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AFFECTIVE FACTORS CONTRIBUTING TO SOUTHEAST ASIAN AND EAST ASIAN EIGHTH GRADERS' SCIENCE ACHIEVEMENT IN TIMSS 2015

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Abstract

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. This proposed study is aimed to identify the affective factors contributing to eighth graders' science achievement in TIMSS among Southeast Asian and East Asian countries. The freely-downloadable secondary data were analyzed using IEA's International Database (IDB) Analyzer (version 4.0) for TIMSS, a plug-in for SPSS. TIMSS uses an imputation methodology, involving plausible values, to report student performance. This study found that students' views on engaging teaching in science (BSBGESL) were negatively and significantly contributed to eighth-grade students' science achievement in Thailand, Singapore, Chinese Taipei, and Hong Kong SAR. Students Like Learning Science (BSBGSLS) were positively and significantly contributed to eighth-grade students' science achievement in Malaysia, Singapore, Thailand, Hong Kong SAR, and Chinese Taipei. Students Confident in Science (BSBGSCS) were positively and significantly contributed to eighth-grade students' science achievement in Korea, Japan, Chinese Taipei, Hong Kong, Thailand, and Singapore. Students Value Science (BSBGSVS) was positively and significantly contributed to eighth-grade students' science achievement in Japan, Korea, Thailand, Chinese Taipei, Singapore, and Malaysia. Based on the research findings, policy recommendations were made to the Malaysian Ministry of Education to boost Malaysian eighth graders' science performance in the forthcoming TIMSS studies.
Keywords: *TIMSS, comparative study, affective factors, science achievement*

Introduction

Science extends explicitly to all aspects of the human life and culture, from protecting and enhancing human health to recognizing and addressing local, national, and global environmental issues. Students require early stage of learning science education and cognitive skills. It is essential not only to be a considerate person when involved in communication with society on important social challenges in science, but also to be able to make contributions across a wide variety of fields in science, medicine, and technology. The study of science in the primary and early secondary grades thereby establishes a vital framework for the potential employment and life achievement of the students.

On the other hand, students need to develop mathematical understanding to manage successfully in school and society. Mathematics is the foundation for further learning in several

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online) https://doi.org/10.33225/pec/20.78.1107

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school subjects, most notably the sciences and mathematics problem solving builds logical reasoning skills that can be applied in many situations. For students' everyday life, today and in the future, mathematics is pervasive, from managing money to a range of other tasks. The world is becoming increasingly "quantified," and all students need to have good knowledge of mathematical and technological thinking to live a fruitful life. Students need mathematics to be effective future citizens as this will help them to understand daily news and be well informed of world events, which are often described through increase and decrease of statistical data. Considering students' future careers, mathematics is important to some degrees in most occupations. It is required at a high level in many fields which need higher level training such as engineers, scientists, accountants, doctors, etc.

Quality education in science fosters scientific literacy. Research across a range of countries has demonstrated a positive correlation between high literacy in science and the level of basic education achieved (Pardo & Calvo, 2004; Shukla et al., 2005). Formal education will provide the students with basic science literacy for workplace readiness. Technology education in schools, however, can hardly meet the general public's needs to boost its scientific literacy. Informal and non-formal education in sciences are also key components of continuous learning.

Besides, the number of research awareness also plays a critical role in securing support from the public for continued developments in scientific fields. Community-based scientific education through science institutes, where all members of the community have the chance to learn in an informal and engaging environment about science and discoveries. Attempts to improve universal science literacy are an important factor in securing support from the public for continued developments in scientific fields.

Trends in International Mathematics and Science Study (TIMSS)

The International Association for the Assessment of Educational Achievement (hereafter abbreviated as IEA) pioneered international comparative evaluation of educational achievements in the 1960s as an attempt to get a deeper understanding of the impact of educational policies and procedures across various school systems. Trends in International Mathematics and Science Study (hereafter abbreviated as TIMSS), one of the international comparative assessments, is directed by IEA's TIMSS & PIRLS International Study Center at Boston College.

TIMSS seeks to help the participating countries make better decisions on how to improve mathematics and science by teaching and learning. Since 1995, TIMSS is a regular student assessment program in grades four and eight which has been administered every four years. TIMSS provides participating countries with a wealth of information about trends in the science and mathematics knowledge and skills of their respective students. At the heart of TIMSS is a wide-ranging state-of-the-art assessment of how well students master the essential science and mathematics content, concepts, and procedures that countries expect them to learn as they progress through primary and lower secondary school.

Problem Statement

Science education, which transcends the pervasive divide between natural sciences and social sciences, is potentially unique in its ability to promote the awareness and participation of new generations and to address the social, economic, and environmental aspects of global challenges. Therefore, addressing diversity and equity-related priorities of science education is of vital significance in the light of the global picture of a rapidly evolving world.

Malaysia joined TIMSS studies since 1999 at the eighth-grade level. Malaysia with a mean score of 492 was ranked 22nd place in 1999 among 38 participating countries, 21st place in 2003 among 46 participating countries with a mean score of 510, 21st place in 2007 among

https://doi.org/10.33225/pec/20.78.1107 ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)

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59 participating countries with a mean score of 471, 32nd place in 2011 among 63 participating countries with a mean score of 426, and 24th place in 2015 among 63 participating countries with a mean score of 471 (Table 1).

The results of the latest TIMSS 2015 phase indicate that in the fourth and eighth grades, Singapore, Korea, and Japan are the best ranked nations in education. Table 1 shows the TIMSS science scores for Southeast Asian and East Asian Eighth Grade Students (EGS) from 1995 to 2015.

Table 1

TIMSS (Grade 8) science scores for Southeast Asian and East Asian countries (1995 – 2015)

Year	No. of Participating Countries	TIMSS Science Scores of Grade 8 Students							
		Malaysia	Singapore	Thailand	Japan	Korea	Hong Kong, SAR	Chinese Taipei	Average
1995	45	-	580	-	554	546	510	-	N.A.
1999	38	492	568	482	550	549	530	569	488
2003	46	510	578	-	552	558	556	571	474
2007	59	471	567	471	554	553	530	561	500
2011	63	426	590	451	558	560	535	564	500
2015	63	471	597	456	571	556	546	569	500

Literature Review

Students' Engagement in Science Lessons and Science Achievement

Commitment or engagement is typically perceived to have behavioral, affective, and cognitive aspects (Fredricks et al., 2016). By attending school and engaging in school activities, students display interpersonal engagement, affectively by the feelings of joy and dedication to their schooling, and intellectually by engaging in learning. However, students' engagement research believed that a cumulative indicator of total attendance is a greater indicator of student outcomes than a single factor (Archambault, Janosz, Fallu, & Pagani, 2009). The participation of students in every assignment has greater academic achievement (Archambault et al., 2009; Lawson & Masyn, 2015; Wang & Eccles, 2013). Although this existing research has provided substantial evidence that engagement is important for student academic success, the variables affecting engagement are less well known.

Students' Attitudes toward Science and Science Achievement

TIMSS assessments routinely present a very strong evidence showing that students who display more positive attitudes toward science have considerably higher average science achievement, and TIMSS results are consistent with previous assessments. However, there were some exceptional cases, for example, in TIMSS 2015, it was found that 38% of Qatari students "very much like science," but their performance was significantly lower than Japanese and Korean students who showed 15% and 10%, respectively. Every successive TIMSS assessment has shown a positive association between student attitudes towards science and their success in

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science. There is a comprehensive study documenting that the more optimistic the attitudes of students towards mathematics and science, the higher the average achievement in mathematics and science (e.g., Lay et al., 2015; Lay et al., 2016; Lay et al., 2014; Ng & Kim, 2012; Ng et al., 2012; Ng, Lay et al., 2012; Reinikainen, 2007; TIMSS BC, 1999). To illustrate, a meta-analysis of students' attitudes towards education, it was found that attitudes towards mathematics or science were linked to mathematics and science achievement through 288 studies (Hattie, 2009)). However, it is noteworthy that the relationship between positive attitudes and high science achievement can go both ways, in which there were mutual influences between attitudes and achievement. For example, students who enjoy learning science are likely to be good at science or vice-versa.

On the other side of the coin, a considerable amount of study into the attitudes of students towards learning has examined the multifaceted motivation phenomenon (e.g., Ng, 2012; Ng et al., 2013; Valijarvi, 2013; Wigfield & Eccles, 2000). For example, students find the subject enjoyable and their interest on the topic may have an effect on the willingness of the students to learn. Concerning this, students' motivation can be affected by their self-confidence in learning the subject as revealed from literature by Ng et al. (2012) as well as Valijarvi (2013).

Students Like Learning Science and Science Achievement

Quality educators have indeed been described as those who love what they teach, who equate real life with subjects taught in the classroom, and who educate in a structured way. Children have indeed noted the use of globally competitive teaching approaches and the participation of students in constructive learning has a significant effect on their attitude to science at school (Osborne & Collins, 2001). Learners with positive behavior or attitudes to science are starting to have a more favorable outlook towards school-learned subjects and science class as a whole (Atwater et al., 1995). Science is described by many students as a noble discipline on an individual basis, and "smarter" is seen by students who excel in science.

Previous research, nevertheless, shows that there is a substantial decrease in interest in classroom instruction, starting at junior high and becoming much greater at secondary school (Sorge, 2006; Reiss, 2004). Furthermore, Osborne et al. (2003) reported that, considering the general understanding of the importance of experimental research, students are more concerned with science as a connected transmission for progress than as an orientation to the outcome of the mission.

Around the same time, learners did not think that research was intriguing, and they often discovered that, in their opinion, some science subjects were irrelevant. One of the other factors which could be responsible for the inability of students to study science was the lack of motivation and focus. And though, students need to support themselves in a student-teacher social atmosphere and even a student-student partnership where students have stronger academic results has to be encouraged and preserved in their desires and values.

Students Value Science and Science Achievement

Intrinsic motivation refers to doing an activity because it is interesting or enjoyable. And though, learners need to support oneself in a student-teacher social atmosphere and even a student-student partnership where students have stronger academic results has to be encouraged and preserved in their desires and values.

Some phenomena have been noted, amid a small number of studies undertaken on the attitudes of primary school children towards science (Yager & Penick, 1986, Murphy & Beggs, 2001, Pell & Jarvis, 2001). These include the teacher's position and significance, appreciation of science as necessary, impression of science class as optimistic, "fun" experience (Murphy &

https://doi.org/10.33225/pec/20.78.1107 ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)

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Beggs, 2001), in the behaviors of the pupils, a specific gender disparity (Jarman, 1993, Reiss, 2004) and a common keen interest in performing experiments (Reiss, 2004).

In addition, analyses of the degree of comfort of students with their science classes have found that the enjoyment of students resulting from science classes and their passion for learning science was influenced by their teaching process (Brok et al., 2005). It has been seen the exception of adult students, students view science as incredibly important and critical, even as an object in itself (Neathery, 1997). In terms of excitement, a significant number of primary school children talked about science, though its functional value is by no means ignored: about 90% of elementary school students believed that science would help them in their future careers, and more than 70% of them identified science as fascinating and useful in everyday life (Yager & Penick, 1986).

Students Confident in Science and Science Achievement

Motivation for studying means making the feeling that you have been going to succeed. A simple self-concept helps students to interact and display engagement, effort, and concentration with the teaching. The Student Trust in Science Scale measures the self-esteem or self-concept of students in their ability to grasp evaluation of science. Self-efficacy, known as confidence in one's capacity to successfully accomplish a particular task, was among the most powerful motivational determinants of how well a person performs in practically every undertaking. An individual's self is now a clear predictor of his or her dedication, determination, and plan, as well as learning and success. Past researchers have said that the consciousness of students regarding their skill in science has a consistent and critical influence on the production of their behavior towards science classes and science in general (Haladyna et al., 1982; George, 2000).

A high degree of self-efficacy against another task correlates to a greater desire to excel and makes the task more meaningful and satisfying (Schunk, 1991). Teachers' actions may provide students with verbal and nonverbal feedback of their success, so they use to develop their self-efficacy. Though that is valid for high school students, it was observed that elementary students had a reasonably clear and consistent sense of self-efficacy in science that did not rely on external influences, such as their personal progress in school or academic success in other disciplines (Pell & Jarvis, 2001).

If an individual has faith, he or she seems to engage in lessons more easily, to work better, and to try faster (Schunk & Miller, 2002). Thus, it should go without saying that learners try to develop and accomplish as both a result of higher confidence levels.

Research Objectives

This study embarks on the following objectives:

i) To identify affective factors [Students' Views on Engaging Teaching in Science (BSBGESL) lessons, Students Like Learning Science (BSBGSLS), Students Confident in Science (BSBGSCS), Students Value Science (BSBGSVS)] contributing to Grade 8 students' science achievement in TIMSS among Southeast Asian and East Asian countries;
ii) To make policy recommendations to the Ministry of Education to boost Malaysian Grade 8 students' science performance in the forthcoming TIMSS assessments.

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online) https://doi.org/10.33225/pec/20.78.1107

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Research Methodology

General Background

Data for the study were drawn from the TIMSS 2015 database (http://timssandpirls.bc.edu/timss2015/international-database/). TIMSS employs a two-stage stratified sampling approach. First, schools were selected based on the probability proportional to the school's size. The classrooms within the selected schools are randomly chosen afterward. Due to the TIMSS sampling scheme, the surveyed samples can represent the whole population in the participating countries. More information regarding data and sampling procedures of TIMSS can be found in the technical reports by Martin et al. (2016).

Science Achievement

The science achievement scale of TIMSS 2015 was focused on science subjects like information (Biology, Chemistry, Physics, Earth Science) and cognitive (Knowing, Implementing, Reasoning) domains. To report student results, TIMSS uses a synthetic data approach, which requires plausible values. Realistic values are natural factors from either the set of ratings, consists of a process proposed by Mislevy and Sheehan (1987, 1989) and based on Rubin's principle of imputation (1987) (i.e., random draws from the marginal posterior of the latent distribution used as a measure of science achievement). A plug-in for SPSS, the IEA International Database (IDB) Analyzer for TIMSS, had been used to aggregate the five plausible values and to generate their weighted average and to address standard errors.

Students' Views on Engaging Teaching in Science (SVETS) Lessons Scale

In TIMSS 2015 eighth grade science assessment, with ten remarks on the SVETS scale, students were graded according to their levels of agreement. "In science classes, students who observed "Extremely Stimulating Instruction" had a rating of at least 10.2, which correlates to their "agreeing a number" with five of the ten comments and, on average, "agreeing a little" with some of the other five. Students who encountered "Less than Engaging" instruction had a ranking of no more than 8.1, which correlates, on average, to their "disagree a little" with five of the ten assertions and "agree a little" with the remaining five. "Engaging Teaching" was witnessed by all other learners in science classes. [Malaysia, .931; Singapore, .935; Thailand, .922; Japan, .927; Korea, .940; Hong Kong SAR, .958; Chinese Taipei, 931]. The Cronbach Alpha coefficients for the SVETS scale were consistently high.

Students Like Learning Science (SLLS) Scale

Learners were graded on the SLLS scale according to their intention to comply with nine claims in the TIMSS 2015 eighth grade science examination. "Students who had a score of at least 10.7 on the scale of "Very Much Enjoy Studying Science," which relates to their "agreeing a number" for five of the nine assertions and, on average, "agreeing a little" with the remaining four. Students who "Do Not Like Learning Science" had a grade of no more than 8.3, referring, on average, to their "disagree a little" with five of the nine assertions and "agree a little" with the remaining four. "Like Learning Science" by all those learners. [Malaysia, .900; Singapore, .924; Thailand, .871; Japan, .919; Korea, .929; Hong Kong SAR, .926; Chinese Taipei, 929]. The Cronbach Alpha coefficients for the SLLS scale were incredibly strong.

https://doi.org/10.33225/pec/20.78.1107 ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)

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Students Confident in Science (SCS) Scale

Learners were graded on the SCS scale due to high degree of consensus with eight claims in the TIMSS 2015 eighth grade science assessment. Students "Very Confident in Science" would have a ranking of at least 11.5, which correlates with four of the eight claims and "agreeing a little" with the other four, on average, to their "agreeing a lot". Learners who had been "Not Confident in Science" had a grade of no more than 9.2, which correlates, on average, to their "disagree a little" with four of the eight claims and "agree a little" with the remaining four. "Confident in Science" were all the other teachers. [Malaysia, .716; Singapore, .908; Thailand, .750; Japan, .894; Korea, .927; Hong Kong SAR, .882; Chinese Taipei, 929]. The Cronbach reliability coefficient for the SCS scale was consistently strong.

Students Value Science (SVS) Scale

Students were graded on the SVS scale according to their degree of compliance with nine claims in the TIMSS 2015 eighth grade science assessment. Students who now have a rating of at least 10.7 on the measure of "Strongly Value Science," which translates to their "agreeing a lot" for five of the ninth claims and "agreeing a little" with all the other four, on average. Learners who used to have a ranking of "Do Not Value Science" much lower than 8.4, leading on average to their "disagreeing a little" with fifth of the ninth claims and "agreeing a little" with the remaining group, "Value Science" by all other teachers. [Malaysia, .894; Singapore, .906; Thailand, .915; Japan, .895; Korea, .919; Hong Kong SAR, .937; Chinese Taipei, 924]. The Cronbach 's alpha coefficient for the SVS scale was consistently high.

Research Results

Based on the average scale scores, as shown in Table 2 and Table 3, Malaysian (M = 10.21) and Thai (M = 10.20) eighth-grade students were the most engaged with teaching in science lessons. This is followed by Singaporean (M = 9.78), Hong Kong (M = 9.65), Chinese Taipei (M = 8.96), Japanese (M = 8.41), and Korean (M = 8.36) students.

In terms of students like learning science, Malaysian (M = 10.85), Thai (M = 10.34), and Singaporean (M = 10.29) eighth-grade students liked science learning the most. This is followed by Hong Kong (M = 9.87), Chinese Taipei (M = 9.16), Japan (M = 8.99), and Korea (M = 8.59) students.

In terms of students' confident in science, Singaporean (M = 9.66), Hong Kong (M = 9.44), and Thai (M = 9.32) eighth-grade students were the most confident in science. This is followed by Malaysian (M = 8.66), Korean (M = 8.66), Chinese Taipei (M = 8.63), and Japanese (M = 8.56) students.

In terms of student value science, Thai (M = 10.75), Malaysian (M = 10.37), and Singaporean (M = 10.24) eighth-grade students valued science the most. This is followed by Chinese Taipei (M = 9.57), Hong Kong (M = 9.44), Korean (M = 8.96), and Japanese (M = 8.64) students.

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online) https://doi.org/10.33225/pec/20.78.1107

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Table 2

Descriptive statistics (weighted) with average scale scores for Southeast Asian students' views on engaging teaching in science lessons, students like learning science, students confident in science, and students value science

Statement Code	Statement	Southeast Asian Countries					
		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	3.33	.679	3.24	.668	3.08	.759
BSBS22B	My teacher is easy to understand	3.37	.702	3.16	.785	3.35	.711
BSBS22C	I am interested in what my teacher says	3.38	.698	3.15	.797	3.35	.711
BSBS22D	My teacher gives me interesting things to do	3.32	.729	3.10	.803	3.31	.738
BSBS22E	My teacher has clear answers to my questions	3.45	.682	3.22	.753	3.31	.745
BSBS22F	My teacher is good at explaining the science	3.50	.652	3.29	.742	3.42	.708
BSBS22G	My teacher lets me show what I have learned	3.25	.724	3.07	.771	3.25	.745
BSBS22H	My teacher does a variety of things to help us learn	3.56	.636	3.19	.754	3.44	.702
BSBS22I	My teacher tells me how to do better when I make a mistake	3.51	.657	3.20	.741	3.42	.703
BSBS22J	My teacher listens to what I have to say	3.29	.743	3.16	.755	3.29	.748
	Average scale score	10.21 (.05)		9.78 (.04)		10.20 (.04)	
Students Like Learning Science							
BSBS21A	I enjoy learning science	3.54	.642	3.25	.800	3.38	.698
BSBS21B*	I wish I did not have to study science	3.48	.739	2.98	.964	3.07	.981
BSBS21C*	Science is boring	3.40	.767	3.04	.909	2.92	.978
BSBS21D	I learn many interesting things in science	3.62	.611	3.46	.700	3.54	.642
BSBS21E	I like science	3.48	.690	3.18	.846	3.25	.744
BSBS21F	I look forward to learning science in school	3.19	.792	3.06	.870	2.97	.817
BSBS21G	Science teaches me how things in the world work	3.66	.577	3.41	.685	3.47	.673
BSBS21H	I like to conduct science experiments	3.50	.682	3.37	.801	3.46	.724
BSBS21I	Science is one of my favorite subjects	3.36	.771	3.00	.965	3.20	.812
	Average scale score	10.85 (.06)		10.29 (.04)		10.34 (.05)	
Students Confident in Science							
BSBS23A	I usually do well in science	2.18	1.205	2.86	.854	2.99	.700
BSBS23B*	Science is more difficult for me than for many of my classmates	2.31	1.182	2.75	.891	2.33	.895
BSBS23C*	Science is not one of my strengths	2.36	1.185	2.62	.985	2.40	.937
BSBS23D	I learn things quickly in science	2.06	1.111	2.80	.838	2.85	.764
BSBS23E	I am good at working out difficult science problems	2.37	1.242	2.57	.867	2.74	.789
BSBS23F	My teacher tells me I am good at science	2.54	1.236	2.43	.870	2.48	.857

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BSBS23G*	Science is harder for me than any other subject	2.20	1.152	2.82	.924	2.39	.929
BSBS23H*	Science makes me confused	2.21	1.164	2.68	.945	2.46	.958
	Average scale score	8.66 (.03)		9.66 (.04)		9.32 (.04)	
Students Value Science							
BSBS24A	I think learning science will help me in my daily life	3.46	.658	3.37	.699	3.59	.602
BSBS24B	I need science to learn other school subjects	3.31	.781	2.95	.845	3.32	.724
BSBS24C	I need to do well in science to get into the university of my choice	3.32	.695	3.27	.778	3.46	.687
BSBS24D	I need to do well in science to get the job I want	3.30	.715	3.12	.862	3.43	.713
BSBS24E	I would like a job that involves using science	3.12	.849	2.80	.978	3.14	.848
BSBS24F	It is important to learn about science to get ahead in the world	3.36	.647	3.34	.718	3.46	.690
BSBS24G	Learning science will give me more job opportunities when I am an adult	3.33	.699	3.31	.749	3.43	.694
BSBS24H	My parents think that it is important that I do well in science	3.31	.710	3.36	.720	3.37	.719
BSBS24I	It is important to do well in science	3.35	.667	3.50	.648	3.47	.685
	Average scale score	10.37 (.04)		10.24 (.03)		10.75 (.04)	

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

Table 3

Descriptive statistics (weighted) with average scale scores for East Asian students' views on engaging teaching in science lessons, students like learning science, students confident in science, and students value science

Statement Code	Statement	East Asian Countries							
		Japan		Korea		Hong Kong, SAR		Chinese Taipei	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Students' Views on Engaging Teaching in Science Lessons									
BSBS22A	I know what my teacher expects me to do	2.12	.779	2.37	.803	3.17	.774	3.10	.793
BSBS22B	My teacher is easy to understand	2.80	.853	2.61	.844	3.09	.836	2.78	.889
BSBS22C	I am interested in what my teacher says	2.66	.917	2.59	.870	3.04	.891	2.75	.927
BSBS22D	My teacher gives me interesting things to do	2.40	.860	2.38	.825	3.11	.846	2.55	.892
BSBS22E	My teacher has clear answers to my questions	2.832	.847	2.80	.820	3.11	.836	2.93	.882
BSBS22F	My teacher is good at explaining the science	2.86	.850	2.90	.799	3.16	.835	3.00	.889
BSBS22G	My teacher lets me show what I have learned	2.34	.833	2.35	.820	2.99	.851	2.57	.869

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BSBS22H	My teacher does a variety of things to help us learn	2.89	.801	2.63	.820	3.17	.806	3.02	.849
BSBS22I	My teacher tells me how to do better when I make a mistake	2.80	.819	2.57	.825	3.13	.817	3.04	.836
BSBS22J	My teacher listens to what I have to say	2.63	.853	2.74	.822	3.10	.838	2.84	.911
	Average Scale Score	8.41 (.05)		8.36 (.05)		9.65 (.08)		8.96 (.05)	
Students Like Learning Science									
BSBS21A	I enjoy learning science	2.79	.875	2.48	.864	3.05	.880	2.69	.900
BSBS21B*	I wish I did not have to study science	2.75	.901	2.40	.899	2.84	.961	2.69	.962
BSBS21C*	Science is boring	2.83	.841	2.50	.856	2.88	.939	2.78	.911
BSBS21D	I learn many interesting things in science	2.84	.851	2.84	.840	3.23	.814	3.01	.834
BSBS21E	I like science	2.65	.930	2.44	.890	3.04	.889	2.67	.922
BSBS21F	I look forward to learning science in school	2.50	.913	2.15	.814	2.93	.911	2.51	.911
BSBS21G	Science teaches me how things in the world work	2.53	.873	2.86	.815	3.31	.755	3.10	.790
BSBS21H	I like to conduct science experiments	3.12	.880	2.94	.881	3.36	.809	3.19	.831
BSBS21I	Science is one of my favorite subjects	2.52	.965	2.33	.913	2.90	.966	2.45	.953
	Average scale score	8.99 (.05)		8.59 (.04)		9.87 (.06)		9.16 (.04)	
Students Confident in Science									
BSBS23A	I usually do well in science	2.13	.785	2.28	.828	3.81	.841	2.47	.866
BSBS23B*	Science is more difficult for me than for many of my classmates	2.59	.874	2.60	.835	2.68	.919	2.49	.945
BSBS23C*	Science is not one of my strengths	2.39	.940	2.35	.846	2.54	.955	2.32	.976
BSBS23D	I learn things quickly in science	2.23	.759	2.31	.776	2.72	.864	2.30	.841
BSBS23E	I am good at working out difficult science problems	1.92	.779	2.12	.757	2.51	.878	2.15	.837
BSBS23F	My teacher tells me I am good at science	1.86	.709	2.12	.758	2.27	.874	2.12	.820
BSBS23G*	Science is harder for me than any other subject	2.59	.910	2.46	.885	2.69	.937	2.39	.978
BSBS23H*	Science makes me confused	2.75	.942	2.29	.862	2.79	.942	2.45	.981
	Average Scale Score	8.56 (.04)		8.66 (.04)		9.44 (.06)		8.63 (.04)	
Students Value Science									
BSBS24A	I think learning science will help me in my daily life	2.69	.868	2.87	.833	3.25	.776	2.99	.853
BSBS24B	I need science to learn other school subjects	2.31	.827	2.62	.836	2.85	.909	2.37	.874
BSBS24C	I need to do well in science to get into the university of my choice	2.70	.936	2.78	.866	2.94	.907	2.50	.954
BSBS24D	I need to do well in science to get the job I want	2.58	.947	2.69	.899	2.80	.936	2.33	.912
BSBS24E	I would like a job that involves using science	2.06	.891	2.16	.892	2.64	.984	2.16	.894

https://doi.org/10.33225/pec/20.78.1107 ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)

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BSBS24F	It is important to learn about science to get ahead in the world	2.47	.877	2.84	.883	2.86	.931	2.44	.906
BSBS24G	Learning science will give me more job opportunities when I am an adult	2.57	.882	2.83	.866	2.85	.917	2.50	.922
BSBS24H	My parents think that it is important that I do well in science	2.45	.911	2.59	.850	2.71	.924	2.64	.927
BSBS24I	It is important to do well in science	3.18	.809	2.88	.838	2.98	.857	2.81	.917
	Average Scale Score	8.64 (.03)		8.96 (04)		9.44 (.05)		9.57 (.01)	

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

Tables 4 to 7 show the percentage of Southeast Asian and East Asian students according to their views on engaging teaching in science lessons, students like learning science, students confident in science, and students value science with their respective average science achievement.

Table 4
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	489.30 (3.55)	42.25	467.01 (4.83)	9.07	407.69 (10.41)	10.21 (.05)
Singapore	6086	35.04	606.47 (4.06)	51.78	594.96 (3.28)	13.19	577.77 (5.23)	9.78 (.04)
Thailand	6451	49.51	460.83 (4.14)	42.25	451.59 (4.78)	8.24	450.94 (8.16)	10.20 (.04)
Japan	4738	11.20	592.13 (3.64)	45.93	580.87 (2.21)	42.87	554.80 (2.35)	8.41 (.05)
Korea	5297	10.06	604.05 (4.96)	46.64	566.63 (2.32)	43.40	532.62 (2.82)	8.36 (.05)
Hong Kong, SAR	4133	34.24	557.22 (3.91)	48.31	545.26 (4.40)	17.45	525.90 (7.20)	9.65 (.08)
Chinese Taipei	5698	20.74	591.45 (3.35)	48.33	573.43 (2.57)	30.92	548.75 (3.11)	8.96 (.05)
Average		29.93	557.35 (1.50)	46.50	539.96 (1.38)	23.58	514.07 (2.38)	9.37 (.02)

Note: Standard errors in parentheses

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Table 5
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 (3.17)	41.52	453.59 (5.03)	7.00	389.27 (10.34)	10.85 (.06)
Singapore	6084	38.01	622.25 (3.84)	47.47	588.30 (3.26)	14.52	558.06 (4.49)	10.29 (.04)
Thailand	6421	37.19	477.48 (4.45)	54.67	445.10 (4.32)	8.14	433.72 (6.79)	10.34 (.05)
Japan	4739	15.45	605.72 (2.91)	47.57	579.43 (1.93)	36.98	545.55 (2.51)	8.99 (.05)
Korea	5301	10.14	621.70 (5.07)	41.26	571.73 (2.53)	48.60	528.23 (2.34)	8.59 (.04)
Hong Kong, SAR	4126	29.83	573.54 (3.80)	51.36	542.49 (4.16)	18.81	511.68 (5.23)	9.87 (.06)
Chinese Taipei	5699	17.97	619.65 (3.38)	46.46	574.47 (2.40)	35.56	537.57 (2.50)	9.16 (.04)
Average		28.58	574.11 (1.46)	47.19	536.44 (1.34)	24.23	500.58 (2.11)	9.73 (.02)

Note: Standard errors in parentheses

Table 6
Students Confident 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 (5.26)	25.25	455.34 (4.80)	69.18	476.78 (4.22)	8.66 (.03)
Singapore	6083	16.93	633.02 (4.74)	39.53	608.30 (3.46)	43.54	572.10 (3.50)	9.66 (.04)
Thailand	5297	6.82	512.75 (6.34)	36.57	467.35 (4.58)	56.61	442.09 (4.18)	9.32 (.04)
Japan	4738	5.32	637.21 (4.82)	26.23	605.80 (2.43)	68.45	552.51 (2.06)	8.56 (.04)
Korea	5297	7.29	641.89 (4.49)	23.20	599.27 (3.02)	69.51	532.04 (1.87)	8.66 (.04)
Hong Kong, SAR	4119	13.23	592.30 (4.42)	37.87	559.78 (3.76)	48.91	522.84 (4.79)	9.44 (.06)
Chinese Taipei	5695	9.19	645.73 (3.44)	24.74	605.63 (2.92)	66.07	545.49 (2.08)	8.63 (.04)
Average		9.19	596.41 (1.84)	30.48	557.35 (1.38)	60.32	520.55 (1.30)	8.99 (.02)

Note: Standard errors in parentheses

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Table 7
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 (3.36)	53.52	481.45 (4.30)	8.58	386.58 (8.88)	10.37 (.04)
Singapore	6077	37.37	621.01 (3.38)	53.07	588.51 (3.37)	9.56	547.81 (4.67)	10.24 (.03)
Thailand	6446	49.35	472.22 (4.61)	44.81	442.48 (4.25)	5.85	426.86 (7.15)	10.75 (.04)
Japan	4739	8.90	604.73 (3.61)	44.19	586.24 (2.03)	46.91	550.21 (2.32)	8.64 (.03)
Korea	5301	13.11	604.69 (4.21)	51.34	566.25 (1.88)	35.55	522.32 (2.48)	8.96 (04)
Hong Kong, SAR	4130	23.53	565.13 (5.01)	45.80	548.55 (4.17)	30.67	527.84 (4.34)	9.44 (.05)
Chinese Taipei	5697	10.78	616.27 (4.52)	37.84	588.57 (2.55)	51.38	545.80 (2.12)	8.56 (.03)
Average		25.85	566.67 (1.57)	47.22	543.15 (1.27)	26.93	501.06 (1.95)	9.57 (.01)

Note: Standard errors in parentheses

Correlation and simultaneous multiple regression analyses were conducted separately for each of the education systems in Southeast Asian and East Asian countries to determine if BSBGESL, BSBGSLS, BSBGSCS, and BSBGSVS were predictors of EGS' science achievement (see Table 8 and Table 9).

The results in Table 8 indicated that BSBGESL , BSBGSLS, BSBGSCS, and BSBGSVS were positively and significantly associated with students' science achievement in Malaysia (r = .20-.35), Singapore (r = .08-.27), Thailand (r = .07-.22), Japan (r = .21-.37), Korea (r = .32-.45), Hong Kong SAR (r = .16-.32), and Chinese Taipei (r = .21-.38). However, Malaysian EGS' confidence in science was negatively associated with their science achievement (r = .16).

On the other hand, there were positive and significant correlations among BSBGESL , BSBGSLS, SCS, and BSBGSVS in Singapore (r = .48-71), Thailand (r = .35-.66), Japan (r = .38-.64), Korea (r = .49-.73), Hong Kong SAR (r = .45-.69), and Chinese Taipei (r = .46-.72), except Malaysia. Malaysian eighth-grade BSBGESL, BSBGSLS, and BSBGSVS were negatively associated with their confidence in science.

Table 8
Correlations between Students' Views on Engaging Teaching in Science Lessons, Students Like Learning Science, Students Confident in Science, Students Value Science with Science Achievement

	Malaysia							
	BSBGESL	BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.70*	.01	-.14*	.02	.41*	.03	.23*	.03
BSBGSLS				-.25*	.01	.37*	.02	.35*	.03
BSBGSCS				-.01	.01	-.16*	.02		
BSBGSVS					.20*	.03			
Science									

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Singapore

	BSBGESL		BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.63*	.01	.50*	.01	.50*	.01	.08*	.02
BSBGSLS				.71*	.01	.62*	.01	.27*	.02
BSBGSCS				.48*	.01	.24*	.02		
BSBGSVS					.25*	.02			
Science									

Thailand

	BSBGESL		BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.66*	.01	.41*	.01	.61*	.01	.07*	.03
BSBGSLS				.58*	.01	.57*	.01	.22*	.02
BSBGSCS				.35*	.01	.17*	.02		
BSBGSVS					.21*	.02			
Science									

Japan

	BSBGESL		BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.62*	.01	.38*	.01	.48*	.02	.21*	.02
BSBGSLS				.64*	.01	.53*	.01	.31*	.02
BSBGSCS				.38*	.01	.37*	.01		
BSBGSVS					.32*	.02			
Science									

Korea

	BSBGESL		BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.70*	.01	.54*	.02	.58*	.02	.32*	.02
BSBGSLS				.73*	.01	.64*	.01	.40*	.02
BSBGSCS				.49*	.01	.45*	.01		
BSBGSVS					.38*	.01			
Science									

Hong Kong, SAR

	BSBGESL		BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.64*	.01	.47*	.02	.55*	.02	.16*	.03
BSBGSLS				.69*	.01	.60*	.01	.32*	.02
BSBGSCS				.45*	.01	.31*	.02		
BSBGSVS					.21*	.03			
Science									

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Chinese Taipei								
	BSBGESL		BSBGSLS		BSBGSCS		BSBGSVS		Science	
		r	*s.e.*	*r*	*s.e.*	*r*	*s.e.*	*r*	*s.e.*
BSBGESL		.62*	.01	.46*	.01	.54*	.01	.21*	.02
BSBGSLS				.72*	.01	.65*	.01	.38*	.02
BSBGSCS				.55*	.01	.38*	.01		
BSBGSVS					.35*	.02			
Science									

Note: *$p < .05$; BSBGESL = Students' Views on Engaging Teaching in Science Lessons; BSBGSLS = Students Like Learning Science; BSBGSCS = Students Confident in Science; BSBGSVS = Students Value Science; Science = Science Achievement

Based on Table 9, BSBGESL were negatively and significantly contributed to eighth-grade students' science achievement in Thailand (β = -11.07), Singapore (β = -9.19), Chinese Taipei (β = -4.20), and Hong Kong SAR (β = -3.71).

BSBGSLS was positively and significantly contributed to eighth-grade students' science achievement in Malaysia (β = 16.12), Singapore (β = 9.76), Thailand (β = 9.44), Hong Kong SAR (β = 8.57), and Chinese Taipei (β = 7.98).

BSBGSCS was positively and significantly contributed to EGS' science achievement in Korea (β = 11.89), Japan (β = 11.47), Chinese Taipei (β = 7.34), Hong Kong (β = 5.70), Thailand (β = 5.14), and Singapore (β = 3.95). However, Malaysian eighth-grade students' confidence in science was negatively associated with their science achievement (β = -4.33)

BSBGSVS was positively and significantly contributed to EGS science achievement in Japan (β = 10.66), Korea (β = 9.46), Thailand (β = 9.09), Chinese Taipei (β = 7.95), Singapore (β = 7.95), and Malaysia (β = 5.47)

On the other hand, female eighth graders in Thailand (β = -15.36), Japan (β = -12.67), Chinese Taipei (β = -10.35), Malaysia (β = -6.10), Singapore (β = -5.95) and Korea (β = -5.02) (except Hong Kong SAR) outperformed their counterparts in science achievement in TIMSS 2015.

Table 9

Students' Views on Engaging Teaching in Science Lessons, Students Like Learning Science, Students Confident in Science, and Students Value Science in Predicting Students' Science Achievement

	Malaysia	Singapore	Thailand	Japan	Korea	Hong Kong, SAR	Chinese Taipei
	β (s.e.)	*β (s.e.)*	*β (s.e.)*	*β (s.e.)*	*β (s.e.)*	*β (s.e.)*	*β (s.e.)*
Constant	308.52*	469.79*	333.23*	382.19*	353.85*	427.12*	407.94*
BSBG01_D2	-6.10*	-5.95*	-15.36*	-12.67*	-5.02*	2.21	-10.35*
BSBGESL	-2.55	-9.19*	-11.07*	-.41	-.23	-3.71*	-4.20*
BSBGSLS	16.12*	9.76*	9.44*	.91	2.17	8.57*	7.98*
BSBGSCS	-4.33*	3.95*	5.14*	11.47*	11.89*	5.70*	7.34*
BSBGSVS	5.47*	7.95*	9.09*	10.66*	9.46*	1.62	7.95*
Adjusted R^2	.13 (.02)	.11 (.01)	.09 (.01)	.18 (.01)	.24 (.01)	.12 (.01)	.19 (.01)

Note: *$p < .05$; BSBGESL = Students' Views on Engaging Teaching in Science Lessons; BSBGSLS = Students Like Learning Science; BSBGSCS = Students Confident in Science; BSBGSVS = Students Value Science

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Discussion

This study found that Southeast Asian and East Asian EGS' views on engaging teaching in science lessons, students like learning science, students confident in science, and students value science are positively and significantly correlated with their science achievement in TIMSS. This finding corroborates with previous findings which highlighted that students' active engagement in academic tasks will result in greater academic achievement (Lawson & Masyn, 2015; Wang & Eccles, 2013). Previous literatures have also generated clear evidence that engagement is extremely important for students ' academic performance. Osborne and Collins (2001) had highlighted that the use of diversified methods of teaching and engaging pupils in active learning positively affects children's approach to science at school.

Rationally, previous studies have also shown that students' academic self-conception of their potential in science continually and crucially influences the level of their attitude towards science lessons and science in general (Haladyna et al., 1982; George, 2000).

Similarly, western researchers revealed that a significant number of primary school children are curious about science. Still, its real value is by no means overlooked: about 90% of the students believed that science would help the students for their future career, and more than 70% identified science as interesting and useful in their everyday lives (Yager & Penick, 1986).

Conclusions

This study found that students' views on engaging teaching in science were negatively and significantly contributed to eighth-grade students' science achievement in Thailand, Singapore, Chinese Taipei, and Hong Kong SAR. On the other hand, Students Like Learning Science was positively and significantly contributed to eighth-grade students' science achievement in Malaysia, Singapore, Thailand, Hong Kong SAR, and Chinese Taipei. Students Confident in Science was positively and significantly contributed to eighth-grade students' science achievement in Korea, Japan, Chinese Taipei, Hong Kong, Thailand, and Singapore. Students Value Science was positively and significantly contributed to eighth-grade students' science achievement in Japan, Korea, Thailand, Chinese Taipei, Singapore, and Malaysia. Based on the research findings, it is advocated that Malaysian Ministry of Education should put more emphasis on students' affective attributes in learning science (i.e., students like learning science, students confident in science, and students value science) in an effort to boost Malaysian eighth graders' science achievement in the forthcoming TIMSS assessments.

Acknowledgements

The authors wish to acknowledge UMS Special Fund Research Grant Scheme (SDK0242-2020) awarded by University Malaysia Sabah.

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Received: *October 30, 2020* Accepted: *December 25, 2020*

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Vol. 78, No. 6A, 2020

Cite as: Lay, Y. F., & Rajoo, M. (2020). Affective factors contributing to Southeast Asian and East Asian eighth graders' science achievement in TIMSS 2015. *Problems of Education in the 21st Century*, *78*(6A), 1107-1125. https://doi.org/10.33225/pec/20.78.1107

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