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TIMSS 2011:
What Can We Learn Together?
REACHING GREATER HEIGHTS

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Teacher and Classroom Correlates of TIMSS 2011 Grade 8 Mathematics Achievement in Malaysia, Singapore, Indonesia, and Thailand

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Abstract

The authors explored the relationships of teacher- and classroom-level characteristics to mathematics achievement among secondary students in four SEAMEO countries that took part in the Trends in International Mathematics and Science Study (TIMSS) in 2011. Employing multilevel modelling, teacher characteristics (i.e., gender, age, teaching experience, confidence in teaching mathematics, career satisfaction, collaborate to improve teaching, instruction to engage students, preparedness to teach TIMSS 2011 mathematics topics) and classroom characteristics (i.e., teachers' perceptions of working conditions and school climate, mathematics instructional hours per week) were regressed onto the TIMSS 2011 Grade 8 mathematics achievement in Malaysia, Singapore, Indonesia, and Thailand. The results of the study and the implications of the findings for educational policy and practice are discussed.

Keywords: classroom environment; teacher preparedness; mathematics achievement; teacher education, TIMSS

Introduction

Background and overview

Learning culture includes a set of attitudes, values, and practices that support the process of continuous learning. In many developing countries with the vision to achieve industrialised nation contributed by critical mass of people involved in science, mathematics, and technology-related careers, promoting and nurturing the culture of mathematics and science learning have been the focus of the government especially in the education sectors. Hence, ensuring conducive learning environments with numerous support and teacher preparedness are part of the major efforts towards enhancing quality mathematics and science education.

Over the last four decades, researchers in many countries have shown increasing interest in the conceptualisation, assessment, and investigation of students' perceptions of psychosocial dimensions of their classroom environment. A considerable amount of work on the assessment and investigation of classroom environment in schools has been conducted. These includes studies on the associations between students' perception of interpersonal teacher behaviour and learning outcomes in primary mathematics classrooms (Goh & Fraser, 1996) and environment-attitude associations in secondary science classrooms (Wong & Fraser, 1996). In relation to this, the Harvard Project Physics of Walberg (Welch & Walberg, 1972) in the USA and the studies by Fraser (1981, 1986) in Australia are educationally noteworthy.

Interest in the study of learning environments becomes more prominent when there is evidence that learning outcomes and students' attitudes toward learning are closely linked to the classroom environment. Research conducted over the past 40 years has shown the quality of the classroom environment in schools to be a significant determinant of student learning. Studies were conducted to determine the degree of importance of the classroom environment in the teaching and learning processes. The nature of the classroom environment and psycho-social interactions can make a difference in how the students learn and achieve their goals (McRobbie, Roth, & Lucas, 1997).

Since 1995, the *Third International Mathematics and Science Study* (TIMSS 1995) now known as the *Trends in International Mathematics and Science Study* (TIMSS) was implemented to improve the teaching and learning of mathematics and science. Data were provided about student achievement in relation to different types of curricula, instructional practices, and school environments (IEA, 2011). Although much concerns were shown among the government in the developing countries towards secondary learners' mathematics/science achievement including their performance in TIMSS, very little research was done to study the predictive effects of various factors such as classroom environment and teacher preparedness towards students' mathematics/science achievement. This article aims to contribute to this aspect by exploring the relationship between classroom environment and teacher preparedness with students' mathematics achievement among Indonesian, Malaysian, Singaporean, and Thai secondary eighth-graders who participated in TIMSS 2011.

Literature Review on School Climate, Teacher Preparedness, Students' Engagement, and Classroom Learning Environment

Promoting positive school climate with adequate teacher preparedness

Teacher preparedness or readiness could be evaluated from the perspectives of their qualification, confidence, and their readiness to teach certain subjects such as mathematics and science (O'Neill & McMahon, 2011; Rosas & West, 2011; Weiner, 1979). 'Self-confidence' is operationally defined as a combination of self-esteem and general self-efficacy. It refers to the belief of oneself towards his/her personal worth and the likelihood of himself/herself to be successful. 'Self-esteem' is the general feelings of self-worth or self-value. 'Self-efficacy' is belief of oneself towards his/her own capacity to succeed at tasks. It is the belief that a person has about whether he or she can successfully engage in and execute a specific behaviour. There are two types of self-efficacy. General self-efficacy is belief in one's general capacity to handle tasks, e.g., to engage students' learning in the case of teacher's preparedness. Specific self-efficacy refers to beliefs about one's ability to perform specific tasks (e.g., public speaking, studying, teaching, and so forth) (Atkinson, Atkinson, Smith, & Bem, 1993; Lefton, 1991; O'Neill & McMahon, 2011; Phillips, 2007; Weiner, 1979).

The readiness of teachers also includes their resourcefulness and preparation of lessons that are related to student's daily life, readiness to collaborate with others to improve teaching, assessment of students' learning, and their participation in Continuing Professional Development (CPD)(Allen, 2009). Teachers can refer to the taxonomy of educational behaviours for cognitive, affective, and socio-psychological domains for more knowledge and to enhance the ability to formulate indicators for the assessment/evaluation of students' learning. For example, Krathwohl's taxonomy of educational objectives of *affective domains* includes the levels of receiving, responding, valuing, organisation, characterisation by value (Krathwohl, Bloom, & Masia, 1956). The indicators in the affective domain may be further formulated in any evaluative studies of educational programmes focusing on the aspects of students' motivation results in their active engagement in mathematics/science-related activities. For example, students find the task inherently enjoyable (*intrinsic motivation*); have an established long-term interest in particular topics (*personal interest*); believe he/she has the ability and confidence to succeed in the learning task (*expectancy* and *self-efficacy* beliefs); and believe that success will be related to effort (*an attribution*)(Atkinson et al., 1993; Phillips, 2007).

Research showed that 'learning' occurs if and only if a learner interacts with the home, school, and out-of-school environment through one or more of the five senses. Positive school climate can be promoted through interactive learning environment with adequate teacher preparedness to engage students' active learning. Constructivists believe that knowing is a process and that learners from diverse socio-cultural backgrounds and levels of achievement must involve actively and individually to discover, transform, and 'own' complex information (Martin, Sexton, Wagner, & Gerlovich, 1994) in positive learning environment.

Assessing students' engagement in positive classroom learning environment

Children began to develop ideas about the world from very young age. They bring various informal ideas from home and out-of-school environments into the classroom learning environment. 'Classroom environment' could be evaluated from the aspects of instructional activities and time spent on a subject matter such as mathematics, instructional approaches used to engage students learning as well as mode of assessment/evaluation in the classroom teaching and learning activities (Susuwele-Banda, 2005). Viewed from the constructivist perspective that emphasises on students' prior knowledge, teachers should be prepared and take into consideration the pupils' initial ideas to develop further. This is because the aim of education especially those involving language, mathematics, science related learning is to give pupils more explanatory power so that their ideas can be developed to become useful concepts (Martin et al., 1994). For example, Treffers (1987) suggested that students should be given the authentic tasks in contextual learning environment or school climate with opportunity to reflect on their own mathematical experiences by asking them a critical question or by exploration in a novel but related learning context. Interactive questioning provides the context for modifications of the schema and building of new schemas in the positive school climate. The breaking up of the present schema into sub-schemas will also occur through the process of accommodation as an alternative (Treffers, 1987; Phillips, 2007).

According to the key principles in 'constructivism' (Vygotsky, 1978), knowledge is embedded in the authentic tasks including problem-solving activities in realistic learning context or school climate in which it is used and learning is an active process of constructing knowledge with learners engaged in using tools. For example, 'situational approach' that is anchored on social constructivist framework gives major emphasis on problem-solving in daily life. This type of social constructivist learning is also elaborated as social mediation with collaborative and participatory knowledge construction whereby interaction among group members (e.g., peer group) serves as the socially shared vehicles of thought with possible coach or support from facilitator (e.g., teacher) who helps an individual to learn in positive school climate. Social mediation could be elaborated by cultural scaffolding [in which the emphasis is on use of non-digital (e.g., books) or digital resources including ICT tools in mediating learning] and with the social entity as a learning system that may bring about changes in its underlying values and norms (McConnell, 2000).

When the learners are motivated and involve or engage actively (Darling-Hammond, 1997) in the subject taught such as mathematics, they are willing to pursue the assigned intellectual activities in their favourable school climate even when these become difficult (Finn, Pannozzo, & Voekl, 1995; Natriello, 1984; Reeve, 2005; Schlechty, 2001). Many educational researchers are interested to find out how the different pedagogical approaches and students' engagement in classroom environment and out-of school activities implemented could have impacted their development of pedagogical-content knowledge (PCK) and academic achievement in various subject disciplines. For example, studies on students' engagement in mathematics and science in classroom learning environment included areas such as cognitive development (e.g., Piaget, 1964) and problem-solving behaviour (e.g., Garton, 2004). Brophy (1998) also studied the 'time on task behaviors' that included academic learning time spent among students.

Background, Rationale, and Research Questions

Background information of four participating countries and rationale of sampling

This study examined the predictive effects of teacher preparedness and classroom environment on the mathematics achievement of Grade 8 students from four SEAMEO member countries, i.e. Malaysia, Singapore, Indonesia, and Thailand participating in TIMSS 2011. Since 1995, TIMSS was implemented by the *International Association for Evaluation of Educational Achievement* (IEA) as an international comparative study, involving more than 63 countries to date. TIMSS was designed to assess the quality of the teaching and learning of mathematics and science among the Grades 4 and 8 students across participating countries. There are 11 SEAMEO countries in the Southeast-Asian (SEA) region. Four out of the 11 SEAMEO member countries participated in TIMSS 2011. Malaysia and

Indonesia joined the TIMSS studies since 1999 at the eighth grade level. Thailand joined the TIMSS studies since 1995 at eighth grade level. Singapore joined the TIMSS studies since 1995 at both the fourth and eighth grade levels. A summary of Grade 8 students' mathematics performance of these four SEAMEO member countries in TIMSS 1995 to TIMSS 2011 is provided in Table 1.

Table 1
TIMSS (Grade 8) Mathematics Scores from 1995 to 2011 for Indonesia, Malaysia, Singapore, and Thailand

		Mathematics Grade 8			
	No. of Participating Countries	Indonesia	Malaysia	Singapore	Thailand
TIMSS 1995	45	-	-	609	522
TIMSS 1999	38	403	519	604	467
TIMSS 2003	46	411	508	605	-
TIMSS 2007	59	397	474	593	441
TIMSS 2011	63	386	440	611-	427

The main reason why these four countries were chosen in this study is that these are the four SEAMEO member countries participated in TIMSS 2011. These four countries were also chosen for the following reasons. First, the educational systems of these countries share some common or similarities in terms of socio-cultural background despite some differences in terms of geographical structures as reflected in Table 2. Secondly, the purpose of this study was to identify areas in which the educational systems in these countries can be improved on after analysing the various classroom environment and instructional practices implemented in these respective countries.

Table 2
Selected Socio-Cultural and Geographical Structures of Four SEAMEO Member Countries Participating in TIMSS 2011

Country (unit)	Indonesia	Malaysia	Singapore	Thailand
Area of Country (Square Kilometers)	1,904,589	329,847	710	513,120
Population Size (in millions)	237.4	29.6	4.5	26.1
Population Density (People per Square Kilometer)	123.76	124	6,508	80
Urban Population (% of total)	15	68	100	68
Infant Mortality Rate (per 1000 Live Births)	29.2	10	2.65	15.9
Life Expectancy at Birth (years)	68.5	74	81.2	73.9
Gross National Income per Capita (in US Dollars)	2,940	8,770	42,930	4,400
GNI per Capita (Purchasing Power Parity)	1,211,911	463,684	314,906	602,216

Source: IEA's Trends in International Mathematics and Science Study (TIMSS) 2011

As shown in Table 2, although Indonesia, Malaysia, Singapore, and Thailand are all neighbouring countries with about the same history of development tracing back to 1950s, there are many factors contributing to their differences in mathematics achievement. In terms of land area of the country, Malaysia is 465 times bigger than Singapore, but 1/6 times smaller than Indonesia and 3/5 times smaller than Thailand. In terms of population size, Malaysia is almost six times as much as Singapore, but 3 and 5 times smaller than Indonesia and Thailand, respectively. Indonesia is the most populated country among the four countries while Singapore has the least population. All Singaporean live in urban area while in Indonesia only 15% of the population live in urban area, and 68% of the population live in urban area in Malaysia and Thailand. Singapore showed the highest population density among all the four countries. Singapore also has a longer life expectancy and higher population density and lower infant mortality rate as compared to Malaysia, Indonesia, and Thailand. Singaporean also has a higher purchasing power parity making Singapore the most developed nation among ASEAN countries with per capita income of almost five times of Malaysia, 14 times of Indonesia, and 10 times of Thailand (Mullis et al., 2000).

There are some similarities among these four countries especially from the aspects of the educational systems. The educational systems in Indonesia, Malaysia, and Singapore are centralised and are managed by the jurisdiction of the respective Ministry of Education (MoE). As for the case of Thailand, the country has achieved impressive success in expanding its educational system quantitatively at all levels and improving its basic educational infrastructure during the past several decades. The educational reforms in Thailand have the key elements of major structural changes in the management of education, including decentralisation to local education areas as well as rationalisation and reengineering of the administration of education (Net Industries, 2013). Educational structures and schooling age in these countries are also more or less the same. There is not much difference in terms of weekly time allocation for mathematics and instruction. These countries also follow more or less similar educational system of: (1) three years of pre-school starting from age 4; (2) six years of primary schooling starting from age 7; (3) four to five years of secondary schooling starting from age 13; and (4) 2 years of pre-university. However, the educational system in Indonesia includes at least one year of pre-school, six years of primary schooling, six years of secondary schooling, with no pre-university programme. Communication through multi-languages is a common characteristic of Malaysia and Singapore as both of them consist of three major ethnic groups: Chinese, Malay and Indians. Malay is the national language for both countries (Gary et al., 2008). In Malaysia, English was once used as the medium of instruction in the teaching and learning of mathematics and science since 2003 (till 2012) for all Year One pupils in primary school and Form One and Lower Six students in secondary school. However, from 2014 onwards, it will be reverted to the use of Malay language or *Bahasa Malaysia* as the medium of instruction. As for Singapore, English is the medium of instruction (Mullis, Martin, & Foy, 2008) and is also used in the teaching and learning of science and mathematics. Indonesians communicate in *Bahasa Indonesia* and Thai people use Thai languages that are also used as medium of instruction for the teaching and learning of mathematics and science. Apparently, there are differences among these four countries in terms of medium of instruction for science and mathematics.

Rationale of the Study and Research Questions

A review of previous studies and rationale for this study

Literature search revealed the increase of research studies emphasising the influences of socio-cultural factors such as students' demographic factors on the academic achievement of secondary school students for TIMSS studies. For example, Ghagar, Najib, Othman, and Mohammadpour (2011) conducted a study to explore the variation in mathematics achievement as a function of student-level and school-level differences among Malaysian (N= 5,314 students nested within 150 schools) and Singaporean (N= 6,018 students nested within

164 schools) Grade 8 students who participated in TIMSS 2003. The findings revealed that at the student level, mathematics self-concept was found to be the most influential factor on mathematics achievement of students from both Malaysia and Singapore (Ghagar et al., 2011). Nevertheless, not much research, especially with the newly released TIMSS 2011 results, has been conducted to find out if the classroom environment and teacher preparedness in the SEAMEO region showed any association with students' mathematics achievement based on TIMSS 2011.

Research questions

In light of the scarcity of empirical research especially on the recent TIMSS 2011, the research question underpinned this study was: Are the teacher and classroom-level characteristics significantly associated with Grade 8 mathematics achievement in Malaysia, Singapore, Indonesia, and Thailand?

Research Method, Data Collection, and Analysis

Data

Data for this study were drawn from the 2011 Trends in International Mathematics and Science Study (TIMSS) database (http://timssandpirls.bc.edu/timss2011/international-database.html). The present study was based on the TIMSS 2011 Grade 8 student and mathematics teacher background data for Malaysia (5,733 students and their 180 mathematics teachers), Singapore (5,927 students and their 330 mathematics teachers), Indonesia (5,795 students and their 170 mathematics teachers), and Thailand (6,124 students and their 172 mathematics teachers).

Variables and measures

Mathematics achievement. The TIMSS 2011 Grade 8 mathematics achievement scale (BSMMAT01 to BSMMAT05) was the outcome measure in this study (see Martin & Mullis, 2012).

Teacher/Classroom characteristics. The current study used the TIMSS 2011 indices, such as 'teachers report problems with working conditions' (BTDGTWC: 1 = *hardly any problems* to 3 = *moderate problems*), 'safe and orderly school' (BTDGSOS: 1 = *safe and orderly* to 3 = *not safe and orderly*), 'confidence in teaching mathematics' (BTDMCTM: 1 = *somewhat confident* to 2 = *very confident*), 'teacher career satisfaction' (BTDGTCS: 1 = *less than satisfied* to 3 = *satisfied*), 'collaborate to improve teaching' (BTDGCIT: 1 = *sometimes collaborative* to 3 = *very collaborative*), and 'instruction to engage students' (BTDGIES: 1 = *some lessons* to 3 = *most lessons*). All these aforementioned indices were constructed using item response theory (IRT) scaling procedures (see Martin & Mullis, 2012). In addition to these indices, single explanatory variables such as 'teacher gender' (BTBG02: 1 = *female*, 0 = *male*), 'age of teacher' (BTBG03: 1 = *under 25* to 6 = *60 or more*), 'teaching experience' (BTDG01: 1 = *less than 5 years* to 4 = *20 years or more*), 'mathematics instructional hours per week' (BTDMHW; *continuous variable*), and 'teacher preparedness to teach TIMSS 2011 mathematics topics' (a continuous variable including BTDM30NU [Number], BTDM30AL [Algebra], BTDM30GE [Geometry], and BTDM30DT [Data]) were also included in the study.

All large-scale datasets often encounter with problem of missing data, and the TIMSS dataset is no exception. Hence, missing values were handled using the expectation-maximisation algorithm (see Dempster, Laird, & Rubin, 1977). Given the nested structure of the TIMSS data, separate multilevel regression analyses were conducted for each country (see Table 4). In the context of this study, the student-level variable, mathematics achievement, was the outcome measure. The teacher/classroom-level variables were the predictors in the multilevel regression models. All multilevel regression analyses were performed using full information maximum likelihood estimation (FIML). Dichotomous variables were kept in their original metric. All other variables were grand-mean centered.

Results

Teacher characteristics investigated in this study were age of teacher, teaching experience, confidence in teaching mathematics, career satisfaction, collaborate to improve teaching, instruction to engage students, and preparedness to teach TIMSS 2011 mathematics topics, i.e. number, algebra, geometry, and data. Classroom characteristics investigated were teachers' perceptions of working conditions and school climate, and mathematics instructional hours per week. The descriptive statistics of all the study variables are presented in Table 3.

Table 3
Descriptive Statistics of the Study Variables

	Singapore		Malaysia		Indonesia		Thailand	
	M	SE	M	SE	M	SE	M	SE
Mathematics achievement	610.99	3.77	439.82	5.38	385.84	4.31	427.11	4.28
Age of teacher	2.87	0.06	3.13	0.08	3.28	0.09	3.45	0.10
Teaching experience	3.11	0.05	2.62	0.08	2.46	0.11	2.39	0.09
Weekly instructional hours	3.64	0.04	3.08	0.10	4.10	0.17	3.21	0.10
Perceptions of school climate	1.44	0.03	1.60	0.05	1.64	0.04	1.50	0.04
Working conditions	1.89	0.03	2.16	0.05	2.51	0.05	2.08	0.05
Engage students	2.53	0.03	2.69	0.04	2.90	0.06	2.67	0.04
Collaboration	2.04	0.03	2.21	0.04	2.41	0.05	2.11	0.05
Confidence in teaching	1.59	0.03	1.77	0.03	1.90	0.02	1.39	0.04
Career satisfaction	2.19	0.03	2.61	0.04	2.59	0.04	2.69	0.04
Prepared to teach number	95.82	1.00	92.90	1.48	63.09	4.22	72.90	2.46
Prepared to teach algebra	90.07	1.38	85.30	2.17	66.12	4.13	44.55	3.26
Prepared to teach geometry	84.82	1.54	85.25	2.18	59.00	3.25	58.94	1.32
Prepared to teach data	66.02	1.88	59.96	2.36	9.62	2.35	37.27	3.82

Prior to running the full models, three basic multilevel regression models (null models) were built (see equations 1-3). Null models are intercept-only models, and they were used to decompose the total variance into within- and between-classroom variance components. In Malaysia, 68% of the variance in mathematics achievement was between the classrooms and 32% of the variance in mathematics achievement was within the classrooms. In Singapore, 76% of the variance in mathematics achievement was between the classrooms and the remaining 24% of the variance in mathematics achievement was within the classrooms. In Indonesia and Thailand, 45% and 56% of the variance in mathematics achievement was between the classrooms, while 55% and 44% of the variance in mathematics achievement was within the classrooms, respectively (Table 4).

Level-1 Model

$$BSMMAT01_{ij} = \beta_{0j} + r_{ij} \quad (1)$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (2)$$

Mixed Model

$$BSMMAT01_{ij} = \gamma_{00} + u_{0j} + r_{ij} \quad (3)$$

Table 4

Results of Multilevel Regression Analyses Predicting Mathematics Achievement for Singapore, Malaysia, Indonesia, and Thailand

	Singapore		Malaysia		Indonesia		Thailand	
	B	SE	B	SE	B	SE	B	SE
Intercept	591.75***	5.96	411.92***	10.11	395.08***	5.79	428.23***	7.82
Teacher Gender (female)	22.66**	8.15	32.27*	13.27	6.20	8.41	6.62	10.71
Age of teacher	-2.59	4.89	1.55	8.73	1.08	6.85	-2.07	7.67
Teaching experience	3.55	5.15	0.78	9.14	17.45**	6.69	9.56	8.23
Instructional hours	-10.22**	4.71	-1.12	5.05	-0.36	1.76	9.30	3.90
Perceptions of school climate	-22.17**	6.99	-33.27**	10.76	6.51	8.16	-9.63	10.52
Working conditions	-3.60	6.23	11.01	9.95	-22.88***	5.93	-3.31	8.72
Engage students	3.58	6.51	9.69	11.50	5.61	13.24	-6.90	9.12
Collaboration	-1.68	6.35	-3.20	10.03	-2.57	7.08	-2.41	8.93
Confidence in teaching	-34.10***	8.10	14.35	14.06	-11.15	13.73	22.25*	9.94

Career satisfaction	12.79	6.65	-11.67	11.44	0.14	8.31	-0.17	12.62
Prepared to teach number	-0.01	0.24	0.06	0.38	0.09	0.11	0.03	0.16
Prepared to teach algebra	0.77***	0.22	0.31	0.34	0.47**	0.16	0.06	0.17
Prepared to teach geometry	0.00	0.22	0.21	0.26	-0.28	0.16	0.01	0.16
Prepared to teach data	-0.03	0.10	-0.22	0.17	-0.08	0.13	-0.07	0.14
Intercept variance	4798.73		5507.55		2901.45		4381.71	
Level 1 variance	1726.41		2842.57		3920.93		3582.15	

*$p < .05$, **$p < .01$, ***$p < .001$.

The multilevel regression equations for the two-level full models are displayed below (see equations 4-6). The results of multilevel regression analyses indicated that teacher gender was significantly and positively associated with mathematics achievement in Singapore and Malaysia (Table 4). Students who were taught by female mathematics teachers scored significantly higher on the TIMSS mathematics assessment than did their peers who were taught by male mathematics teachers. However, teacher gender was not significantly linked to mathematics achievement in Indonesia and Thailand (Table 4). While weekly mathematics instructional hours were significantly and negatively related to mathematics achievement in Singapore, it was not significantly associated with mathematics achievement in Malaysia, Indonesia, and Thailand.

Level-1 Model

$$BSMMAT01_{ij} = \beta_{0j} + r_{ij} \qquad (4)$$

Level-2 Model (5)

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(BTBG02_j) + \gamma_{02}*(BTBG03_j) + \gamma_{03}*(BTDGTWC_j) + \gamma_{04}*(BTDGSOS_j) + \gamma_{05}*(BTDMHW_j) + \gamma_{06}*(BTDM30NU_j) + \gamma_{07}*(BTDM30AL_j) + \gamma_{08}*(BTDM30GE_j) + \gamma_{09}*(BTDM30DT_j) + \gamma_{010}*(BTDG01_j) + \gamma_{011}*(BTDGIES_j) + \gamma_{012}*(BTDGCIT_j) + \gamma_{013}*(BTDGTCS_j) + \gamma_{014}*(BTDMCTM_j) + u_{0j}$$

Mixed Model (6)

$$BSMMAT01_{ij} = \gamma_{00} + \gamma_{01}*BTBG02_j + \gamma_{02}*BTBG03_j + \gamma_{03}*BTDGTWC_j + \gamma_{04}*BTDGSOS_j + \gamma_{05}*BTDMHW_j + \gamma_{06}*BTDM30NU_j + \gamma_{07}*BTDM30AL_j + \gamma_{08}*BTDM30GE_j + \gamma_{09}*BTDM30DT_j + \gamma_{010}* BTDG01_j + \gamma_{011}* BTDGIES_j + \gamma_{012}* BTDGCIT_j + \gamma_{013}* BTDGTCS_j + \gamma_{014}*CONF_j + u_{0j} + r_{ij}$$

Further, mathematics teachers' perceptions of negative school climate was significantly and negatively associated with mathematics achievement in Malaysia and Singapore (Table 4), suggesting that students whose mathematics teachers perceived the school climate more negatively scored significantly lower on the TIMSS mathematics assessment than did their peers whose mathematics teachers perceived the school climate more positively. Nevertheless, mathematics teachers' perceptions of negative school climate were not significantly related to mathematics achievement in Indonesia and Thailand (Table 4).

Working conditions were significantly and negatively associated with mathematics achievement in Indonesia alone (Table 4). Students whose mathematics teachers reported having better working conditions performed significantly higher on the TIMSS mathematics assessment than did their counterparts whose mathematics teachers reported having poor working conditions. Mathematics teachers' teaching experience was also significantly associated with mathematics achievement in Indonesia alone (Table 4). Students who had more experienced mathematics teachers performed significantly better on the TIMSS mathematics assessment than did their peers who had less experienced mathematics teachers.

Mathematics teachers' confidence in teaching mathematics was negatively linked to mathematics achievement in Singapore, whereas it was positively linked to mathematics achievement in Thailand (Table 4). Students whose mathematics teachers reported having more confidence in teaching mathematics scored significantly lower on the TIMSS mathematics assessment in Singapore. In contrast, students whose mathematics teachers reported more confidence in teaching mathematics scored significantly higher on the TIMSS mathematics assessment in Thailand. However, mathematics teachers' confidence in teaching mathematics was not significantly associated with mathematics achievement in Malaysia and Indonesia. The counterintuitive finding with regard to mathematics teachers' confidence in teaching mathematics and student mathematics achievement in Singapore indicates one of the flaws of self-reported measures, namely self-promotion. According to Stangor (2010, p. 79), "self-promotion occurs when research participants respond in ways that they think will make them look good. They will overestimate their positive qualities and underestimate their negative qualities. These responses occur because people naturally prefer to answer questions in a way that makes them look intelligent, knowledgeable, caring, healthy, and non-prejudiced."

Teacher preparedness in algebra was significantly and positively associated with mathematics achievement in Singapore and Indonesia. Students whose mathematics teachers felt well prepared to teach algebra scored significantly higher on the TIMSS mathematics assessment in Singapore and Indonesia. Teacher preparedness in other TIMSS mathematics topics (i.e., number, geometry, data) was not significantly related to mathematics achievement. Moreover, no other teacher and classroom-level variable was significantly associated with mathematics achievement in Malaysia, Singapore, Indonesia, and Thailand.

Discussion

This paper examined the possible associations between teacher-level and classroom-level characteristics with Grade 8 mathematics achievement in Malaysia, Singapore, Indonesia, and Thailand. It was interesting to note that teacher gender was significantly and positively associated with students' mathematics achievement in Malaysia and Singapore, but not in Indonesia and Thailand. Malaysian and Singaporean students who were taught by female mathematics teachers scored significantly higher on TIMSS mathematics assessment as compared to their peers who were taught by male mathematics teachers. This may possibly due to the fact that there are higher percentages of female teachers (25 to 54 years old) teaching in secondary school, with a minimum of 5.7% (female) and 4.25% (male) for the age group 50 to 54, and a maximum of 13.45% (female) and 3.77% (male) for the age group 30 to 34 (EPRD-MOE, 2012, p.24). In fact, research showed that female student enrolment is equitable with that of males, sometimes even surpassing male student enrolment at the university level (Chiam, 2004). The study by Cabanilla-Pedro, Myint, Karnasih, & Ng (2005) also showed that 60% of the female respondents being interviewed in Indonesia, Malaysia, and Myanmar planned to pursue a career in areas related to mathematics.

The population size of Indonesia is the highest among the four countries with 237.4 million as compared to the second highest Malaysia with 29.6 million, third highest Thailand with 26.1 million, and Singapore 4.5 million. The area of Singapore is the smallest with 710 square kilometers, the second smallest area 329,847 square kilometers for Malaysia as compared to the largest area for Indonesia with 1.9 million square kilometers. Since the population size and the number of teachers in Malaysia and Singapore are smaller, the chances of these teachers getting in-service training may be higher. More support may be provided in the school systems and the promotion of positive school climate may be one of the important emphases among educators in these two countries with relatively high competitive culture. This may be the reason why mathematics teachers' perception of school climate was significantly and negatively associated with students' mathematics achievement in Malaysia and Singapore as compared to the other two countries.

Although not all the classroom-level characteristics have shown significant associations with Grade 8 mathematics achievement among four SEAMEO member countries, numerous international studies had shown evidences of the relationship between students' perceptions of classroom environment and their academic achievement. These include studies conducted by researchers in Indonesia (Wahyudi & Treagust, 2006) and in Korea (Baek & Choi, 2002) which showed that classroom environment was apparently a good predictor of students' achievement. Contradictory research findings found among these four SEAMEO member countries granted for more indepth studies to investigate the effects of socio-cultural background and geographical structures on students' mathematics achievement in TIMSS.

On the other hand, the findings of this study concurred with numerous studies that found significant links between teacher preparedness and student achievement. An example is the Louisiana Board of Regents recently used its Value-Added Teacher Preparation Model to examine the effectiveness of its teacher preparation programs (Louisiana Board of Regents, 2008 in AACTE, 2013). A study of New York City Teaching Fellows on the effect of teacher qualifications on student achievement (Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2008) showed the effects of a teacher's initial path into teaching on 4^{th} and 5^{th} graders' mathematics performance. The findings of this study also concurred with the findings of an international research that revealed the five key findings on teacher preparation. It was revealed that teacher preparation helps candidates develop the knowledge and skills they need for effective teaching in today's heterogeneous classrooms. Well-prepared teachers are more likely to remain in teaching and produce higher student achievement. Leading industrialised nations invest heavily in pre-service teacher preparation. *National Council for Accreditation of Teacher Education* (NCATE) also made a difference in teacher preparation (NCATE, 2013).

Conclusion

This study has identified some classroom-level characteristics (mathematics weekly instructional hours, mathematics teachers' perceptions of school climate, working condition) and teacher-level characteristics (teacher gender, mathematics teachers' teaching experience, mathematics teachers' confidence and preparedness in teaching mathematics) that relate significantly to the mathematics achievement among secondary students in the four participating SEAMEO member countries. These characteristics should be given adequate emphasis in an effort to enhance secondary students' mathematics achievement.

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