JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

THE CONTRIBUTION OF TEACHER PREPARATION ON GRADE 8 STUDENTS' SCIENCE ACHIEVEMENT IN TIMSS: A COMPARATIVE STUDY BETWEEN MALAYSIA AND SINGAPORE

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Abstract. *The ultimate aim of this research was to explore the contribution of teacher preparedness or readiness (in terms of their academic background, confidence in teaching science and career satisfaction) towards the achievement in science among Malaysian and Singaporean eighth-graders. The TIMSS 2011 international assessment of student achievement at the eighth grade comprises written tests together with sets of questionnaires that gather information on the educational and social contexts for achievement in science. The TIMSS 2011 science achievement scale was used to gauge Grade 8 students' science achievement. Confidence in Teaching Science Scale and Teacher Career Satisfaction Scale was used to explore science teachers' confidence in teaching science and career statisfaction, respectively. Data were obtained from 5,733 Malaysian students and 5,927 Singaporean students who participated in the TIMSS 2011 study using two-stage random sample design.Higher science achievement among Singaporean eighth grade students was related to teachers having more teaching experience, being confident in science teaching, and being satisfied with careers . However, these findings were not evident in Malaysia. The findings of such a research may help science educators and policy makers to identify and nurture the strong learning prerequisites of early adolescents in different education systems.*

Keywords: *confidence in teaching science, career satisfaction, science achievement, TIMSS, teacher preparation*

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Introduction

Singapore schools have consistently been outperforming their counterparts in mathematics and science on each and every cycle of the Trends in International Mathematics and Science Study (TIMSS) ever since its inception in 1995. The findings of the recent cycle of TIMSS reveal that Korea and Singapore are the top-performing countries in science in TIMSS 2011 at the fourth grade, followed by Finland, Japan, Russian Federation, and Chinese Taipei. At the eighth grade, Singapore had the highest average science achievement. This was followed by the next highest-performing-countries for science achievement, namely Korea, Chinese Taipei, and Japan.

There is growing evidence that teacher preparation or preparedness is a powerful predictor of students' achievement, perhaps even overcoming socioeconomic and language background factors. Although a sound knowledge of science would seem to be a prerequisite for effective science teaching, evidence directly linking teacher preparation in science to the achievement of their students is quite limited. A meta-analysis of the effects of teachers' subject matter preparation on their students' achievement in mathematics and science found some studies showing a positive effect, but in general results were mixed (Wilson, Floden, & Ferrini-Mundi, 2002). In addition to the importance of a college or university degree or advanced degree, the literature reports widespread agreement that teachers should have solid mastery of the content in the subject to be taught. In a review of teacher quality research, the relationship between teachers' advanced degrees and student achievement was examined and found a positive relationship between subject-specific advanced degrees and student achievement in mathematics and in science.

Besides, evidence from recent meta-analyses of research conducted in the United States shows that teacher professional development that is focused on science content has a significant positive effect on student achievement and that the amount of professional development was an important factor (Garet, Porter, Desimone, Birman, & Yoon, 2001; Johnson, Kahle & Fargo,

2007). Research studies have shown that teachers' self-confidence in their teaching skills is not only associated with their professional behavior, but also with students' performance and motivation (Urdan & Schoenfelder, 2006). Hence, higher science achievement was related to teachers' having more teaching experience, being confident in their science teaching, and being satisfied with their careers.

It is undoubtedly and undeniably that students' achievements are linked to teacher qualifications. However, in what way and how much the degree of teachers' preparedness or readiness affects students' achievement remain unanswerable. Furthermore, there is a dearth of research on the predictive effects of teacher preparation on science achievement among early adolescents in Southeast Asian education systems. Hence, the purpose of the present research was to examine the predictive effects of teacher preparation (in terms of science teachers' formal education, teachers majoring in education and science, teachers' years of experience, teachers' professional development, teachers' preparation to teach the TIMSS science topics, teachers' confidence in teaching science, teachers' career satisfaction) on science achievement among eighth grade students in Malaysia and Singapore who participated in the TIMSS 2011 assessment. The findings of such a research may help science educators and policy makers to identify and nurture the strong learning prerequisites of early adolescents in different education systems.

Literature Review

Background and Socio-cognitive Factors Influencing Teachers' Preparedness

The literature revealed that teachers' educational or academic background including their qualifications has great bearing on their preparedness or readiness in teaching science and mathematics. For example, Wenglinsky (1992) claimed that teachers who have a strong academic background and are qualified to teach in the related subject are better in the teaching profession and can make a difference to becoming an effective teacher. Among the sociocultural factors influencing teachers' preparedness to teach science include their formal education, years of related experience as well as the major subjects they took during the formal training such as pure science or TIMSS science related topics and science education. The studies by Monk (1994) as well as Saderholm and Tretter (2008) showed that the number of science courses taken by a science teacher had a positive influence on students' science achievement while teacher content preparedness has a large impact on students' achievement.

Teachers' preparedness also includes their resourcefulness as well as lesson preparation that is related to a student's daily life, their readiness to collaborate with others to improve teaching through regular participation in Continuing Professional Development (CPD) as well as their ability to evaluate or assess students' learning. According to the NCATE (2010), knowledge and skill in how to teach are a must. Hence teachers' involvement in CPD to develop required knowledge and skills is also an important contributing factor towards teachers' preparedness. The taxonomy of educational behaviours for cognitive, affective and socio-psychological domains should be referred to more often by teachers for better understanding of pedagogical teaching approaches and evaluation/assessment methods. Teachers' ability to formulate indicators for the assessment/evaluation of students' learning from the aspects of their cognitive (e.g., through Bloom's Taxonomy) and affective (e.g., using Krathwohl, Bloom & Masia's Taxonomy) development should also be enhanced regularly for better preparedness.

Affective Factors and the Relationship of Readiness with Students' Achievement

Hence, apart from teachers' qualifications, their preparedness or readiness could also be evaluated from the perspectives of affective domains or psychological factors such as their confidence levels and career satisfaction. 'Self-confidence' is a combination of general self-efficacy as well as self-esteem, i.e., the general feelings of self-worth or self-value. 'Self-confidence' is operationally defined as the belief of oneself towards his/her personal worth and the likelihood of he / she to be successful. 'Self-efficacy' is belief of oneself towards his/her own capacity to be engaged in and execute a specific behavior. It is the belief that a person has about whether or not he/she can succeed at completing tasks. There are two types of self-efficacy, i.e., 'general and specific self-efficacy'. The former is the belief in one's general capacity to handle tasks. The latter refers to beliefs about one's ability to perform specific tasks (e.g., cycling, studying and so forth) (Lefton, 1991; O'Neill & McMahon, 2011; Weiner, 1979).

How will teachers' readiness or confidence levels influence students' motivation to learn for better achievement? Research has shown that effective teachers understand and are able to apply strategies with confidence

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

to help students to enhance their performance. For example, a longitudinal research by Goldhaber (2007) who examined over 700,000 student records in grades 4-6 and the licensing records for almost 24,000 teachers revealed positive results in this respect. He found that the students of teachers who are prepared show stronger learning gains in comparison to unprepared and underprepared teachers. Since teachers' confidence levels are important affective factors contributing to students' motivation levels and their achievement, the indicators in the affective domain should also be formulated in any evaluative studies of educational programmes focusing on the aspects of students' motivation and their achievement resulting from their active engagement in science/mathematics related activities. For example, the students may find the task inherently enjoyable (i.e., they have intrinsic motivation) and have an established long-term interest in particular topics (i.e., with personal interest). They will thus believe that they have the ability and confidence to succeed in the learning task (expectancy and self-efficacy belief); and believe that success will be related to effort (an attribution) (Atkinson, Atkinson, Smith & Bem, 1993; Phillips, 2007). Students are then expected to be more motivated to learn and achieve better academically as according to Keller (2008), effective instructional pedagogy anchored on e.g., the 'Attention, Relevance, Confidence and Satisfaction' (ARCS) instructional theory may influence motivation and performance.

Background Information of Malaysia and Singapore in TIMSS 2011

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 the Grades 4 and 8 students across participating countries. This research examined the effects of science teacher preparation on the science achievement among Grade 8 students in Malaysia and Singapore who participated in the TIMSS 2011 study. Singapore joined the TIMSS since 1995 at both the fourth and eighth grade levels. However, Malaysia joined the program in 1999 only at the eighth grade level. A summary of the science performance (Grade 8) of the two countries in TIMSS 1995 to TIMSS 2011 is provided in the Table 1.

Table 1. TIMSS (Grade 8) Science Scores from 1995 to 2011 for Malaysia and Singapore.

		Science Grade 8	
	No. of Participating Countries	**Malaysia**	**Singapore**
TIMSS 1995	45	-	580
TIMSS 1999	38	492	568
TIMSS 2003	46	510	578
TIMSS 2007	59	471	567
TIMSS 2011	63	426	590

Source: Mullis, Martin, Foy, & Arora (2012)

Rationale

There are 11 SEAMEO countries in the Southeast-Asian (SEA) region. Four out of the 11 SEAMEO member countries participated in TIMSS 2011, namely Indonesia, Malaysia, Singapore and Thailand. However, only Singapore as the top-performing country in SEAMEO was selected for discussion in comparison with Malaysia based on two main concerns. First, the purpose of this research was to identify areas in which the Malaysian educational system could be improved after analyzing eighth grade students' attitudes toward science in these respective countries; second, the Malaysian and Singaporean educational systems share some similarities in terms of socio-cultural background and differences in terms of geographical structures.

Research Questions

In light of the scarcity of empirical research especially on the TIMSS 2011 research, the research question that underpinned this research was: How well does teacher preparation (in terms of formal education, majoring

in education and science, years of experience, professional development, preparation to teach the TIMSS science topics, confidence in teaching science, career satisfaction) predict Malaysian and Singaporean Grade 8 students' science achievement in TIMSS, respectively?

Research Methodology

TIMSS is one of the projects of the International Association for the Evaluation of Educational Achievement (IEA). IEA is an independent cooperative of national educational research institutions and governmental research agencies dedicated to improve education. TIMSS is conducted every four years on a regular cycle to assess students' achievement in science and mathematics at both the fourth and eighth grades. The project is dedicated to providing participating countries with information to improve teaching and learning in science and mathematics.

The TIMSS 2011 international assessment of student achievement at the eighth grade comprises written tests together with sets of questionnaires that gather information on the educational and social contexts for achievement in science. TIMSS 2011 employed a two-stage random sample design, with a sample of schools drawn as a first stage and one or more intact classes of students selected from each of the sampled schools as a second stage.

Data

Data for the research were drawn from the TIMSS 2011 database (http://timssandpirls.bc.edu/timss2011/international-database.html). A total of 11,660 eighth-graders from Malaysia (n = 5,733) and Singapore (n = 5,927) took part in the TIMSS 2011 science assessment.

Measures

Science Achievement. The TIMSS 2011 science achievement scale was based on 302 items spanning across several subject domains (i.e., Biology, Chemistry, Physics, Earth Science) and cognitive domains (i.e., Knowing, Applying, Reasoning) in science. TIMSS uses an imputation methodology, usually referred to as plausible values, to report student performance. The plausible values, 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) that could be attributed to each student. For each student, the mean plausible value was 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 correct standard errors.

Teachers' Confidence in Teaching Science

To explore teachers' confidence in teaching science, teachers of students taking the eighth grade TIMSS assessments were asked to indicate how confident they felt about doing each of the following: "answer students' questions about science", "explain science concepts or principles by doing science experiments", "provide challenging tasks for capable students", 'adapt teaching to engage students' interest" and "help students appreciate the value of learning science". All items in the Confidence in Teaching Science Scale were rated on a 3-point Likert type scale, ranging from '1' (Not Confident) to '3' (Very Confident). The Cronbach's alpha reliability coefficients for the scale were 0.81 and 0.82 for Malaysia and Singapore, respectively.

Teachers' Career Satisfaction

To investigate teachers' career satisfaction, teachers of students taking the eighth grade TIMSS assessments were asked to indicate how much teachers agreed with each of the following six statements: "I am content with my profession as a teacher", "I am satisfied with being a teacher at this school", "I had more enthusiasm when I began

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

teaching than I have now", "I do important works as a teacher", "I plan to continue as a teacher for as long as I can", and "I am frustrated as a teacher". All items in the Teacher Career Satisfaction Scale 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 0.34 and 0.72 for Malaysia and Singapore, respectively. In addition to these measures, teacher demographic characteristics such as gender (1 = 'female', 0 = 'male') was included in the research as control variables.

Research Results

Descriptive statistics for the predictor variables (namely teachers' confidence in teaching science, teachers' career satisfaction) are presented in Table 2.

Table 2. Descriptive statistics (Weighted) for teachers' confidence in teaching science and teachers' career satisfaction.

Variables	Malaysia		Singapore	
	M	*SD*	*M*	*SD*
Teachers' Confidence in Teaching Science				
Answer students' questions about science	2.76	.447	2.80	.402
Explain science concepts or principles by doing science experiments	2.77	.465	2.68	.486
Provide challenging tasks for capable students	2.48	.532	2.46	.546
Adapt my teaching to engage students' interest	2.60	.502	2.44	.551
Help students appreciate the value of learning science	2.76	.441	2.46	.580
[1 = Not Confident, 3 = Very Confident]				
Teachers' Career Satisfaction				
I am content with my profession as a teacher.	3.81	.422	3.41	.672
I am satisfied with being a teacher at this school.	3.69	.539	3.26	.733
I had more enthusiasm when I began teaching than I have now.*	3.07	.885	2.90	.944
I do important works as a teacher.	3.88	.324	3.58	.585
I plan to continue as a teacher for as long as I can.	3.76	.496	3.34	.739
I am frustrated as a teacher.*	1.30	.598	2.19	.880
[1 = Disagree A Lot, 4 = Agree A Lot; * negatively-worded items]				

Table 3-10 show the percentage of students based on teachers' formal education level, teachers majored in education and science, teachers' years of experience, teachers' professional development, teachers' preparation to teach the TIMSS science topics, teachers' confidence in teaching science, and teachers' career satisfaction with Malaysian and Singaporean students' average science achievement, respectively.

Science Teachers' Formal Education

Table 3 presents teachers' reports about their highest level of formal education for the TIMSS 2011 eighth grade assessment. In Malaysia, on average, only 4% of the students had science teachers with a postgraduate university degree, 82% had teachers with a bachelor's degree, 12% had teachers who had completed post-secondary education, and 1% had teachers with an upper secondary education. In contrast, on average, in Singapore, 13% of the students had science teachers with a postgraduate university degree, 84% had teachers with a bachelor's degree, only 3% had teachers who had completed post-secondary education and none of the students had teachers with an upper secondary education.

ISSN 1648–3898 /Print/
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Table 3. Science teachers' formal education.

Country	Percentage of Students by Teacher Formal Education Level			
	Completed Postgraduate University Degree	Completed Bachelor's Degree or Equivalent	Completed Post-secondary Education	No Further than Upper-secondary Education
Malaysia	4 (1.6)	82 (2.8)	12 (2.4)	1 (0.9)
Singapore	13 (1.9)	84 (2.2)	3 (0.9)	0 (0.0)
International Average	27 (0.4)	63 (0.4)	8 (0.2)	2 (0.1)

Reported by teachers; Standard errors appear in parentheses.

Internationally, on average across the eighth grade, 27% of the students had science teachers with a post-graduate university degree, 63% had teachers with a bachelor's degree, 8% had teachers who had completed post-secondary education (usually a three-year teacher education program), and 2% had teachers with an upper secondary education. However, it is noteworthy that different countries have different educational paths for becoming a primary level teacher.

Teachers Majoring in Education and Science

In addition to the importance of a college or university degree or advanced degree, the literature reports widespread agreement that teachers should have solid mastery of the content in the subject to be taught. In a review of teacher quality research, Rice (2003) examined the relationship between teachers' advanced degrees and student achievement and found a positive relationship between subject-specific advanced degrees and student achievement in mathematics and science.

Table 4 shows the percentage of students in the TIMSS 2011 eighth grade assessment whose teachers had a major or specialization in science education and science. In Malaysia, the majority of eighth grade students were taught science by teachers who had a major in science but not in science education (43%), or who had a major in science and science education (20%). There were small differences in average science achievement associated with the majors of the students' teachers; students taught by teachers with a major in science but not in science education had somewhat higher achievement (434) than the 19% of students taught by teachers majoring in science education but not in science (385).

Table 4. Teachers majored in education and science.

Country	Major in Science and Science Education		Major in Science Education but No Major in Science		Major in Science but No Major in Science Education		All Other Majors		No Formal Education Beyond Upper-secondary	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Malaysia	20 (3.2)	429 (12.0)	19 (2.8)	385 (15.3)	43 (4.2)	434 (9.2)	16 (2.9)	440 (15.5)	2 (0.9)	~~
Singapore	37 (2.8)	578 (7.7)	2 (0.8)	~~	57 (2.7)	597 (5.7)	4 (1.2)	602 (23.4)	0 (0.0)	~~
International Average	28 (0.5)	480 (1.2)	11 (0.3)	470 (2.2)	51 (0.5)	478 (1.0)	8 (0.3)	476 (2.7)	2 (0.1)	~~

Reported by teachers; Standard errors appear in parentheses. A tilde (~~) indicates insufficient data to report achievement.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

The majority of eighth grade students in Singapore were taught science by teachers who had a major in science but not in science education (57%), or who had a major in both (37%). There were even smaller differences in average science achievement associated with the majors of the students' teachers; students taught by teachers with a major in science but not in science education had somewhat higher achievement (597) than the students taught by teachers majoring in science and science education (578).

Internationally, the majority of eighth grade students were taught science by teachers who had a major in science but not in science education (51%), or who had a major in both (28%). There were only small differences in average science achievement associated with the majors of the students' teachers; students taught by teachers with a major in science and science education had somewhat higher achievement (480) than the 11% of students taught by teachers majoring in science education but not in science (470).

Teachers' Years of Experience

Table 5 presents science teachers' reports about their years of experience in the TIMSS eighth grade assessment. On average, the Malaysian eighth grade teachers were somewhat less experienced, leading to lower percentages of students taught by experienced teachers – 47% were taught by teachers with at least ten years of experience. The relationship between teacher experience and average student achievement was less pronounced among the eighth grade students. Surprisingly, on average, science achievement was highest for students whose teachers had less than 5 years of experience (437) compared to students whose teachers had between 5 and 10 years of experience (416).

Table 5. Teachers' years of experience.

Country	20 Years or More		At Least 10 but Less than 20 Years		At least 5 but Less than 10 Years		Less than 5 Years		Average Years of Experience
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	
Malaysia	22 (2.9)	417 (15.9)	25 (3.6)	423 (11.9)	17 (3.0)	416 (14.2)	37 (3.6)	437 (11.0)	11 (0.6)
Singapore	13 (1.8)	586 (12.5)	17 (1.8)	578 (14.9)	25 (2.5)	597 (7.1)	46 (2.5)	592 (6.6)	8 (0.4)
International Average	33 (0.4)	480 (1.3)	29 (0.5)	480 (1.2)	19 (0.4)	475 (1.3)	20 (0.4)	471 (1.3)	15 (0.1)

Reported by teachers; Standard errors appear in parentheses.

On average, the Singaporean eighth grade teachers were somewhat less experienced, leading to a lower percentage of students taught by experienced teachers – 30% were taught by teachers with at least ten years of experience. The relationship between teacher experience and average student achievement was also less pronounced among the eighth grade students. On average, science achievement was highest for students whose teachers had between 5 and 10 years of experience (597), compared to students whose teachers had more than 20 years of experience (586), or between 10 and 20 years of experience (578).

On average, the eighth grade teachers were somewhat more experienced, leading to a higher percentage of students taught by experienced teachers – 62% were taught by teachers with at least ten years of experience. The relationship between teacher experience and average student achievement was more pronounced among the eighth grade students. On average across countries, science achievement was highest for students whose teachers had 20 or more years of experience or between 10 and 20 years of experience (480 in each case), compared to students whose teachers had between 5 and 10 years of experience (475), or less than five years of experience (471).

It is undeniable that it is difficult to examine the effects of teacher experience on student achievement, be-

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

cause sometimes more experienced teachers are assigned to students of higher ability and with fewer discipline problems, and at other times the more experienced teachers are assigned to the lower-achieving students in need of more help. However, experience can have a large positive impact primarily in the first two years of teaching, although the benefits can continue beyond the first five years of a teacher's career (Harris & Sass, 2011; Leigh, 2010).

Teachers' Professional Development

Table 6 presents teachers' reports about areas of professional development in science in which they had participated in the past two years for the eighth grade TIMSS assessment. On average, science teachers of Malaysian students reported somewhat lower levels of participation in science professional development. The majority of students were taught by science teachers who had participated in professional development in science assessment (48%), science content and integrating information technology into science (44% respectively), or science curriculum (43%) in the past two years. Slightly less than 40% of the students had teachers with professional development in science pedagogy/instruction (39%) and improving students' critical thinking or inquiry skills (38%).

Table 6. Teacher participation in professional development in science in the past two years.

Country	Percent of Students by Teacher's Area of Professional Development					
	Science Content	Science Pedagogy/ Instruction	Science Curriculum	Integrating Information Technology into Science	Improving Students' Critical Thinking or Inquiry Skills	Science Assessment
Malaysia	44 (3.2)	39 (3.1)	43 (3.7)	44 (3.5)	38 (3.3)	48 (3.7)
Singapore	71 (2.2)	88 (1.6)	67 (2.7)	70 (2.5)	74 (2.1)	65 (2.4)
International Average	55 (0.5)	58 (0.5)	53 (0.5)	49 (0.5)	43 (0.5)	48 (0.5)

Reported by teachers; Standard errors appear in parentheses.

In contrast, on average, science teachers of Singaporean students in the TIMSS eighth grade assessment reported somewhat higher levels of participation in science professional development. The majority of students were taught by science teachers who had participated in professional development in science pedagogy and instruction (88%), improving students' critical thinking or inquiry skills (74%), or science content (71%) in the past two years. Slightly less than 70% of the students had teachers with professional development in integrating information technology into science (70%), science curriculum (67%), and science assessment (65%).

Internationally, on average, science teachers of students in the TIMSS eighth grade assessment reported somewhat higher levels of participation in science professional development, as compared to Malaysia. On average, across countries that participated in the eighth grade assessment, the majority of students were taught by science teachers who had participated in professional development in science pedagogy and instruction (58%), science content (55%), or science curriculum (53%) in the past two years. Slightly less than half of the students had teachers with professional development in integrating information technology into science (49%), science assessment (48%), and improving students' critical thinking or inquiry skills (43%).

Evidence from recent meta-analyses of research conducted in the United States shows that teacher professional development focused on science content has a significant positive effect on student achievement (Blank & de las Alas, 2009) and that the amount of professional development (more than 14 hours) was an important factor (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007).

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Teachers' Preparation to Teach the TIMSS Science Topics

TIMSS 2011 gathered information from the teachers of students taking the assessment on whether or not they felt very well prepared, somewhat prepared, or not well prepared to teach the science content topics assessed by TIMSS. Table 7 presents reports of teachers about their level of preparation to teach the science topics in the four content domains covered by the eighth grade assessment. The 20 topics are grouped by content domain i.e., biology, chemistry, physics, and earth science.

Table 7. Teachers feel "very well" prepared to teach TIMSS science topics.

Country	Percent of Students Whose Teachers Feel "Very Well" Prepared to Teach TIMSS Science Topics				
	Overall Science (20 Topics)	Biology (7 Topics)	Chemistry (4 Topics)	Physics (5 Topics)	Earth Science (4 Topics)
Malaysia	68 (1.7)	79 (2.3)	84 (2.1)	78 (2.7)	21 (1.9)
Singapore	57 (1.4)	60 (2.8)	80 (2.2)	75 (2.0)	6 (1.1)
International Average	72 (0.3)	77 (0.4)	82 (0.4)	78 (0.4)	47 (0.5)

Reported by teachers; Standard errors appear in parentheses.

In Malaysia, on average, a larger percentage of eighth grade students (68%) were taught by teachers who felt very well prepared to teach the TIMSS science topics. Across the content domains, most students had teachers who felt very well prepared to teach biology topics (79%), chemistry topics (84%), and physics topics (78%). However, only approximately one-fifth of the students (21%) had teachers who felt well prepared to teach the earth science topics.

Conversely, on average, a smaller percentage of Singaporean eighth grade students (57%) were taught by teachers who felt very well prepared to teach the TIMSS science topics. Across the content domains, most students had teachers who felt very well prepared to teach biology topics (60%), chemistry topics (80%), and physics topics (75%). However, fewer than one-tenth of the students (6%) had teachers who felt well prepared to teach the earth science topics.

Internationally, on average, a larger percentage of eighth grade students (72%) were taught by teachers who felt very well prepared to teach the TIMSS science topics. Across the content domains, most students had teachers who felt very well prepared to teach biology topics (77%), chemistry topics (82%), and physics topics (78%). Surprisingly, nearly half of the students (47%) had teachers who felt well prepared to teach the earth science topics.

Teachers' Confidence in Teaching Science

Table 8 shows the eighth grade TIMSS assessment results for the Confidence in Teaching Science Scale. Students were scored according to their teachers' responses to how confident they felt in using five instructional strategies on the Confidence in Teaching Science scale. Students with very confident teachers had a score on the scale of at least 9.3, which corresponds to their teachers being "Very Confident" in using three of the five instructional strategies and "somewhat confident" in using the other two, on average. All others students had somewhat confident teachers.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 8. Confidence in teaching science.

Country	Very Confident		Somewhat Confident		Average Scale Score
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	
Malaysia	74 (3.5)	426 (6.2)	26 (3.5)	424 (13.5)	10.0 (0.18)
Singapore	60 (2.5)	595 (5.6)	40 (2.5)	583 (7.8)	9.4 (0.11)
International Average	73 (0.4)	479 (0.7)	27 (0.4)	467 (1.5)	

Reported by teachers; Standard errors appear in parentheses.

On average, a larger percentage of Malaysian students had teachers who were Very Confident (74%). Students who had teachers who were Very Confident had higher science achievement (426) than did students who had teachers who were Somewhat Confident (424). In Singapore, a smaller percentage of students had teachers who were Very Confident (60%). Students who had teachers who were Very Confident had higher achievement (595) than did students who had teachers who were Somewhat Confident (583). On average across countries, a larger percentage of students had teachers who were Very Confident (73%). Students who had teachers who were Very Confident had higher achievement (479) than did students who had teachers who were Somewhat Confident (467).

Table 9 provides further information about the components of the Confidence in Teaching Science Scale showing the percentages of students whose teachers reported feeling "very confident" in using each of the five instructional strategies.

Table 9. Components of confidence in teaching science scale.

Country	Percent of Students Whose Teachers Feel Very Confident to				
	Answer Student Questions About Science	Explain Science Concepts or Principles by Doing Science Experiments	Provide Challenging Tasks for Capable Students	Adapt Teaching to Engage Student Interests	Help Students Appreciate the Value of Learning Science
Malaysia	76 (3.5)	78 (3.4)	50 (3.8)	61 (3.8)	77 (3.4)
Singapore	80 (2.2)	69 (2.2)	49 (2.5)	47 (2.9)	51 (2.5)
International Average	81 (0.4)	72 (0.5)	57 (0.5)	65 (0.5)	70 (0.5)

Reported by teachers; Standard errors appear in parentheses.

In Malaysia, on average, teachers were most often very confident about explaining science concepts or principles by doing science experiments (78% of students taught by such teachers), helping students appreciate the value of learning science (77%). Teachers were less often very confident about adapting their teaching to engage student interests (61%) and providing challenging tasks for capable students (50%).

In Singapore, on average, teachers were most often very confident about answering student questions about science (80% of students taught by such teachers), explaining science concepts or principles by doing science experiments (69%). Teachers were less often very confident about providing challenging tasks for capable students (49%) and adapting their teaching to engage student interests (47%).

On average across countries, teachers were most often very confident about answering student questions about science (81% of students taught by such teachers), explaining science concepts or principles by doing science experiments (72%). Teachers were less often very confident about adapting their teaching to engage student interests (65%) and providing challenging tasks for capable students (57%).

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The literature had shown that teachers with a strong sense of personal ability to organize and execute their teaching are more open to new ideas and less likely to experience emotional burnout. Research has shown that teachers' self-confidence in their teaching skills is not only associated with their professional behaviour, but also with students' performance and motivation (Bandura, 1997; Henson, 2002).

Teachers' Career Satisfaction

Table 10 illustrates Teacher Career Satisfaction. Students were scored according to their teachers' degree of agreement with six statements on the Teacher Career Satisfaction scale. Students with Satisfied teachers had a score of at least 10.4, which corresponds to their teachers "agreeing a lot" with three of the six statements and "agreeing a little" with the other three, on average. Students with Less Than Satisfied teachers had a score no higher than 7.0, which corresponds to their teachers'"disagreeing a little" with three of the six statements and "agreeing a little" with the other three, on average. All other students had Somewhat Satisfied teachers.

Table 10. Teacher career satisfaction.

Country	Satisfied		Somewhat Satisfied		Less Than Satisfied		Average Scale Score
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	
Malaysia	66 (3.6)	429 (6.5)	34 (3.6)	419 (10.6)	0 (0.0)	~	10.4(0.09)
Singapore	28 (2.3)	592 (8.6)	59 (2.7)	592 (5.4)	13 (1.8)	576 (11.5)	9.2 (0.09)
International Average	47 (0.5)	481 (0.8)	45 (0.5)	474 (0.8)	8 (0.3)	473 (2.3)	

Reported by teachers; A tilde (~) indicates insufficient data to report achievement; Standard errors appear in parentheses.

In Malaysia, the eighth grade science teachers reported somewhat higher levels of career satisfaction with 66% of students taught by 'Satisfied' teachers. All of the eighth grade students (100%) were taught science by teachers who were 'Satisfied' or 'Somewhat Satisfied' with their careers. The eighth grade students taught by 'Satisfied' teachers had higher science achievement (429) than those taught by 'Somewhat Satisfied' teachers (419).

In contrast, the Singaporean eighth grade science teachers reported somewhat lower levels of career satisfaction with only 28% of students taught by 'Satisfied' teachers. Almost all of the eighth grade students (87%) were taught science by teachers who were 'Satisfied' or 'Somewhat Satisfied' with their careers. The eighth grade students taught by 'Satisfied' teachers and 'Somewhat Satisfied' teachers had higher science achievement (592 respectively) than those taught by 'Less than Satisfied' teachers (576). It is noteworthy that several of the highest performing East Asian countries in science at the eighth grade (e.g., Japan and Korea) had among the lowest percentages of students taught by 'Satisfied' teachers (22% and 13%, respectively).

On average, across countries, the eighth grade science teachers reported somewhat lower levels of career satisfaction with 47% of students taught by 'Satisfied' teachers. Almost all of the eighth grade students (92%) were taught science by teachers who were 'Satisfied' or 'Somewhat Satisfied' with their careers. The eighth grade students taught by 'Satisfied' teachers had higher science achievement (481) than those taught by 'Somewhat Satisfied' (474) or 'Less than Satisfied' teachers (473). Teachers who are satisfied with their profession and the working conditions at their school are more motivated to teach and prepare their instruction.

To address the purpose of the research, correlation and separate simultaneous multiple regression analyses were conducted for both education systems to determine whether or not teacher preparation was predictive of students' science achievement in the TIMSS 2011 assessment (see Table 11).

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Table 11. Correlations between teachers' gender, years of experience, confidence in teaching science, and career satisfaction with students' science achievement in TIMSS 2011.

	Malaysia		Singapore	
	r	*SE*	*r*	*SE*
Teacher's Gender	.12	.08	.10*	.05
Years of Experience	-.05	.07	-.06	.04
Confidence in Teaching Science	-.01	.05	.08*	.04
Career Satisfaction	.09	.05	.10*	.04

**p < or = .05*

Teachers' confidence in teaching science and teachers' career satisfaction is positively and significantly correlated with Singaporean students' science achievement in TIMSS 2011. Higher science achievement was related to teachers being confident in their science teaching and being satisfied with their careers.

Table 12. Teachers' gender, years of experience, confidence in teaching science, and career satisfaction in predicting students' science achievement in TIMSS 2011.

	Malaysia		Singapore	
	β	*SE*	*β*	*SE*
Teacher's Gender	29.16	18.57	22.24*	10.26
Years of Experience	-.20	.79	-1.08*	.53
Confidence in Teaching Science	-1.20	2.56	4.03*	1.96
Career Satisfaction	9.18	5.03	4.72*	1.93
Adjusted R2	.03		.03	

**p < or = .05*

Teachers' confidence in teaching science and teachers' career satisfaction positively and significantly contributed to Singaporean students' science achievement in TIMSS 2011. Higher science achievement was related to teachers being confident in their science teaching and being satisfied with their careers. However, teachers' years of experience adversely contributed to students' science achievement in Singapore; on average, science achievement was highest for students whose teachers had between 5 and 10 years of experience, compared to students whose teachers had more than 20 years of experience, or between 10 and 20 years of experience.

Discussion

This research found that higher science achievement among Singaporean eighth grade students was related to teachers having more teaching experience, being confident in science teaching, and being satisfied with their careers. These findings corroborated with previous studies (e.g., Urdan & Schoenfelder, 2006) which have shown that teachers' self- confidence in their teaching skills is not only associated with their professional behaviour, but also with students' performance and motivation. Effective teachers understand and are able to apply strategies with confidence to help students to enhance their performance. Students with teachers who are prepared show stronger learning gains in comparison to unprepared and underprepared teachers (Goldhaber, 2007).

On the other hand, the research results have shown that Malaysian eighth grade students were taught by science teachers who had more science teaching experience, more confident in teaching science, and more satisfied with their teaching career as compared to Singaporean eighth grade science teachers. Despite of these advantages,

ISSN 1648–3898 /Print/
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Malaysian eighth grade students did not perform better than Singaporean eighth grade students in TIMSS 2011 science assessment. These unexpected findings challenge the contribution of Malaysian science teachers' preparedness or readiness in affecting students' achievement in TIMSS. Seemingly, some other student-level factors (e.g., attitudes towards science, readiness to learn science, home environment support) and school-level factors (e.g., school climate, school resources for teaching science) might have contributed to Malaysian eighth grade students' science achievement in TIMSS 2011 (Mullis, et al., 2012).

Conclusions

Based on the secondary analysis using TIMSS 2011 data, it was evident that higher science achievement among Singaporean eighth grade students was related to teachers having more teaching experience, being confident in science teaching, and being satisfied with their careers. In contrast, Malaysian science teachers' years of teaching experience, confidence in teaching science and career satisfaction did not significantly contribute to eigth grade students' science achievement. These contradictory research findings may inspire science educators, curriculum developers, and policy makers in both countries to identify and nurture more prerequisites of science learning among early adolescents in the countries. Hence, future researches to explore the contribution of student-level and school-level factors on eighth grade students' science achievement seem crucial and warranted for further investigation. On top of that, the interplay relationships betweem student-level, teacher-level, and school-level factors in affecting students' science achievement worth further exploration using advanced statistical procedures such as Hierarchical Linear Modeling (HLM) in an effort to fill the knowledge gaps in this research area.

Note

Chinese Taipei was listed as one of the 45 countries participated in TIMSS 2011 (Mullis, Martin, Foy, & Arora, 2012).

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Received: *March 31, 2018* Accepted: *June 26, 2018*

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