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THE PREDICTIVE EFFECTS OF ENGAGEMENT IN SCIENCE LESSONS AND ATTITUDES TOWARD SCIENCE ON SOUTHEAST ASIAN GRADE 8 STUDENTS' SCIENCE ACHIEVEMENT IN TIMSS 2015

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Abstract: This study explored the predictive effects of students' engagement in science lessons and attitudes toward science on science achievement among Southeast Asian eighth graders in TIMSS 2015. In this study, students' views on engaging teaching in science lessons, students' interest in and liking of learning science, 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 were measured. Data were obtained from 9,726 Malaysian students, 6,116 Singaporean students, and 6,482 Thai students who participated in TIMSS 2015. The results of the present study indicated that Southeast Asian eighth graders' views on engaging teaching in science lessons, liking, valuing, and confidence in learning science were positively and significantly associated with their science achievement in TIMSS 2015 except for the relationship between students confidence in science with science achievement for Malaysian samples. Southeast Asian eighth graders' liking, valuing, and confidence in science also showed significant predictive effects on their science achievement except for Malaysian grade 8 students' confidence in science which showed an inverse contribution to science achievement. On the other hand, Malaysian and Thai female students scored significantly higher than their male counterparts on the TIMSS 2015 science assessment. This study provides information on prerequisites of Southeast Asian students' science learning. Implications of the findings for educational policy and practice are discussed.

***Keywords*:** Engagement in science lessons, attitudes toward science, science achievement; TIMSS

Introduction

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 Singapore and Korea are the top achievers in science at the fourth grade whereas Japan, Russian Federation, and Hong Kong SAR are listed in the top five. At the eighth grade, Singapore is the top achiever in science whereas Japan, Chinese Taipei, Korea, and Slovenia are listed in the top five. East Asian countries like Singapore, Hong Kong SAR, Korea, Chinese Taipei, and Japan are also the top achievers in mathematics at the fourth grade and eighth grade. On the other hand, Southeast Asian countries like Malaysia and Thailand was ranked 24th and 28th in TIMSS 2015 science assessment at the eighth grade. Malaysia and Thailand was also ranked 22nd and 30th in TIMSS 2015 mathematics assessment at the eighth grade.

Even though the curricular policies and the school resources often set the tone for accomplishment as well as teaching effectiveness, what students experience in the classroom are more likely to have a considerable direct impact on their science learning. It can be concluded that classroom instruction is at the core of student learning. In relation to this, the concept of student content engagement has been highlighted by McLaughlin, McGrath, Burian-Fitzgerald, Lanahan, Scotchmer, Enyeart, and Salganik (2005) in an effort to build a better linkage between curriculum and instruction.

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It is undeniable that factors which might have contributed to the outstanding science 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 countries in the Southeast-Asian region. Three out of the 11 SEAMEO member countries, Malaysia, Singapore, and Thailand, participated in TIMSS 2015. 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. A summary of the Grade 8 science and mathematics performance of these three Southeast Asian countries from TIMSS 1995 to TIMSS 2015 is provided in Table 1.

Table 1: TIMSS (Grade 8) science scores for Malaysia, Singapore, and Thailand (1995 – 2015)

		TIMSS Science Scores of Grade 8 Students		
Year	**No. of Participating Countries**	**Malaysia**	**Singapore**	**Thailand**
1995	45	-	580	-
1999	38	492	568	482
2003	46	510	578	-
2007	59	471	567	471
2011	63	426	590	451
2015	46	471	597	456

The purpose of the present study is to examine the predictive effects of students' views on engaging teaching in science lessons and attitudes toward science on science achievement among eighth grade students in Southeast Asian countries who participated in the TIMSS 2015 assessment. The research question that underpinned this study was: Using the TIMSS 2015 data, how well do Grade 8 Southeast Asian students' views on engaging teaching in science lessons and attitudes toward *science predict their science achievement?*

Review Of Literature

Effective Pedagogical Practices and Students' Engagement in Science Learning

Engagement or sometimes being referred to as participation or involvement is a type of commitment to appear at a certain time and place, in educational contexts, should be the school or various learning environment, be it in or out-of-school or home. Research showed that students' attitude towards learning will be better reinforced if teachers use a plethora of diverse strategies that include innovative pedagogical approaches and interesting instructional materials to engage or involve students' learning. For example, teachers could arouse students' curiosity and interest towards science learning by relating the lessons to the environmental phenomena and their daily lives. Moreover, viewing from constructivist perspective emphasizing on students' prior knowledge, teachers should be prepared and consider the initial ideas of students to develop further. Students should also be given more explanatory power so that their ideas can be developed into useful concepts (Martin, Sexton, Wagner, & Gerlovich, 1994).

Science is a constantly evolving field. Students will become more effective citizens by being able to locate, analyse, and critique information to form their own opinions since everyday people are required to make decisions in unfamiliar contexts (Tytler, 2007). Hence, science curriculum should not be presented with too many superficial ideas, leaving students with disconnected ideas that cannot be used to solve problems and explain phenomena they encounter in their everyday world (Krajcik & Merritt, 2012). Educators are also encouraged to use effective questioning techniques to elicit students' prior knowledge as well as to promote their communication, thinking, and reasoning skills. For example, Treffers (1987) suggested that students should be given the opportunity to reflect on their own science related experiences by asking them critical questions in related context. In fact, according to researchers, interactive questioning provides the context for modifications of the schema and the building of new schemas. Through the process of accommodation as an alternative, there

will also be the breaking up of the present schema into subschemas to facilitate teaching and learning (Treffers, 1987 in Aida Suraya, 1997).

Feedback is one of the most powerful influences on learning and achievement (Hattie & Timperley, 2007). Students will hence be more engaged in learning if teachers are able to provide useful feedback with praise for their good effort completed for given tasks and summary on what the students should have learned from each lesson. Students should also be encouraged to improve their performance from time to time by engaging in various types of learning environment, be it within or out-of-school and home.

Psychological Factors and Students' Engagement in a Learning Environment

Literature revealed that 'learning' occurs if the learners communicate and interact with their learning environment. Learners must be engaged actively and individually to discover, transform, and 'own' complex information (Martin, et al., 1994). Students' engagement in learning is found to be affected by a number of cognitive and socio-psychological factors such as values, attitudes, interest, motivation and expectation. Numerous researches were conducted on students' engagement in science including areas of cognitive development [e.g., by Piaget (1964)] and problem-solving behaviour [e.g., by Garton (2004)]. There is also research on academic learning time spent among students, e.g., the study on 'time on task behaviors' (Brophy, 1998 in Chapman, 2005).

A big challenge to science teaching is in the affective domain (Quick & Anderson, 2005). Hence, apart from the cognitive domains of learning as proposed by Bloom's taxonomy, the planning of science lessons should also consider the affective domains as suggested in the Krathwohl's taxonomy of educational objectives. These include the levels of receiving, responding, valuing, organization, and characterization by value (Krathwohl, Bloom & Masia, 1956). These indicators may serve as guidelines for any evaluative studies on students' active engagement in science learning as a result of their attitude, interest, or motivation levels. For example, students with high 'self-esteem' (i.e., the general feelings of self-worth or self-value) will be more engaged on certain tasks such as science activities as they have of themselves towards their own capacity to succeed at the tasks given. Those with personal interest on particular topics will be more likely to be engaged in that topics and develop long-term interest to pursue further.

Students who believe they have the ability and confidence to succeed in the learning tasks (i.e., with expectancy and self-efficacy beliefs) would likely to be more engaged in the given tasks such as science activities. Those who have intrinsic motivation will find the task inherently enjoyable and be more engaged in the activities (Atkinson, Atkinson, Smith & Bem, 1993; Lefton, 1991; Weiner, 1979). When the learners are motivated and involved or engaged actively (Darling-Hammond, 1997) in the subject taught such as mathematics, they are willing to pursue the assigned intellectual activities even when these become difficult (Finn, Pannozzo, & Voekl, 1995; Natriello, 1984; Reeve, 2005; Schlechty, 2001).

Self-Efficacy Beliefs and Achievement in Science

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 behavior 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 behavior 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 2015 database (http://timssandpirls.bc.edu/timss2015/international-database/). A total of 22,324 Grade 8 students from Malaysia (N =9,726), Singapore (N = 6,116), Thailand (N = 6,482) participated in the TIMSS 2015 assessment.

Science Achievement

The TIMSS 2015 science achievement scale was based on items involving content (in Biology, Chemistry, Physics, Earth Science) and cognitive (Knowing, Applying, Reasoning) domains in science. 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) Analyzer 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' Views on Engaging Teaching in Science Lessons

The Students' Views on Engaging Teaching in Science Lessons Scale was developed to measure students' views on engaging teaching in science lessons. The scale was based on ten items (BSBS22A to BSBS22J). 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 0.930, 0.935, 0.921 for Malaysia, Singapore, and Thailand, respectively.

Students Liking for Learning Science

The Students Like Learning Science Scale was developed to measure students' interest in and liking for learning science. The scale was based on nine items (BSBS21A to BSBS21I). 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 0.897, 0.923, and 0.860 for Malaysia, Singapore, and Thailand, respectively.

Students Value Science

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 nine items (BSBS24A to BSBS24I). 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 0.890, 0.902, and 0.914 for Malaysia, Singapore, and Thailand, respectively.

Students Confident in Science

The Student Confident in Science Scale assesses students' self-confidence or self-concept in their ability to learn science. The scale was based on eight items (BSBS23A to BSBS23H). 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 0.715, 0.908, and 0.747 for Malaysia, Singapore, and Thailand, 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 and Findings

Table 2: Descriptive statistics (weighted) with average scale scores for students' views on engaging teaching in science lessons, students like learning science, students value science, and students' confidence in science

Statement Code	Statement	Malaysia		Singapore		Thailand	
		M	SD	M	SD	M	SD
Students' Views on Engaging Teaching in Science Lessons							
BSBS22A	I know what my teacher expects me to do.	1.67	.679	1.76	.670	1.92	.761
BSBS22B	My teacher is easy to understand.	1.63	.703	1.84	.786	1.65	.713
BSBS22C	I am interested in what my teacher says.	1.63	.700	1.85	.798	1.65	.714
BSBS22D	My teacher gives me interesting things to do.	1.68	.730	1.90	.803	1.69	.740
BSBS22E	My teacher has clear answers to my questions.	1.55	.685	1.78	.753	1.69	.746
BSBS22F	My teacher is good at explaining science.	1.50	.653	1.71	.742	1.58	.711
BSBS22G	My teacher lets me show what I have learned.	1.75	.725	1.93	.771	1.75	.748
BSBS22H	My teacher does a variety of things to help us learn.	1.44	.637	1.81	.754	1.56	.702
BSBS22I	My teacher tells me how to do better when I make a mistake.	1.50	.658	1.80	.742	1.58	.704
BSBS22J	My teacher listens to what I have to say	1.72	.744	1.84	.756	1.71	.750
	Average scale score	10.21 (0.05)		9.78 (0.04)		10.20 (0.04)	
Students Like Learning Science							
BSBS21A	I enjoy learning science.	1.46	.644	1.76	.802	1.62	.701
BSBS21B	I wish I did not have to study science.*	3.48	.739	2.98	.964	3.06	.983
BSBS21C	Science is boring.*	3.40	.769	3.03	.909	2.91	.980
BSBS21D	I learn many interesting things in science.	1.39	.613	1.54	.701	1.46	.646
BSBS21E	I like science.	1.52	.692	1.82	.847	1.76	.747
BSBS21F	I look forward to learning science in school.	1.81	.792	1.94	.871	2.03	.816
BSBS21G	Science teaches me how things in the world work.	1.34	.578	1.59	.687	1.54	.675
BSBS21H	I like to conduct science experiments.	1.50	.685	1.63	.804	1.54	.726
BSBS21I	Science is one of my favourite subjects.	1.65	.774	2.00	.967	1.80	.813
	Average scale score	10.85 (0.06)		10.29 (0.04)		10.34 (0.05)	
Students Value Science							
BSBS24A	I think learning science will help me in my daily life.	1.54	.660	1.63	.700	1.41	.605

BSBS24B	I need science to learn other school subjects.	1.69	.782	2.05	.845	1.68	.724
BSBS24C	I need to do well in science to get into the university of my choice.	1.68	.696	1.73	.780	1.54	.690
BSBS24D	I need to do well in science to get the job I want	1.70	.716	1.88	.863	1.57	.715
BSBS24E	I would like a job that involves using science.	1.88	.849	2.20	.978	1.86	.848
BSBS24F	It is important to learn about science to get ahead in the world.	1.64	.647	1.66	.719	1.55	.692
BSBS24G	Learning science will give me job opportunities when I am an adult.	1.68	.700	1.69	.751	1.57	.695
BSBS24H	My parents think that it is important that I do well in science.	1.69	.710	1.65	.721	1.64	.719
BSBS24I	It is important to do well in science.	1.65	.666	1.50	.649	1.54	.687
	Average scale score	10.37 (0.04)		10.24 (0.03)		10.75 (0.04)	
Students Confident in Science							
BSBS23A	I usually do well in science.	2.82	1.204	2.14	.855	2.01	.703
BSBS23B	Science is more difficult for me than for many of my classmates.*	2.31	1.182	2.75	.891	2.33	.896
BSBS23C	Science is not one of my strengths.*	2.36	1.185	2.62	.985	2.40	.939
BSBS23D	I learn quickly in science.	2.94	1.110	2.20	.838	2.15	.765
BSBS23E	I am good at working out difficult science problems.	2.63	1.241	2.43	.868	2.26	.789
BSBS23F	My teacher tells me I am good at science.	2.46	1.236	2.57	.870	2.52	.859
BSBS23G	Science is harder for me than any other subject.*	2.20	1.151	2.82	.924	2.39	.930
BSBS23H	Science makes me confused.*	2.21	1.164	2.68	.946	2.46	.958
	Average scale score	8.66 (0.03)		9.66 (0.04)		9.32 (0.03)	

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

Based on the average scale scores as shown in Table 2, Malaysian and Thai students engaged in the science lessons the most as compared to Singaporean students. 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.

Tables 3 to 6 show the percentage of Southeast Asian students who engaged in science lessons, liked learning science, valued science, confident in science with their average science achievement, respectively.

Students' Views on Engaging Teaching in Science Lessons

Table 3: Students' views on engaging teaching in science lessons

Country	N	Very Engaging Teaching		Engaging Teaching		Less than Engaging Teaching		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	9581	48.69 (1.39)	489.30 (3.55)	42.25 (.98)	467.01 (4.83)	9.07 (.84)	407.69 (10.41)	10.21 (0.05)
Singapore	6086	35.04 (.92)	606.47 (4.06)	51.78 (.74)	594.96 (3.28)	13.19 (.84)	577.77 (5.23)	9.78 (0.04)
Thailand	6451	49.51 (1.23)	460.83 (4.14)	42.25 (.89)	451.59 (4.78)	8.24 (.65)	450.94 (8.16)	10.20 (0.04)

Average		44.41	518.87	45.42	504.52	10.17	478.80	10.06
		(.69)	(2.27)	(.51)	(2.51)	(.45)	(4.74)	(0.03)

Note: Standard errors in parentheses

On average, 49% of the Malaysian eighth grade students reported being very engaged during their science lessons. 42% reported being engaged and another 9% reported being less than engaged in science lessons. Very engaged students had higher science achievement than their counterparts who reported being engaged and students who were less than engaged (489 vs. 467 and 408, respectively). In contrast, only 35% of the Singaporean eighth grade students reported being very engaged during their science lessons, 52% reported being engaged, and another 13% reported being less than engaged. Engaged students had higher science achievement than their counterparts who reported being engaged and less than engaged (606 vs. 595 and 578, respectively). Almost 50% of the Thai eighth grade students reported being very engaged during their science lessons. 42% reported being engaged and another 8% reported being less than engaged in science lessons. Very engaged students had higher science achievement than their counterparts who reported being engaged and students who were less than engaged (461 vs. 452 and 451, respectively).

Students Like Learning Science

Table 4: Students like learning science

Country	N	Very Much Like Learning Science		Like Learning Science		Do Not Like Learning Science		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	9615	51.48	498.45	41.52	453.59	7.00	389.27	10.85
		(1.33)	(3.17)	(1.00)	(5.03)	(0.66)	(10.34)	(0.06)
Singapore	6084	38.01	622.25	47.47	588.30	14.52	558.06	10.29
		(.84)	(3.84)	(.76)	(3.26)	(.62)	(4.49)	(0.04)
Thailand	6421	37.19	477.48	54.67	445.10	8.14	433.72	10.34
		(1.29)	(4.45)	(1.09)	(4.32)	(.60)	(6.79)	(0.05)
Average		42.23	532.73	47.88	495.66	9.89	460.35	10.49
		(.68)	(2.23)	(.56)	(2.46)	(.36)	(4.39)	(0.03)

Note: Standard errors in parentheses

Table 4 presents the Grade 8 students' results for the Students Like Learning Science Scale in TIMSS 2015. On average, 51% of the Malaysian students like learning science very much and only 7% do not like learning science as compared to 38% of the Singaporean students who like learning science very much and 15% do not like learning science and 37% of the Thai students who like learning science very much and only 8% do not like learning science. Accompanying the decrease in liking learning science is a widening achievement gap between students who like learning science very much and those who do not like learning science: Malaysian students (498 vs. 389), Singaporean students (622 vs. 558), Thai students (477 vs. 433), respectively. It can be concluded that students who liked learning science very much had higher average science achievement than those who liked or did not like learning science.

Students Value Science

Table 5: Students value science

Country	N	Strongly Value Science		Value Science		Do Not Value Science		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	9455	37.90	482.65	53.52	481.45	8.58	386.58	10.37
		(.96)	(3.36)	(.83)	(4.30)	(.80)	(8.88)	(0.04)
Singapore	6077	37.37	621.01	53.07	588.51	9.56	547.81	10.24
		(.75)	(3.38)	(.73)	(3.37)	(.51)	(4.67)	(0.03)
Thailand	6446	49.35	472.22	44.81	442.48	5.85	426.86	10.75
		(1.15)	(4.61)	(1.06)	(4.25)	(.40)	(7.15)	(0.04)
Average		41.54	525.29	50.46	504.15	8.00	453.75	10.45
		(.56)	(2.21)	(.51)	(2.31)	(.35)	(4.11)	(0.02)

Note: Standard errors in parentheses

Table 5 presents the results for the TIMSS 2015 Students Value Science Scale for Grade 8 students. On average, 38% of the Malaysian students strongly value science and only 9% do not value science as compared to 37% of the Singaporean students who strongly value science and 10% who do not value science, and 49% of the Thai students strongly value science and only 6% who do not value science. Accompanying the decrease in valuing science is a widening achievement gap between students who strongly value science and those who do not value science: Malaysian students (483 vs. 387), Singaporean students (621 vs. 548), and Thai students (472 vs. 427). Hence, across Grade 8, students who said they strongly valued science typically had higher achievement than students who valued it, and those students, in turn, had higher achievement than students who did not value science.

Students' Confidence in Science

Table 6: Students' confidence in science

Country	N	Very Confident in Science		Confident in Science		Not Confident in Science		Average Scale Score
		%	Average Achievement	%	Average Achievement	%	Average Achievement	
Malaysia	9503	5.57	511.99	25.25	455.34	69.18	476.78	8.66
		(.33)	(5.26)	(.64)	(4.80)	(.70)	(4.22)	(0.03)
Singapore	6083	16.93	633.02	39.53	608.30	43.54	572.10	9.66
		(.65)	(4.74)	(.65)	(3.46)	(.86)	(3.50)	(0.04)
Thailand	6440	6.82	512.75	36.57	467.35	56.61	442.09	9.32
		(.46)	(6.34)	(.95)	(4.58)	(1.14)	(4.18)	(0.03)
Average		9.77	552.59	33.78	510.33	56.44	496.99	9.21
		(.29)	(3.17)	(.44)	(2.49)	(.53)	(2.30)	(0.02)

Note: Standard errors in parentheses

Table 6 presents the Grade 8 students' results for the TIMSS 2015 Students' Confidence in Science Scale. On average, only 6% of the Grade 8 students in Malaysia expressed confidence in their science ability, with 25% confident in science, and 69% not confident in science. On the other hand, 17% of Singaporean students, on average, expressed confidence in their science ability, with 40% confident in science, and 44% not confident in science. 7% of the Grade 8 students in Thailand expressed confidence in their science ability, with 37% confident, and 57% not confident in science. Accompanying the decrease in confidence in science is a widening achievement gap between students who are very confident in science and those who are not confident in science: Malaysian students (512 vs. 477), Singaporean students (633 vs. 572), and Thai students (513 vs. 442), respectively. Hence, across Grade 8, students who expressed confidence in their science ability typically had higher achievement than students who were confident, and those students, in turn, had higher achievement than students who were not confident in science.

Correlation and simultaneous multiple regression analyses were conducted separately for each education system to determine whether or not students' views on engaging teaching in science lessons and attitudes toward science were predictive of their science achievement (see Table 7 and Table 8).

Table 7: Correlations between students' views on engaging teaching in science lessons, students liking science, students value science, students' confidence in science with science achievement

	Malaysia									
	ESL		SLS		SVS		SCS		Science	
	r	SE	*r*	SE	*r*	SE	*r*	SE	*r*	SE
ESL	1.00	.00	.70*	.01	.41*	.03	-.14*	.02	.23*	.03
SLS			1.00	.00	.37*	.02	-.25*	.01	.35*	.03
SVS					1.00	.00	-.01	.01	.20*	.03
SCS							1.00	.00	-.16*	.02
Science									1.00	.00
	Singapore									
	ESL		SLS		SVS		SCS		Science	
	r	SE	*r*	SE	*r*	SE	*r*	SE	*r*	SE
ESL	1.00	.00	.63*	.01	.50*	.01	.50*	.01	.08*	.02
SLS			1.00	.00	.62*	.01	.71*	.01	.27*	.02

SVS					1.00	.00	.48*	.01	.25*	.02
SCS							1.00	.00	.24*	.02
Science									1.00	.00
	Thailand									
	ESL		**SLS**		**SVS**		**SCS**		**Science**	
	r	**SE**	***r***	**SE**	***r***	**SE**	***r***	**SE**	***r***	**SE**
ESL	1.00	.00	.66*	.01	.61*	.01	.41*	.01	.07*	.03
SLS			1.00	.00	.57*	.01	.58*	.01	.22*	.02
SVS					1.00	.00	.35*	.01	.21*	.02
SCS							1.00	.00	.17*	.02
Science									1.00	.00

*$p < 0.05$; ESL- Engaging Science Lessons; SLS – Students Liking Science; SVS – Students Value Science; SCS – Students' Confidence in Science

The results in Table 7 indicated that Grade 8 students' views on engaging teaching in science lessons, liking, valuing, and confidence of learning science were significantly associated with science achievement (r = 0.16 to 0.35 for Malaysia; r = 0.08 to 0.27 for Singapore, r = 0.07 to 0.22 for Thailand). However, Malaysian students' confidence in science was negatively correlated with their science achievement. Southeast Asian students' views on engaging teaching in science lessons, liking, valuing, and confidence of learning science were also moderately and significantly correlated among each other (r = 0.14 to 0.70 for Malaysia, r = 0.48 to 0.71 for Singapore, and r = 0.35 to 0.66 for Thailand).

Table 8: Grade 8 students' views on engaging teaching in science lessons and attitudes towards science in predicting their science achievement

	Malaysia		**Singapore**		**Thailand**	
	β	***SE***	***β***	***SE***	***β***	***SE***
Constant	308.52*	25.22	469.79*	10.98	333.23*	15.88
Gender	-6.10*	3.01	-5.95	3.40	-15.36*	4.55
Engaging in Science Lessons	-2.55	1.31	-9.19*	1.18	-11.07*	1.90
Students like science	16.12*	1.32	9.76*	1.11	9.44*	1.29
Students value science	5.47*	1.19	7.95*	.98	9.09*	1.54
Students confident in science	-4.33*	.82	3.95*	.89	5.14*	1.36
Adjusted R^2	.13		.11		.09	

*$p < 0.05$

Based on Table 8, the largest β value (16.12 and 9.76, respectively) of students like science suggests that this variable makes the strongest unique significant contribution to explaining science achievement for the Malaysian and Singaporean samples, when the variance explained by all the other variables in the model is controlled for. The significant β values (4.33, 3.95, and 5.14) of students confident in science for Malaysian, Singaporean, and Thai samples were the lowest indicating that students confident in science made the least contribution to their science achievement. Malaysian grade 8 students' confidence in science showed an inverse contribution to science achievement. On the other hand, Malaysian and Thai female students scored significantly higher than their male counterparts on the TIMSS 2015 science assessment.

Conclusion

The results of the present study indicated that Southeast Asian eighth graders' views on engaging teaching in science lessons, liking, valuing, and confidence in learning science were positively and significantly associated with their science achievement in TIMSS 2015 except for the relationship between students confidence in science with science achievement for Malaysian samples. Southeast Asian eighth graders' liking, valuing, and confidence in science also showed significant predictive effects on their science achievement except for Malaysian grade 8 students' confidence in science which showed an inverse contribution to science achievement. On the other hand, Malaysian and Thai female students scored significantly higher than their male counterparts on the TIMSS 2015 science 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 also are more likely to enjoy learning science. Due to the fact that this study was a non-experimental survey research using secondary data drawn from the TIMSS 2015 database, it is highly recommended that an experimental research design should be adopted to further investigate the predictive

effects of students' views on engaging teaching in science lessons and attitudes toward science on students' science achievement in future researches.

References

Aida Suraya, M.Y. (1997). *Creating constructivist environment in the teaching of decimals*. Paper presented and compiled in the proceedings of International Conference on Cooperative Learning and Constructivism (CLAC) in Science and Mathematics Education, 1 to 4 April at SEAMEO RECSAM.

Atkinson, R. L., Atkinson, R. C., Smith, E. E. & Bem, D .J. (1993). *Introduction to Psych*ology. 11th Edition.
Fort Worth, TX: Harcourt Brace Jovanich, Inc.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman.

Chapman, E. (2005). Assessing student engagement rates. *Eric Digest Online*. Retrieved 5 March 2006 from http://www.ericdigests.org/2005-2/engagement.html

Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work*. San Francisco: Jossey-Bass.

Finn, J.D., Pannozzo, G.M. & Voekl, K.E. (1995). Disruptive and inattentive-withdrawn behaviour and achievement among fourth graders. *Elementary School Journal*, *95*, 421-454.

Garton, A.F. (2004). *Exploring cognitive development: The child as problem solver*. Victoria, Australia: Blackwell Publishing.

Glynn, S.M., Taasoobshirazi, G., & Brickman, P. (2007). Nonscience majors learning science: A theoretical model of motivation. *Journal of Research in Science Teaching*, *44*(8), 1088-1107.

Hattie, J. & Timperley, H. (2007). The power of feedback. *Review of Educational Research*. March 2007, 77(1), 81-112.

Krajcik, J, & Merritt, J. (2012). *Engaging student in scientific practices: What does constructing and revising models look like in the science classroom?* March 2012 issues of NSTA's K-12 journals. Retrieved June 25, 2015 from http://nstahosted.org/pdfs/ngss/resources/201203_framework-krajcikandmerritt.pdf

Krathwohl, D., Bloom, B., & Masia, B. (1956). Taxonomy of Educational Objectives. *Handbook II: Affective Domain*. New York: David McKay.

Lefton, L. A. (1991). *Psychology*. Fourth edition. Boston, MA: Allyn and Bacon.

Linnenbrink, E. A., & Pintrich, P. R. (2003). The role of self-efficacy beliefs in student engagement and learning in the classroom. *Reading & Writing Quarterly: Overcoming Learning Difficulties*, *19*(2), 119-137.

McLaughlin, M., McGrath, D.J., Burian-Fitzgerald, A., Lanahan, L., Scotchmer, M., Enyeart, C., & Salganik, L. (2005). *Student content engagement as a construct for the measurement of effective classroom instruction and teacher knowledge*. Retrieved from http://www.air.org/files/AERA2005 Student_Content_Engagement11.pdf.

Martin, M. O., Mullis, I. V., Foy, P., & Stanco, G. M. (2012). *TIMSS 2011 International Results in Science*. Amsterdam, The Netherlands: International Association for the Evaluation of Educational Achievement.

Martin, R.E., Sexton, C., Wagner, K. & Gerlovich, J. (1994). *Teaching science for all children*. Boston: Allyn and Bacon.

Mislevy, R. J., & Sheehan, K. M. (1987). Marginal estimation procedures. In A. E. Beaton (Ed.), *The NAEP 1983/84 Technical Report* (NAEP Report 15-TR-20, pp. 121–211) Princeton, NJ: Educational Testing Service.

Mislevy, R. J., & Sheehan, K. M. (1989). Information matrices in latent-variable models. *Journal of Educational and Behavioral Statistics*, *14*(4), 335-350.

Natriello, G. (1984). Problems in the evaluation of students and student disengagement from secondary schools. *Journal of research and development in education*, *17*, 14-24.

Nolen, S. B. (2003). Learning environment, motivation, and achievement in high school science. *Journal of Research in Science Teaching*, *40*(4), 347-368.

Ong, S. L., & Gonzalez, E. J. (2012). *TIMSS 2007: What can we learn?* (Eds.). Penang: SEAMEO-RECSAM.

Ong, S. L., Gonzalez, E. J., & Shanmugam, S.K.S. (2013). *TIMSS 2011: What can we learn together in reaching greater heights?* (Eds.). Penang: SEAMEO-RECSAM.

Palmer, D. (2007). What is the best way to motivate students in science? *Teaching Science: The Journal of the Australian Science Teachers Association*. *53*(1), 38-42.

Phillips, J. A. (2007). *HMEF 5043: Psychology of learning and instruction*. Kuala Lumpur, Malaysia: UNITEM Sdn. Bhd.

Piaget, J. (1964). *Judgment and reasoning in child*. Paterson N.J.: Litlefield Adams.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of educational Psychology*, *95*(4), 667.

Quick, M. & Anderson, L. (2005). Engaging students in the learning of science. USC College. Retrieved June 25, 2015 from http://cet.usc.edu/resources/teaching_learning/docs/learningscience_oct05.pdf

Reeve, J.M. (2005). *Understanding motivation and emotion*. 4th edition. Iowa: John Wiley & Sons, Inc.

Rubin, D. B. (1987).*Multiple imputation for nonresponse in surveys*. New York: Wiley.

Schlechty, P. C. (2001). *Shaking up the schoolhouse*. San Francisco: Jossey-Bass

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research*, *95*(6), 323-332.

Tytler, R. (2007). *Re-imagining science education: Engaging students in science for Australia's future*. Victoria, Australia: Australia Council for Educational Research. Retrieved June 25, 2015 from http://research.acer.edu.au/cgi/viewcontent.cgi?article=1002&context=aer

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology*, *71*(1), 3-25.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68-81.