

**A COMPARISON OF STUDENTS SELF-BELIEF AND MATHEMATICS
ACHIEVEMENT IN THE ASIAN COUNTRIES: FINDING FROM THE THIRD
INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS)**

Desi Rahmatina

Universitas Maritim Raja Ali Haji. Tanjungpinang, desirahmatina@gmail.com

Abstract.

The Trends in Mathematics and Science Study (TIMSS) is an international assessment of fourth and eighth grade students achievement in mathematics and science. The purpose of this study was examine the compares of student self- belief and mathematics in Asian countries using data from the Third International Mathematics and Science Study 2011. The analysis is conducted through a Multivariate Analysis of Variance (MANOVA) model with random effects for each country. East Asian countries Korea, Singapore, and Chinese Taipei Hong Kong SAR and Japan were the top-performing countries at the eighth grade to lead the world in mathematics achievement. The null hypotheses used in this study there are no statistically significant difference in self belief and mathematics achievement between Asian students.

Keywords. Self-belief, mathematics achievement, TIMSS.

INTRODUCTION

Self belief in mathematics can be defined as the individual's personal judgement in relation to his/her abilities in mathematical process. During the last twenty years the research area about self beliefs and mathematics achievement, and many different countries have been included in the research, for example Rao, Moely and Sachs (2000, in House J Daniel,2006) noted that self concept of mathematics ability was a significant predictor of subsequent achievement. According to Richardson (1996), beliefs are "psychologically held understandings, premises, or propositions about the world that are felt to be true" and Raymond (1997) defined mathematics beliefs as personal judgments about mathematics formulated from experiences in mathematics, including beliefs about the nature of mathematics, learning mathematics, and teaching mathematics

The purpose of this study was to investigate compares of eighth grades student's self-belief and mathematics achievement using data from the Trends in International Mathematics and Science Study (TIMSS) 2011 in Asian countries.

DATA SOURCE

Data from the Trends in International Mathematics and Science Study (TIMSS) 2011. TIMSS contains International results in Mathematics presents extensive information on student performance in mathematics. TIMSS was originally conducted in 1995 and continue every four years, in 1999,2003,2007 and most recently in 2011.

The TIMSS 2011 database contains achievement data and student, home, teacher and school background data collection in the 63 countries and 14 benchmarking participants including three Canadian provinces, nine US State and two emirates from the United Arab Emirates. Fifty-two countries and seven benchmarking participants administered the fourth

grade assessment and 45 countries and 14 benchmarking participants administered the eighth grade assessment.

In each country, representative samples of approximately 4000 students from 150-200 schools participated in TIMSS 2011 at each grade assessed. In total, more than 300,000 students participated in the TIMSS 2011 fourth grade assessment and a further 300,000 in the eighth grades assessment. For this study, the following database from TIMSS 2011 for eighth grade were used: self belief and student math achievement.

No	Country name	Average Score				
		Overall Mathematics	Number	Algebra	Geometry	Data and Chance
1	Korea, Rep.of	613	618	617	612	616
2	Singapore	611	611	614	609	607
3	Chinese Taipei	609	598	628	625	584
4	Hongkong	586	588	583	597	581
5	Japan	570	557	570	586	579

PARTICIPANT

At the grade level has a range of 0 – 1 (although student performance typically ranges between 300 and 700). The scale center point of 500 was set to correspond to the mean of the overall mathematics achievement and 100 points on the scale was set to correspond to the standard deviation. According to the TIMSS 2011 report, mathematics assessment consisted of content and cognitive domains. There are four content domains, numbers, algebra, geometry, data and chance, whereas knowing, applying and reasoning were assessed in the cognitive domain.

Table 1. Average Score Achievement in Mathematics Cognitive Domain

No	Country name	Average Score			
		Overall Mathematics	Knowing	Applying	Reasoning
1	Korea, Rep.of	613	616	617	612
2	Singapore	611	617	613	604
3	Chinese Taipei	609	611	614	609
4	Hongkong SAR	586	591	587	580
5	Japan	570	558	574	579

Source: TIMSS 2011.

In the study, the targeted sample was top-performing countries at the eighth grade to lead the world in mathematics achievement. Those five countries in East Asian are Korea, Singapore, Chinese Taipei, Hong Kong SAR and Japan. Total the participants was 24,564 students showed in table 2.

Table 2. Summary of the Samples Included in the study

No	Country name	ID Country	Number of student			Number of Schools
			Total	Female	Male	
1	Korea, Rep.of	410	5166	2663	2503	150
2	Singapore	702	5927	2934	2993	165
3	Chinese Taipei	158	5042	2448	2594	150
4	Hongkong SAR	344	4015	1997	2018	117
5	Japan	392	4414	2183	2231	138

INSTRUMENTS

The following items were selected from the TIMSS 2011 about self-belief about mathematics are:

1. Enjoy learning mathematics;
2. Wish have not to study mathematics;
3. Math is boring;
4. Learn Interesting Thing;
5. Like mathematics;
6. Important to do well in math

The item labelled BSBM14A to BSBM14F, a four point scale was used all items (1 = agree a lot, 2 = agree a little, 3 = disagree a little 4 = disagree a lot).

To assess mathematics assessment is based on a comprehensive framework developed collaboratively with the participant countries, the way to measure student's mathematics achievement on that scale in the TIMSS 2011 had five plausible variables which explained mathematics achievement, there are labelled BSMMAT01 through BSMMAT05. In this study only one out of five plausible variables, the one labelled BSMMAT01 was used to measure student's mathematics achievement.

Six Likert - scale item measure student's self belief in learning mathematics. In table 3 shows the mean and standard deviations of item for measure of students self belief.

Table 3. Means and standard deviation of items for measure of student self belief in mathematics.

Country	Statistic	Self Belief					
		Enjoy learning mathematics	Wish have not to study mathematics	Math is boring	Learn Interesting Thing	Like mathematics	Important to do well in math
Korea, Rep.of	Mean	2.6	2.31	2.43	2.51	2.69	1.81
	Std.dev.	0.875	0.923	0.862	0.842	0.901	0.836
	N	5158	5157	5134	5154	5151	5156
Singapore	Mean	1.81	2.90	2.82	1.89	1.93	1.33
	Std.dev.	0.870	1.047	0.974	0.816	0.913	.605
	N	5920	5922	5897	5903	5905	5923
Chinese Taipei	Mean	2.61	2.48	2.50	2.47	2.64	1.96
	Std.dev.	1.003	1.062	1.019	0.952	1.019	0.936
	N	5027	5029	5016	5004	5020	5030
Hongkong SAR	Mean	2.15	2.75	2.56	2.24	2.26	1.73
	Std.dev.	0.980	1.052	1.003	0.921	0.990	0.840
	N	4000	3996	3996	3993	3996	4000
Japan	Mean	2.53	2.66	2.57	2.68	2.69	1.73
	Std.dev.	0.949	0.949	0.906	0.877	0.993	0.812
	N	4410	4411	4397	4406	4404	4409

STATISTICAL ANALYSIS

The analysis data used by SPSS software. The analysis is conducted through a Multivariate Analysis of Variance (MANOVA). Multivariate analysis of variance is used to determine whether

there are any differences between independent groups on more than one continuous dependent variable. In the study used a one way MANOVA, consist of the self belief and mathematics achievement as dependent variables and following countries as independent variables.

Table 4. Summary of the missing respondents

Variable	N	Missing	Total
Self_belief	24564	29	24535
Math_Achievement	24564	0	24564

The student questionnaire seeks information about the self belief students in mathematics. From total of the 24564 students and 29 of them are missing or no response in filling the all questionnaires from BSBM14A to BSBM14F about self-belief.

Table 5. The Number of respondents missing in the self belief

No	Country name	N	Missing	Total
1	Korea, Rep.of	5166	5	5161
2	Singapore	5927	2	5925
3	Chinese Taipei	5042	10	5032
4	Hongkong SAR	4015	11	4004
5	Japan	4414	1	4413

Trend in mathematics achievement of the sample countries from 1995 through 2011 showed in figure below.

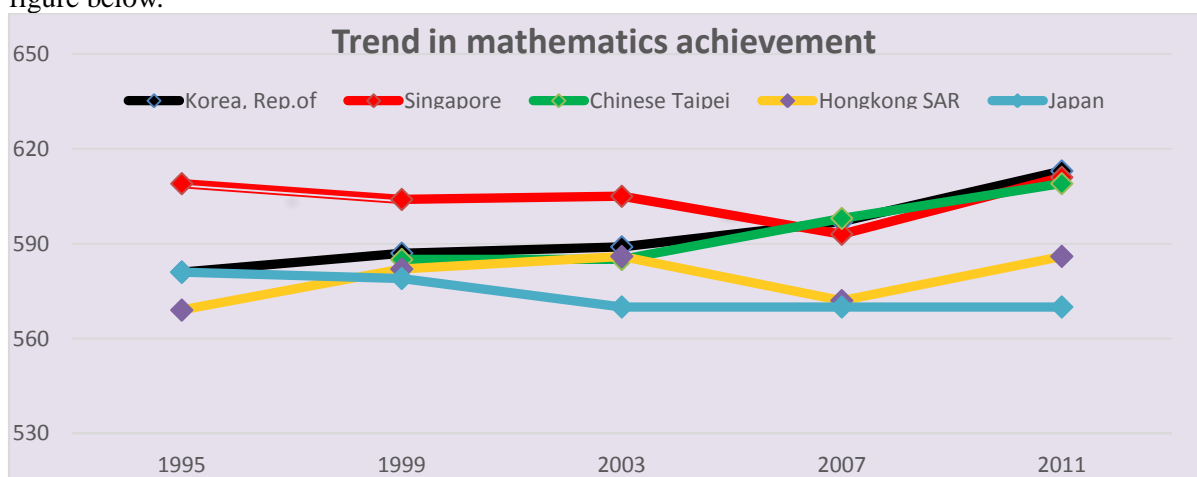


Figure 1. Trend in Mathematics Achievement

In figure 1 shows that Singapore country has the highest score in 1995 year, but in 2011 the highest score achieved by the Korea,Rep of. While Chinese Taipei country began as articpating in TIMSS was in 1999 and showed an increasing trend from 1999 to 2011.

RESULTS

Table 6 shows descriptive statistics for each self belief and for mathematics achievement test scores for five countries. Estimates of the sample mean, ,standard deviation and number of students for each countries. Japanese student's showed higher self belief of

other countries. For mathematics achievement the student's Korea, Rep of who showed higher achievement score.

Table 6. Descriptive Statistics of the self belief and mathematics achievement

	COUNTRY ID	Mean	Std. Deviation	N
Self_belief	Chinese Taipei	2.4428	.38538	5032
	Hong Kong SAR	2.2817	.43408	4004
	Japan	2.4748	.45543	4413
	Korea,Rep.of	2.3901	.34271	5161
	Singapore	2.1136	.31579	5925
	Total	2.3317	.40756	24535
Math_Achievement	Chinese Taipei	612.3158	104.15084	5032
	Hong Kong SAR	586.1075	83.35167	4004
	Japan	570.1066	84.34675	4413
	Korea,Rep.of	612.8784	88.99403	5161
	Singapore	606.2293	83.20299	5925
	Total	599.0953	90.78232	24535

Table 7. Box's Test of Equality of Covariance Matrices^a

Box's M	1860.462
F	155.011
df1	12
df2	3.618E9
Sig.	.000

a. Design: Intercept + IDCNTRY

Box test was used to test the assumptions of MANOVA requires that the variance matrix of the self belief and mathematics achievement variables is not different. Box's M score is 1860.462, and F test score is 156.011 and significant level is 0.000 less than 0.05, so test the null hypothesis that the observed covariance matrices of the self belief and mathematics achievement variables are different across country.

In table 8 shows the analysis of MANOVA using the Wilk's Lambda test, using an alpha level of 0.05, the test is significant, Wilk's lambda = 0.853, $F(8,49058) = 507.71$ and significant on 0.000 ($p < 0.05$). This significant F indicates that there are significant differences among the country (IDCNTRY) groups on a linear combination of the self belief and mathematics achievement.

Table 8. Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.992	1441020.576 ^a	2.000	24529.000	.000
	Wilks' Lambda	.008	1441020.576 ^a	2.000	24529.000	.000
	Hotelling's Trace	117.495	1441020.576 ^a	2.000	24529.000	.000
	Roy's Largest Root	117.495	1441020.576 ^a	2.000	24529.000	.000
IDCNTRY	Pillai's Trace	.151	500.419	8.000	49060.000	.000
	Wilks' Lambda	.853	507.708 ^a	8.000	49058.000	.000
	Hotelling's Trace	.168	515.004	8.000	49056.000	.000
	Roy's Largest Root	.135	826.869 ^b	4.000	24530.000	.000

Table 8. Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.992	1441020.576 ^a	2.000	24529.000	.000
	Wilks' Lambda	.008	1441020.576 ^a	2.000	24529.000	.000
	Hotelling's Trace	117.495	1441020.576 ^a	2.000	24529.000	.000
	Roy's Largest Root	117.495	1441020.576 ^a	2.000	24529.000	.000
IDCNTR Y	Pillai's Trace	.151	500.419	8.000	49060.000	.000
	Wilks' Lambda	.853	507.708 ^a	8.000	49058.000	.000
	Hotelling's Trace	.168	515.004	8.000	49056.000	.000
	Roy's Largest Root	.135	826.869 ^b	4.000	24530.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + IDCNTRY

The Levene's test of equality of error variances tests the assumption of MANOVA that the variances of self belief and mathematics achievement variables are equal across the countries. As can be seen in Table 9 that self belief variable and mathematics achievement are significant (sig = 0.00 < 0.05), the indicates that tests the null hypothesis that the error variance of the self belief and mathematics achievement variables is no equal across countries, whereas MANOVA is robust so next analysis can be continue.

Table 9. Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Self_belief	92.946	4	24530	.000
Math_Achievement	86.762	4	24530	.000

a. Design: Intercept + IDCNTRY

Test of between subject effects to determine how the dependent variables differ for the independent variable, in table 10 shows test of between subject effects that countries (IDCNTRY) has a statistically effect on both self belief ($F(4,2453) = 783.98$, sig value = 0.000 < 0.05) and mathematics achievement ($F(4,2453) = 205.16$, sig value = 0.000 < 0.05). The indicates that there are difference self belief and mathematics achievement between countries categories. The following is significant the univariate ANOVA (Analysis of Variance) with Tukey's HSD post-hoc test, as shown in the Multiple Comparison table. In table 11 shows that for mean scores for self belief were significantly different between each countries (sig value = 0.000 < 0.05). Mean mathematics achievement score were statistically significantly different between Chinese Taipei and Hong Kong SAR, Japan and Singapore (sig value = 0.000), Hong Kong SAR and Japan, Korea Rep. of and Singapore (sig value = 0.000) , Japan and Korea Rep.of, Singapore (sig value = 0.000), and Korea. Rep.of and Singapore (Sig = 0.001) but not different between Chinese Taipei and Korea. Rep.of (sig = 0.998).

Table 10. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Self_belief	461.937 ^a	4	115.484	783.983	.000
	Math_Achievement	6545329.887 ^b	4	1636332.472	205.158	.000
Intercept	Self_belief	131994.299	1	131994.299	896063.952	.000

	Math_Achievement	8.602E9	1	8.602E9	1078539.116	.000
IDCNTRY	Self_belief	461.937	4	115.484	783.983	.000
	Math_Achievement	6545329.887	4	1636332.472	205.158	.000
Error	Self_belief	3613.381	24530	.147		
	Math_Achievement	1.956E8	24530	7975.944		
Total	Self_belief	137464.741	24535			
	Math_Achievement	9.008E9	24535			
Corrected Total	Self_belief	4075.318	24534			
	Math_Achievement	2.022E8	24534			

a. R Squared = .113 (Adjusted R Squared = .113)

b. R Squared = .032 (Adjusted R Squared = .032)

Table 11. Multiple Comparisons
Tukey HSD

Dependent Variable	(I) *COUNTRY ID*	(J) *COUNTRY ID*	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Self_belief	Chinese Taipei	Hong Kong SAR	.1610*	.00813	.000	.1389	.1832
		Japan	-.0321*	.00792	.000	-.0536	-.0105
		Korea,Rep.of	.0527*	.00760	.000	.0320	.0735
		Singapore	.3292*	.00736	.000	.3091	.3493
	Hong Kong SAR	Chinese Taipei	-.1610*	.00813	.000	-.1832	-.1389
		Japan	-.1931*	.00838	.000	-.2159	-.1702
		Korea,Rep.of	-.1083*	.00808	.000	-.1304	-.0863
		Singapore	.1682*	.00785	.000	.1467	.1896
	Japan	Chinese Taipei	.0321*	.00792	.000	.0105	.0536
		Hong Kong SAR	.1931*	.00838	.000	.1702	.2159
		Korea,Rep.of	.0848*	.00787	.000	.0633	.1062
		Singapore	.3612*	.00763	.000	.3404	.3821
	Korea,Rep.of	Chinese Taipei	-.0527*	.00760	.000	-.0735	-.0320
		Hong Kong SAR	.1083*	.00808	.000	.0863	.1304
		Japan	-.0848*	.00787	.000	-.1062	-.0633
		Singapore	.2765*	.00731	.000	.2565	.2964
Singapore	Chinese Taipei	-.3292*	.00736	.000	-.3493	-.3091	
	Hong Kong SAR	-.1682*	.00785	.000	-.1896	-.1467	
	Japan	-.3612*	.00763	.000	-.3821	-.3404	
	Korea,Rep.of	-.2765*	.00731	.000	-.2964	-.2565	
Math_Achievement	Chinese Taipei	Hong Kong SAR	26.2082*	1.89131	.000	21.0488	31.3677
		Japan	42.2091*	1.84185	.000	37.1846	47.2336
		Korea,Rep.of	-.5626	1.76931	.998	-5.3893	4.2640
		Singapore	6.0865*	1.71207	.003	1.4160	10.7570
	Hong Kong SAR	Chinese Taipei	-26.2082*	1.89131	.000	-31.3677	-21.0488
		Japan	16.0009*	1.94920	.000	10.6835	21.3182
		Korea,Rep.of	-26.7709*	1.88080	.000	-31.9017	-21.6401
		Singapore	-20.1218*	1.82706	.000	-25.1059	-15.1376
	Japan	Chinese Taipei	-42.2091*	1.84185	.000	-47.2336	-37.1846

	Hong Kong SAR	-16.0009*	1.94920	.000	-21.3182	-10.6835
	Korea,Rep.of	-42.7718*	1.83107	.000	-47.7669	-37.7766
	Singapore	-36.1226*	1.77582	.000	-40.9670	-31.2783
Korea,Rep.of	Chinese Taipei	.5626	1.76931	.998	-4.2640	5.3893
	Hong Kong SAR	26.7709*	1.88080	.000	21.6401	31.9017
	Japan	42.7718*	1.83107	.000	37.7766	47.7669
	Singapore	6.6491*	1.70046	.001	2.0103	11.2879
Singapore	Chinese Taipei	-6.0865*	1.71207	.003	-10.7570	-1.4160
	Hong Kong SAR	20.1218*	1.82706	.000	15.1376	25.1059
	Japan	36.1226*	1.77582	.000	31.2783	40.9670
	Korea,Rep.of	-6.6491*	1.70046	.001	-11.2879	-2.0103

Based on observed means.

The error term is Mean Square(Error) = 7975.944.

*. The mean difference is significant at the .05 level.

CONCLUSION

Data analysis indicated that self belief are significantly related to the countries, and there are several mathematics achievement are not significantly related to the countries. Mean scores for self belief were significantly different between Chinese Taipei, Hong Kong SAR, Japan, Korea Rep and Singapore. Mean mathematics achievement score were statistically significantly different between Chinese Taipei, Hong Kong SAR, Japan and Singapore, between Hong Kong SAR, Japan, Korea Rep. of and Singapore, between Japan, Korea Rep.of and Singapore, and last between Korea. Rep.of and Singapore but not different between Chinese Taipei and Korea. Rep.of.

REFERENCES

- Abu-Hilal, M. M. (2000). A structural model of attitudes toward school subjects, academic aspirations, and achievement. *Educational Psychology*, 20, 75–84.
- Beaton, A. E. (1998). Comparing cross-national student performance on TIMSS using different test items. *International Journal of Educational Research*, 29, 529-542.
- House, J Daniel (2006). Mathematics Beliefs and Achievement of Elementary School Students in Japan and the United States: Result From the Third International Mathematics and Science Study. *The Journal of Genetic Psychology*, 167(1),31-45
- Raymond, A. M. (1997). Inconsistency between a beginning elementary school teacher's mathematics beliefs and teaching practice. *Journal for Research in Mathematics Education*, 28(5), 550–576.
- Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In: J.Sikula (Ed), *Handbook of Research on Teacher Education*. (pp 102 – 119) New York: Macmillan.
- Ozgen, K. & Bindak, R. (2011). Determination of self-efficacy beliefs of high school students towards math literacy. *Educational Sciences: Theory & Practice*, 11(2), 1073-1089.
- TIMSS. (2011). User Guide for the International Database. International Association for the Evaluation of Education Achievement. <http://timss.bc.edu/timss2011/international-database.html>
- TIMSS. (2011). Assessment Frameworks . International Association for the Evaluation of Education Achievement.. <http://timss.bc.edu/timss2011/frameworks.html>