSBM15E	Teacher gives interesting things to do
10	BSBG12A	Like being in school
11	BSBG12B	Feel safe at school
12	BSBG12C	Feel like belong at school
13	BSBM14A	Enjoy learning mathematics
14	BSBM14B	Wish have not to study mathematics
15	BSBM14C	Mathematics is boring
16	BSBM14D	Learn interesting things
17	BSBM14E	Like mathematics
18	BSBM14F	Important to do well in mathematics
19	BSBM16J	Mathematics will help me
20	BSBM16K	Need mathematics to learn other things
21	BSBM16L	Need mathematics to get into <university>
22	BSBM16M	Need mathematics to get the job I want
23	BSBM16N	Like job involving mathematics
24	BSBM16A	Usually do well in mathematics
25	BSBM16B	Mathematics is more difficult
26	BSBM16C	Mathematics not my strength
27	BSBM16D	Learn quickly in mathematics
28	BSBM16E	Mathematics makes me confused and nervous
29	BSBM16F	Good at working out problems
30	BSBM16G	Teacher thinks I can do well in mathematics
31	BSBM16H	Teacher tells me I am good at mathematics
32	BSBM16I	Mathematics is harder for me