The Predictive Effects of Attitudes toward Science and Mathematics on Science and Mathematics Achievement in TIMSS among Southeast Asian Eighth Grade Students

Yoon Fah Lay

Faculty of Psychology and Education, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia

Abstract

This study explored the predictive effects of attitudes toward science and mathematics on science and mathematics achievement among Southeast Asian eighth graders who participated in the TIMSS 2011. In this study, students' interest in and liking of learning science and mathematics, understanding about the importance of and the usefulness of the subjects (attainment value and utility value), and self-confidence or self-concept in their ability to learn science and mathematics were measured. Data were obtained from 5,733 Malaysian students, 5,927 Singaporean students, 6,124 Thai students, and 5,795 Indonesian students who participated in the TIMSS 2011. The results of the present study indicated that eighth graders' liking and valuing of learning science were positively and significantly associated with science achievement in Malaysia, Singapore, and Thailand. Students' liking of mathematics was positively and significantly associated with mathematics achievement in Malaysia, Thailand, and Indonesia whereas students' confidence in mathematics was significantly associated with mathematics achievement in Malaysia, Singapore, and Indonesia. This study provides information on prerequisites of Southeast Asian students' science and mathematics learning. Implications of the findings for educational policy and practice are discussed.

Keywords: Attitudes toward science; attitude toward mathematics; science achievement; mathematics achievement; TIMSS; Southeast Asian education systems

Corresponding author e-mail address: layyoonfah@yahoo.com.my

Introduction

Trends in International Mathematics and Science Study (TIMSS) is an international comparative study that has been implemented by the International Association for the Evaluation of Educational Achievement (IEA) since 1995. It was designed to assess the quality of the teaching and learning of science and mathematics among Grades 4 and 8 students across participating countries (Martin, Mullis, Foy, & Stanco, 2012). The findings of the recent cycle of TIMSS reveal that South Korea and Singapore are the top-performing countries in science in TIMSS 2011 at the fourth grade. At the eighth grade, Singapore had the highest average science achievement. Singapore and South Korea are also the top-performing countries in mathematics in TIMSS 2011 at the fourth grade. At the eighth grade, South Korea had the highest average mathematics achievement. On the other hand, Thailand, Malaysia, and Indonesia, however, was ranked 27th, 32th, and 40th in TIMSS 2011 science assessment at the eighth grade, respectively. Malaysia, Thailand, and Indonesia were also ranked 26th, 28th, and 38th in TIMSS 2011 mathematics assessment at the eighth grade, respectively.

It is undeniable that factors which might have contributed to the outstanding science and mathematics performance in TIMSS are multi-faceted, and such factors have been widely researched recently, including cognitive, affective (i.e., interest, attitude, and motivation), as well as psycho/sociological aspects (see Ong & Gonzalez, 2012; Ong, Gonzalez, & Shanmugam, 2013). Research about students' learning has studied the complex phenomenon of motivation (Nolen, 2003; Pintrich, 2003; Singh, Granville, & Dika, 2002). For example, students' motivation to learn can be affected by whether or not they find the subject enjoyable and place value on the subject. In addition, students' motivation can be affected by their self-confidence in learning the subject (Linnenbrink & Pintrich, 2003). Hence, TIMSS 2011 included scales about three motivational constructs: intrinsic value (interest), utility value, and ability beliefs (Martin, Mullis, Foy, & Stanco, 2012).

There are 11 SEAMEO (Southeast Asian Ministers of Education Organisation) countries in the Southeast-Asian region. Four out of the 11 SEAMEO member countries, Indonesia, Malaysia, Singapore and Thailand, participated in TIMSS 2011. Singapore joined the TIMSS since 1995 at both the fourth and eighth grade levels. However, Malaysia joined the programme in 1999 only at the eighth grade level. Thailand joined the programme in 1999 at both the fourth and eighth grade levels whereas Indonesia joined the programme in 2007 only at the eighth grade level. A summary of the Grade 8 science and mathematics performance of these four Southeast Asian countries from TIMSS 1995 to TIMSS 2011 is provided in Table 1.

Table 1: TIMSS (Grade 8) Science and Mathematics Scores for Malaysia, Singapore, Thailand, and Indonesia (1995 – 2011)

Year	No. of Participating Countries	TIMSS Scores of Grade 8 Students							
		Science				Mathematics			
		Malaysia	Singapore	Thailand	Indonesia	Malaysia	Singapore	Thailand	Indonesia
1995	45	-	580	-	-	-	609	-	-
1999	38	492	568	482	-	519	604	467	-
2003	46	510	578	-	-	508	605	-	-
2007	59	471	567	471	427	474	593	441	397
2011	63	426	590	451	406	440	611	427	386

The purpose of the present study is to examine the predictive effects of an affective factor, i.e., students' attitudes towards science and mathematics on science and mathematics achievement among eighth grade students in Southeast Asian countries who participated in the TIMSS 2011 assessment. The research question that underpinned this study was: Using the TIMSS 2011 data, how well do Grade 8 Southeast Asian students' attitudes toward science and mathematics predict their achievement in science and mathematics, respectively?

Self-Efficacy Beliefs and Achievement in Science and Mathematics

Constructivist and motivation theories recognize that motivation is influenced by how interesting and relevant the learners perceive the activities and information. According to educational psychologists, student's motivation is influenced by a number of beliefs, values, interests, and attitudes that can be positive or negative in their effects. The construct about 'self' was grounded on the 'self-determination' theory (stating that students may do activities for interest or enjoyment, i.e., intrinsic motivation), and/or the 'self-belief' theory (including self-efficacy which stated when self-confidence is high, students will be more motivated to persist in a task until it is completed). The construct 'belief on own coping ability' (intrinsic motivation) is based on the Expectancy-Value theory explaining that beliefs about one's ability to succeed are expectancy beliefs, beliefs about the extent to which the task is useful, enjoyable, or relates to one's self-image as value beliefs (Glynn, Taasoobshirazi, & Brickman, 2007;

Palmer, 2007; Phillips, 2007; Weiner, 1979). It is believed that students are motivated to learn when they value either the outcome or process of learning and they expect that they will be successful. As explained from psychological theories, students believe that the task is of value (value beliefs) and they believe he/she has the ability and confidence to succeed in the learning task (expectancy and self-efficacy beliefs) (Lefton, 1991; Phillips, 2007).

Self-efficacy is a very specific form of self-concept theory that refers to people's beliefs about their mastery or capabilities to perform a task successfully at designated levels with convictions about their own effectiveness that can determine the types of behaviour they will engage in or the amount of risk they will undertake. It is their belief about whether or not they can successfully engage in and execute a specific behaviour or their confidence in their ability to behave in such a way to produce a desirable outcome (Bandura, 1977, 1997; Lefton, 1991). Self-efficacy determines and flows from the feelings of self-beliefs and self-worth. In other words, the people with self-efficacy consider themselves to be capable and worthy. A strong sense of self-efficacy allows people to feel free to select the influence, construct their own desirable lives, and even effect changes in themselves and persevere in tough times. Self-efficacy or self-beliefs make a difference to how people feel, think, and act, such as in science-related learning or activities. If people feel themselves to be able to control a situation, this increases their perceived self-efficacy or self-beliefs to manage it. In fact, people with a high level of self-efficacy are more likely to attribute success to variables within themselves rather than to chance factors and are more likely to pursue a task (Bandura & Wood, 1989 in Lefton, 1991), subsequently striving towards accomplishing the task with commendable achievement.

Methodology

Data for the study were drawn from the TIMSS 2011 database (http://timssandpirls.bc.edu/timss2011/international-database.html). A total of 23,579 Grade 8 students from Malaysia (N = 5,733), Singapore (N = 5,927), Thailand (N = 6,124), and Indonesia (N = 5,795) participated in the TIMSS 2011 assessment.

Science and Mathematics Achievement. The TIMSS 2011 science achievement scale was based on 302 items involving content (in Biology, Chemistry, Physics, Earth Science) and cognitive (Knowing, Applying, Reasoning) domains in science. On the other hand, the TIMSS 2011 mathematics achievement scale was based on items involving content (in Number, Algebra, Geometry, Data and Chance) and cognitive (Knowing, Applying, Reasoning) domains in mathematics. TIMSS uses an imputation methodology, involving plausible values, to report student performance. Plausible values consisting of an approach developed by Mislevy and Sheehan (1987, 1989) and based on the imputation theory of Rubin (1987), are random elements from the set of scores (i.e., random draws from the marginal posterior of the latent distribution used as a measure of science achievement. The IEA's International Database (IDB) Analyser for TIMSS, a plug-in for SPSS, was used to combine the five plausible values as well as to produce their average values and corrected standard errors.

Students Liking for Learning Science/Mathematics. Essentially, intrinsic motivation refers to doing an activity because it is interesting or enjoyable. The Students Like Learning Science Scale was developed to measure students' interest in and liking for learning science. The scale was based on five items. All items were rated on a 4-point Likert-type scale, ranging from '1' (*Disagree a lot*) to '4' (*Agree a lot*). The Cronbach's alpha reliability coefficients for the scale were 0.84, 0.89, and 0.77 for Malaysia, Singapore and Thailand, respectively. On the other hand, the TIMSS 2011 Students Like Learning Mathematics Scale was also based on five items. All items were also rated on a 4-point Likert-type scale. The Cronbach's alpha reliability coefficients for the scale were 0.83, 0.90, 0.81, and 0.81 for Malaysia, Singapore, Thailand, and Indonesia, respectively.

Students Value Science/Mathematics. In contrast to intrinsic motivation, extrinsic motivation refers to doing something because it leads to a desirable outcome. The TIMSS 2011 Students Value Science Scale addresses students' attitudes about the importance and usefulness of the subject, sometimes called attainment value and utility value (Wigfield & Eccles, 2000). The scale was based on six items. All items were rated on a 4-point Likert type scale, ranging from '1' (*Disagree a lot*) to '4' (*Agree a lot*). The Cronbach's alpha reliability coefficients for the scale were 0.87, 0.87, and 0.83 for Malaysia, Singapore and Thailand, respectively. On the other hand, the TIMSS 2011 Students Value Mathematics Scale was also based on six items. All items were also rated on a 4-point Likert type scale. The Cronbach's alpha reliability coefficients for the scale were 0.79,

0.80, 0.77, and 0.78 for Malaysia, Singapore, Thailand, and Indonesia, respectively.

Students Confident in Science/Mathematics. Motivation to learn includes having the feeling that you can succeed. A strong self-concept encourages students to engage with the instruction and show persistence, effort, and attentiveness. The Student Confident in Science Scale assesses students' self-confidence or self-concept in their ability to learn science. The scale was based on nine items. All items were rated on a 4-point Likert type scale, ranging from '1' (*Disagree a lot*) to '4' (*Agree a lot*). The Cronbach's alpha reliability coefficients for the scale were 0.78, 0.91, and 0.79 for Malaysia, Singapore and Thailand, respectively. On the other hand, the TIMSS 2011 Students' Confidence in Mathematics Scale was also based on nine items. All items were also rated on a 4-point Likert type scale. The Cronbach's alpha reliability coefficients for the scale were 0.78, 0.90, 0.79, and 0.83 for Malaysia, Singapore, Thailand, and Indonesia, respectively.

In addition to these measures, student demographic characteristic such as gender (dummy coded as 0 = 'female', 1 = 'male') was also included in the study as a control variable.

Results

Table 2: Descriptive Statistics (Weighted) with Average Scale Scores for Students Like Learning Science, Students Value Science, and Students' Confidence in Science

Variables	Malaysia		Singapore		Thailand		Indonesia	
	M	SD	M	SD	M	SD	M	SD
Students Like Learning Science								
I enjoy learning science.	3.24	.799	3.25	.779	3.31	.706	-	-
*I wish I did not have to study science.	1.69	.886	1.96	.932	1.95	.964	-	-
*Science is boring.	1.84	.918	1.99	.909	2.02	.911	-	-
I learn many interesting things in science.	3.38	.799	3.41	.722	3.47	.679	-	-
I like science.	3.18	.856	3.17	.827	3.15	.757	-	-
Average scale score	10.4 (0.06)		10.2 (0.03)		10.1 (0.05)			
Students Value Science								
I think learning science will help me in my daily life.	3.31	.810	3.39	.705	3.54	.609	-	-
I need science to learn other school subjects.	3.01	.855	3.00	.849	3.12	.754	-	-
I need to do well in science to get into the university of my choice.	3.35	.874	3.31	.792	3.45	.689	-	-
I need to do well in science to get the job I want	3.29	.878	3.12	.889	3.41	.704	-	-
I would like a job that involves using science.	2.91	.967	2.74	.996	3.03	.803	-	-
It is important to do well in science.	3.52	.761	3.51	.674	3.46	.688	-	-
Average scale score	10.3 (0.07)		10.2 (0.03)		10.5 (0.04)			
Students' Confidence in Science								
I usually do well in science.	2.59	.810	2.89	.832	2.96	.676	-	-
*Science is more difficult for me than for many of my classmates.	2.48	.871	2.18	.870	2.66	.816	-	-
*Science is not one of my strengths.	2.50	.925	2.37	.970	2.70	.797	-	-
I learn quickly in science.	2.80	.855	2.79	.837	2.73	.742	-	-
*Science makes me feel confused and nervous.	2.27	.921	2.23	.900	2.53	.854	-	-
I am good at working out difficult science problems.	2.31	.832	2.48	.857	2.71	.739	-	-
My teacher thinks I can do well in science programs/classes/lessons with difficult materials.	2.29	.882	2.65	.842	2.88	.745	-	-
My teacher tells me I am good at science.	2.26	.897	2.43	.882	2.79	.768	-	-
*Science is harder for me than any other subject.	2.44	.941	2.12	.940	2.64	.881	-	-
Average scale score	9.1 (0.04)		9.6 (0.03)		9.3 (0.04)			

Note: 1 = Disagree A Lot, 4 = Agree A Lot; Standard errors appear in parentheses; * negatively-worded item; (-) No statistics are computed because there are no valid cases;

Based on the average scale scores as shown in Table 2, Malaysian students liked learning science the most as compared to Singaporean and Thai students. On the other hand, Thai students valued science the most whereas Singaporean students expressed their confidence in their science ability the most.

Table 3: Descriptive Statistics (Weighted) with Average Scale Scores for Students Like Learning Mathematics, Students Value Mathematics, and Students' Confidence in Mathematics

Variables	Malaysia		Singapore		Thailand		Indonesia	
	M	SD	M	SD	M	SD	M	SD
Students Like Learning Mathematics								
I enjoy learning mathematics.	3.23	.799	3.20	.865	3.07	.740	3.10	.612
*I wish I did not have to study mathematics.	1.64	.900	2.09	1.042	1.87	.894	1.71	.658
*Mathematics is boring.	1.91	.929	2.17	.970	2.17	.918	1.97	.726
I learn many interesting things in mathematics.	3.22	.839	3.11	.816	3.32	.714	3.12	.601
I like mathematics.	3.18	.851	3.08	.906	2.94	.822	3.06	.666
Average scale score	10.8 (0.05)		10.4 (0.03)		10.3 (0.05)		10.4 (0.04)	
Students Value Mathematics								
I think learning mathematics will help me in my daily life.	3.34	.763	3.37	.742	3.62	.607	3.29	.655
I need mathematics to learn other school subjects.	3.04	.827	3.11	.768	3.10	.732	3.09	.611
I need to do well in mathematics to get into the university of my choice.	3.40	.823	3.44	.704	3.51	.685	3.30	.653
I need to do well in mathematics to get the job I want	3.46	.764	3.34	.768	3.53	.667	3.29	.631
I would like a job that involves using mathematics.	2.83	.896	2.56	.960	2.81	.801	2.79	.734
It is important to do well in mathematics.	3.64	.671	3.67	.603	3.53	.664	3.34	.625
Average scale score	10.1 (0.06)		10.0 (0.03)		10.2 (0.04)		9.7 (0.05)	
Students' Confidence in Mathematics								
I usually do well in mathematics.	2.55	.832	2.86	.915	2.84	.717	2.71	.682
*Mathematics is more difficult for me than for many of my classmates.	2.63	.892	2.29	.916	2.82	.802	2.42	.742
*Mathematics is not one of my strengths.	2.62	.961	2.46	1.071	2.91	.822	2.40	.706
I learn quickly in mathematics.	2.76	.858	2.78	.870	2.51	.767	2.60	.671
*Mathematics makes me confused and nervous.	2.56	.952	2.39	.945	2.81	.807	2.38	.736
I am good at working out difficult mathematics problems.	2.27	.846	2.47	.889	2.54	.754	2.31	.662
My teacher thinks I can do well in mathematics <programs/classes/lessons> with difficult materials.	2.23	.901	2.77	.838	2.75	.761	2.60	.714
My teacher tells me I am good at mathematics.	2.28	.930	2.45	.918	2.66	.811	2.62	.724
*Mathematics is harder for me than any other subject.	2.68	.987	2.15	1.052	2.86	.888	2.52	.805
Average scale score	9.3 (0.04)		10.0 (0.04)		9.3 (0.03)		9.7 (0.05)	

Note: 1 = Disagree A Lot, 4 = Agree A Lot; Standard errors appear in parentheses; * negatively-worded item.

Based on the average scale scores shown in Table 3, Malaysian students liked learning mathematics the most as compared to Singaporean, Thai, and Indonesian students. On the other hand, Thai students valued mathematics the most whereas Singaporean students expressed their confidence in their mathematics ability the most.

Tables 4 to 9 show the percentage of Southeast Asian students who like learning science and mathematics, value science and mathematics, confident in science and mathematics with their average science and mathematics achievement, respectively.

Students Like Learning Science

Table 4 presents the Grade 8 students' results for the Students Like Learning Science Scale in TIMSS 2011.

Table 4: Students Like Learning Science

Country	N	Like Learning Science		Somewhat Like Learning Science		Do Not Like Learning Science		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	5702	42	457	44	418	13	364	10.4
		(1.4)	(5.8)	(0.9)	(6.3)	(1.0)	(9.4)	(0.06)
Singapore	5919	38	617	46	584	16	542	10.2
		(0.8)	(5.2)	(0.7)	(4.2)	(0.5)	(5.4)	(0.03)
Thailand	6000	34	473	56	443	10	431	10.1
		(1.2)	(4.5)	(1.0)	(4.0)	(0.8)	(6.8)	(0.05)
Indonesia	-	-	-	-	-	-	-	-
Average		35	515	44	472	21	450	10.3
		(0.2)	(0.8)	(0.2)	(0.8)	(0.2)	(1.1)	(0.03)

Note: Standard errors in parentheses; (-) No statistics are computed because there are no valid cases.

On average, 42% of the Malaysian students like learning science and only 13% do not like learning science as compared to 38% of the Singaporean students who like learning science and 16% do not like learning science and 34% of the Thai students who like learning science and 10% do not like learning science. Accompanying the decrease in liking learning science is a widening achievement gap between students who like learning science and those who do not for Malaysian students (457 vs. 364), Singaporean students (617 vs. 542), Thai students (473 vs. 431), respectively. It can be concluded that students who liked learning science had higher average science achievement than those who only somewhat liked or did not like learning science (Martin, Mullis, Foy, & Stanco, 2012).

Students Like Learning Mathematics

Table 5 presents the Grade 8 students' results for the Students Like Learning Mathematics Scale in TIMSS 2011.

Table 5: Students Like Learning Mathematics

Country	N	Like Learning Mathematics		Somewhat Like Learning Mathematics		Do Not Like Learning Mathematics		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	5698	39	463	46	430	15	413	10.8
		(1.3)	(5.0)	(0.9)	(5.6)	(0.9)	(8.1)	(0.05)
Singapore	5920	32	637	44	610	23	578	10.4
		(0.7)	(3.9)	(0.7)	(4.1)	(0.7)	(4.4)	(0.03)
Thailand	6070	26	456	57	421	16	408	10.4
		(1.1)	(5.8)	(0.9)	(4.6)	(1.0)	(5.3)	(0.05)
Indonesia	5731	20	396	70	385	10	382	10.4
		(1.4)	(7.7)	(1.2)	(4.4)	(0.8)	(6.2)	(0.04)
Average		26	504	42	467	31	443	26
		(0.2)	(0.8)	(0.1)	(0.6)	(0.2)	(0.7)	(0.2)

Note: Standard errors in parentheses

On average, 39% of the Malaysian students like learning mathematics and only 15% do not like learning mathematics as compared to 32% of the Singaporean students who like learning mathematics and 23% do not like learning mathematics, 26% of the Thai students who like learning mathematics and 16% do not like learning mathematics, and 20% of the Indonesian students who like learning mathematics and 10% do not like learning mathematics. Accompanying the decrease in liking learning mathematics is a widening achievement gap between students who like learning mathematics and those who do not for Malaysian students (463 vs. 413), Singaporean students (637 vs. 578), Thai students (456 vs. 408), and Indonesian students (396 vs. 382), respectively. It can also be concluded that students who liked learning mathematics had higher average mathematics achievement than those who only somewhat liked or did not like learning mathematics (Martin, Mullis, Foy, & Stanco, 2012).

Students Value Science

Table 6 presents the results for the TIMSS 2011 Students Value Science Scale for Grade 8 students.

Table 6: Students Value Science

Country	N	Value		Somewhat Value		Do Not Value		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	5689	49 (1.6)	453 (5.7)	34 (0.9)	419 (6.4)	17 (1.1)	370 (9.2)	10.3 (0.07)
Singapore	5914	41 (0.8)	616 (4.6)	43 (0.7)	583 (4.3)	17 (0.6)	546 (5.9)	10.2 (0.03)
Thailand	6051	49 (1.3)	466 (4.1)	43 (1.0)	441 (4.0)	8 (0.5)	424 (5.8)	10.5 (0.04)
Indonesia	-	-	-	-	-	-	-	-
Average		41 (0.2)	502 (0.8)	33 (0.2)	477 (0.8)	26 (0.2)	457 (1.1)	10.2 (0.04)

Note: Standard errors in parentheses

On average, 49% of the Malaysian students value science and only 17% do not value science as compared to 41% of the Singaporean students who value science and 17% who do not value science, and 49% of the Thai students value science and only 8% who do not value science. Accompanying the decrease in valuing science is a widening achievement gap between students who value science and those who do not for Malaysian students (453 vs. 370), Singaporean students (616 vs. 546), and Thai students (466 vs. 424). Hence, across Grade 8, students who said they valued science typically had higher achievement than students who only somewhat valued it , and those students, in turn, had higher achievement than students who did not value science (Martin et al., 2012).

Students Value Mathematics

Table 7 presents the results for the TIMSS 2011 Students Value Mathematics Scale for Grade 8 students.

Table 7: Students Value Mathematics

Country	N	Value		Somewhat Value		Do Not Value		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	5705	49 (1.5)	453 (5.1)	40 (0.9)	433 (5.7)	11 (0.8)	411 (8.6)	10.1 (0.06)
Singapore	5921	43 (0.7)	619 (4.0)	47 (0.7)	608 (3.9)	10 (0.5)	591 (5.6)	10.0 (0.03)
Thailand	6006	43 (0.7)	619 (4.1)	47 (0.7)	608 (4.0)	10 (0.5)	592 (5.7)	10.2 (0.04)
Indonesia	5734	31 (1.3)	392 (6.0)	61 (1.1)	386 (4.1)	8 (0.5)	367 (7.2)	9.7 (0.05
Average		46 (0.2)	482 (0.7)	39 (0.1)	463 (0.6)	15 (0.1)	439 (0.9)	46 (0.2)

Note: Standard errors in parentheses

On average, 49% of the Malaysian students value mathematics and only 11% do not value mathematics as compared to 43% of the Singaporean students value mathematics and 10% who do not value mathematics, 43% of the Thai students value mathematics and only 10% who do not value mathematics, and 31% of the Indonesian students value mathematics and only 8% who do not value mathematics. Accompanying the decrease in valuing mathematics is a widening achievement gap between students who value mathematics and those who do not for Malaysian students (453 vs. 411), Singaporean students (619 vs. 591), Thai students (619 vs. 592), and Indonesian students (392 vs. 367), respectively. Hence, across Grade 8, students who said they valued mathematics typically had higher achievement than students who only somewhat valued it, and those students, in turn, had higher achievement than students who did not value mathematics (Martin et al., 2012).

Students' Confidence in Science

Table 8 presents the Grade 8 students' results for the TIMSS 2011 Students' Confidence in Science Scale.

Table 8: Students' Confidence in Science

Country	N	Confident		Somewhat Confident		Not Confident		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	5693	4 (0.4)	511 (9.0)	45 (1.1)	437 (6.2)	51 (1.3)	411 (6.5)	9.1 (0.04)
Singapore	5917	14 (0.5)	630 (5.9)	48 (0.7)	600 (4.8)	37 (0.8)	562 (4.2)	9.6 (0.03)
Thailand	6048	5 (0.4)	498 (7.7)	58 (1.3)	451 (4.3)	37 (1.5)	448 (4.3)	9.3 (0.04)
Indonesia	-	-	-	-	-	-	-	-
Average		20 (0.2)	536 (1.0)	49 (0.2)	482 (0.8)	31 (0.2)	450 (0.9)	9.4 (0.03)

Note: Standard errors in parentheses

On average, only 4% of the Grade 8 students in Malaysia expressed confidence in their science ability, with 45% somewhat confident, and 51% not confident. On the other hand, 14% of Singaporean students, on average, expressed confidence in their science ability, with 48% somewhat confident and 37% not confident, 5% of the Grade 8 students in Thailand expressed confidence in their science ability, with 58% somewhat confident, and 37% not confident. Accompanying the decrease in confidence in science is a widening achievement gap between students who are confident in science and those who are not for Malaysian students (511 vs. 411), Singaporean students (630 vs. 562), and Indonesian students (498 vs. 448), respectively. Hence, across Grade 8, students who expressed confidence in their science ability typically had higher achievement than students who only somewhat confident, and those students, in turn, had higher achievement than students who were not confident in science (Martin et al., 2012).

Students' Confidence in Mathematics

Table 9 presents the Grade 8 students' results for the TIMSS 2011 Students' Confidence in Mathematics Scale.

Table 9: Students' Confidence in Mathematics

Country	N	Confident		Somewhat Confident		Not Confident		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	5701	3 (0.3)	532 (10.4)	39 (1.0)	453 (6.3)	58 (1.1)	427 (4.8)	9.3 (0.04)
Singapore	5920	14 (0.5)	662 (4.1)	46 (0.8)	628 (3.6)	40 (0.9)	574 (4.3)	10.0 (0.04)
Thailand	6043	2 (0.3)	509 (14.4)	44 (1.1)	434 (5.0)	54 (1.2)	420 (4.1)	9.3 (0.03)
Indonesia	5736	3 (0.5)	394 (11.6)	52 (1.7)	383 (6.0)	45 (1.8)	390 (3.9)	9.7 (0.05)
Average		14 (0.1)	539 (0.9)	45 (0.1)	478 (0.6)	41 (0.2)	435 (0.6)	14 (0.1)

Note: Standard errors in parentheses

On average, only 3% of the Grade 8 students in Malaysia expressed confidence in their mathematics ability, with 39% somewhat confident, and 58% not confident. On the other hand, 14% of Singaporean students, on average, expressed confidence in their mathematics ability with 46% somewhat confident and 40% not confident. 2% of the Grade 8 students in Thailand expressed confidence in their mathematics ability, with 44% somewhat confident, and 54% not confident. 3% of the Grade 8 students in Indonesia expressed confidence in their mathematics ability, with 52% somewhat confident, and 45% not confident. Accompanying the decrease in confidence in mathematics is a widening achievement gap between students who are confident in mathematics and those who are not for Malaysian students (532 vs. 427), Singaporean students (662 vs. 574), Thai students (509 vs. 420), and Indonesian students (394 vs. 390), respectively.

It is noteworthy that Singapore, one of the highest performing countries in TIMSS shows a smaller percentage of students who liked or valued science and mathematics. The tendency of the smaller

percentage of students in Singapore and some East Asian countries (such as Chinese Taipei, Japan, and South Korea) to report positive attitudes is consistent with previous TIMSS assessments. The relatively low percentages of students who liked and valued science and mathematics may partially be the result of the high level of difficulty of the science and mathematics being taught, and also these countries have a cultural tradition of serious attitudes toward learning. Perhaps, Grade 8 teachers of East Asian countries should make greater efforts to make science and mathematics relevant to students' daily lives and bring interesting materials to the classroom, especially in light of the decrease in students' liking and valuing science and mathematics learning among eighth grade students in this region.

Correlation and simultaneous multiple regression analyses were conducted separately for each education system to determine whether or not students' attitudes toward science and mathematics was predictive of their science and mathematics achievement (see Table 10, Table 11, Table 12, and Table 13).

Table 10: Correlations between Attitudes towards Science with Science Achievement

	Malaysia							
	SLS		SVS		SCS		Science	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLS			0.63*	0.01	0.59*	0.01	0.32*	0.02
SVS					0.46*	0.02	0.34*	0.02
SCS							.0.22*	0.02
Science								
	Singapore							
	SLS		SVS		SCS		Science	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLS			0.59*	0.01	0.71*	0.01	0.29*	0.02
SVS					0.49*	0.01	0.26*	0.02
SCS							0.26*	0.02
Science								
	Thailand							
	SLS		SVS		SCS		Science	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLS			0.57*	0.01	0.54*	0.01	0.22*	0.02
SVS					0.43*	0.01	0.19*	0.02
SCS							0.12*	0.02
Science								

*p < 0.05; SLS – Students Liking Science; SVS – Students Value Science; SCS – Students' Confidence in Science

The results in Table 10 indicated that Grade 8 students' liking, valuing, and confidence of learning science were positively and significantly associated with science achievement (r = 0.22 to 0.34 for Malaysia; r = 0.26 to 0.29 for Singapore, r = 0.12 to 0.22 for Thailand). Southeast Asian students' liking, valuing, and confidence of learning science were also moderately, positively, and significantly correlated among each other (r = 0.46 to 0.63 for Malaysia, r = 0.49 to 0.71 for Singapore, and r = 0.43 to 0.57 for Thailand).

Table 11: Grade 8 Students' Attitudes towards Science in Predicting their Science Achievement

	Malaysia		Singapore		Thailand		Indonesia	
	β	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*
Intercept	187.25*	20.46	392.68*	12.58	318.88*	19.10		
Gender	-5.45*	2.45	-3.41	1.90	-4.77*	2.13	-	-
Students like science	9.40*	1.69	7.17*	1.22	8.22*	1.28	-	-
Students value science	12.49*	1.63	7.31*	1.17	4.93*	1.41	-	-
Students confident in science	1.45	1.89	5.21*	0.98	-.23	1.58	-	-
Adjusted R^2	.14		.10		.06		-	

*p < 0.05; (-) No statistics are computed because there are no valid cases

Based on Table 11, the largest β value of 12.49 for students value science suggests that this variable makes the strongest unique significant contribution to explaining the dependent variable for the Malaysian sample, when the variance explained by all the other variables in the model is controlled for. The significant β value of 4.93 (students value science) for Thai samples was the lowest significant value indicating that it made the least contribution. On the other hand, Malaysian and Thai female students scored significantly higher than their counterparts on the TIMSS science assessment.

Table 12: Correlations between Attitudes towards Mathematics with Mathematics Achievement

	Malaysia							
	SLM		SVM		SCM		Mathematics	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLM			0.51*	0.01	0.55*	0.01	0.23*	0.02
SVM					0.35*	0.02	0.16*	0.03
SCM							.0.21*	0.02
Mathematics								
	Singapore							
	SLM		SVM		SCM		Mathematics	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLM			0.55*	0.01	0.67*	0.01	0.27*	0.02
SVM					0.41*	0.01	0.12*	0.02
SCM							0.40*	0.01
Mathematics								
	Thailand							
	SLM		SVM		SCM		Mathematics	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLM			0.54*	0.01	0.56*	0.01	0.22*	0.02
SVM					0.38*	0.01	0.20*	0.02
SCM							.0.15*	0.02
Mathematics								
	Indonesia							
	SLM		SVM		SCM		Mathematics	
	r	SE	*r*	SE	*r*	SE	*r*	SE
SLM			0.53*	0.01	0.60*	0.01	0.20*	0.01
SVM					0.40*	0.01	0.13*	0.01
SCM							0.19*	0.01
Mathematics								

*$p < 0.05$; SLM – Students Liking Mathematics; SVM – Students Value Mathematics; SCM – Students' Confidence in Mathematics

The results shown in Table 12 indicated that Grade 8 students' liking, valuing, and confidence of learning mathematics were positively and significantly associated with their mathematics achievement (r = 0.16 to 0.23 for Malaysia; r = 0.12 to 0.40 for Singapore; r = 0.15 to 0.22 for Thailand, r = 0.13 to 0.20 for Indonesia). Southeast Asian Grade 8 students' liking, valuing, and confidence of learning mathematics were also moderately, positively, and significantly correlated among each other (r = 0.35 to 0.55 for Malaysia, r = 0.41 to 0.67 for Singapore, r = 0.38 to 0.56 for Thailand, r = 0.40 to 0.60 for Indonesia).

Table 13: Grade 8 Students' Attitudes towards Mathematics in Predicting their Mathematics Achievement

	Malaysia		Singapore		Thailand		Indonesia	
	β	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*
Intercept	266.93*	17.73	459.79*	10.49	265.07*	17.19	352.93*	26.65
Gender	-8.59*	2.09	-7.55*	1.67	-7.11*	2.16	-5.39*	2.06
Students like mathematics	6.95*	1.74	.79	1.13	7.96*	1.74	10.63*	1.89
Students value mathematics	1.89	1.49	-3.01*	.78	5.19*	1.18	0.30	1.55
Students confident in mathematics	8.61*	1.68	17.35*	1.06	2.89	1.69	-8.17*	2.77
Adjusted R^2	.07		.17		.06		.02	

*$p < 0.05$

Based on Table 13, the largest β value of 17.35 for students confident in mathematics suggests that this variable makes the strongest unique significant contribution to explaining the dependent variable for the Singaporean sample, when the variance explained by all the other variables in the model is controlled for. The significant β value of -3.01 (students' value mathematics) for the Singaporean samples was the lowest significant value indicating that it made the least contribution. On the other hand, Malaysian, Singaporean, Thai, and Indonesian female students also scored significantly higher than their counterparts on the TIMSS mathematics assessment.

Conclusion

The results of the present study indicated that eighth graders' liking and valuing of learning science were positively and significantly associated with science

achievement in Malaysia, Singapore, and Thailand. Students' liking of mathematics was positively and significantly associated with mathematics achievement in Malaysia, Thailand, and Indonesia whereas students' confidence in mathematics was significantly associated with mathematics achievement in Malaysia, Singapore, and Indonesia. On the other hand, Malaysian and Thai female students scored significantly higher than their counterparts on the TIMSS science assessment whereas Malaysian, Singaporean, Thai, and Indonesian female students scored significantly higher than their counterparts on the TIMSS mathematics assessment. It is noteworthy to understand that the relationship between positive attitudes and high achievement is bidirectional, with attitudes and achievement mutually influencing each other, e.g., students who are good at science and mathematics also are more likely to enjoy learning science and mathematics. Due to the fact that this study was a non-experimental survey research using secondary data drawn from the TIMSS 2011 database, it is highly recommended that an experimental research design should be adopted to further investigate the predictive effects of attitudes toward science and mathematics on students' science and mathematics achievement in future researches.

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