A Glimpse of Teacher-level Characteristics among Mathematics Teachers at Rural Secondary Schools of Sabah, Malaysia

[1]**Lay Yoon Fah,** [2]**Crispina Gregory K. Han,** [3]**Getrude C. Ah Gang @ Grace**

Unit for Rural Education Research, Faculty of Psychology and Education,
Universiti Malaysia Sabah, Kota Kinabalu, Malaysia

[1]layyoonfah@yahoo.com.my, [2]crispina@ums.edu.my, [3]getrudec@ums.edu.my

Abstract

Factors that might have contributed to students' mathematics performance in TIMSS are multi-faceted, recognizing that students' mathematics achievement is the result of a complex interplay of school-level, teacher-level, and student-level factors. In particular, teacher-level factors have shown significant contribution in predicting students' mathematics performance in TIMSS. The ultimate goal of this study is to develop a database of mathematics teachers' characteristics especially who taught mathematics at the rural secondary schools of Sabah, Malaysia. These characteristics include mathematics teachers' formal education, majoring in education and mathematics, years of teaching experience, professional development, preparation to teach the TIMSS mathematics topics, confidence in teaching mathematics, career satisfaction, collaborate to improve mathematics teaching, engage students in learning mathematics, relate lessons to students' daily lives, resources used for teaching mathematics, instructional activities in mathematics class, computer activities during mathematics lessons, and mathematics classroom assessment. It is hoped that the data base will provide insightful information to the preparation of mathematics teachers especially for rural secondary schools in Sabah, Malaysia.

Keywords: Mathematics achievement, rural secondary schools, teacher-level characteristics

Introduction

Background of the Study

Science and mathematics has direct application to nearly all aspects of life and society. Students need early development in science/mathematics knowledge and thinking skills not only to be thoughtful citizens engaged in public discussions on important social issues involving science and mathematics, but also to be prepared to make contributions through a wide range of careers in science, medicine, and technology. On the other hand, students need to develop mathematical understanding to manage successfully in school and society. Mathematics is the foundation for further study in a number of school subjects, most notably the sciences; and mathematics problem solving builds logical reasoning skills that can be applied in many situations. Trends in International Mathematics and Science Study (TIMSS), a regular programme of student assessment at the fourth and eighth grade conducted by the International Association for the Evaluation of Educational Achievement (IEA) every four years since 1995, has the goal of helping countries make informed decisions about how to improve teaching and learning in mathematics and science.

Problem Statement

Factors that might have contributed to students' mathematics performance in TIMSS are multi-faceted, recognizing that students' mathematics achievement is the result of a complex interplay of school-level, teacher-level, and student-level factors. In particular, teacher-level factors have significant contribution in predicting students' mathematics performance in TIMSS. Hence, the ultimate goal of this study is to develop a database of mathematics teachers' characteristics especially who taught mathematics at the rural secondary schools of Sabah, Malaysia.

Research Question

What are the teacher-level characteristics of those who taught mathematics at rural secondary schools in Sabah, Malaysia?

Research Objective

This study embarks on an objective to develop a data base on teacher-level characteristics of those who taught mathematics at rural secondary schools in Sabah, Malaysia.

Literature Review

Effects of Teacher-Level Characteristics on Students' Mathematics Achievement

There is growing evidence that teacher preparation is a powerful predictor of students' achievement, perhaps even overcoming socioeconomic and language background factors (Darling-Hammond, 2000). 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. Although a sound knowledge of mathematics would seem to be a prerequisite for effective mathematics teaching, evidence directly linking teacher preparation in mathematics to the achievement of their students is scare. A meta-analysis of the effects of teachers' subject matter preparation on their students' achievement in mathematics found some studies showing a positive effect, but in general results were mixed (Wilson, Floden, & Ferrini-Mundi, 2002).

On the other hand, it is difficult to examine the effects of teacher experience on student achievement, because sometimes more experienced teachers are assigned to students of higher ability and with fewer discipline problems, and 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).

In terms of professional development, 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).

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 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 (Bandura, 1997; Henson, 2002).

Part of creating a school learning environment focused on academic success involves a staff that collaborates on curricular activities. Teacher collaboration with colleagues is important in building a professional community. A study including a comprehensive theoretical review and a meta-analysis of studies about professional communities indicated a small but positive effect of professional communities on student achievement (Lomos, Roelande, & Bosker, 2011).

To help build a better bridge between curriculum and instruction, TIMSS 2011 collected information about the concept of student content engagement as described by McLaughlin, McGrath, Burian-Fitzgerald, Lanahan, Scotchmer, Enyeart, and Salganik (2005). Student content engagement focuses on the importance of the activity that brings the student and the subject matter content together. Engagement refers to the cognitive interaction between the student and instructional content, and may take the form of listening to the teacher or providing an explanation of a problem solution. It is the student's in-the-moment cognitive interaction with instructional content. An effective classroom environment for mathematics learning involves using a variety of instructional approaches, capitalizing on technology, and at the eighth grade, extending instruction with homework and regularly assessing student progress.

Availability of computers and other technology in the mathematics classroom can facilitate successful implementation of the mathematics curriculum. Computers and the Internet provide students ways to explore concepts in-depth, trigger enthusiasm and motivation for learning, enable students to learn at their own pace, and provide students with access to vast information sources. A recent study summarizing 25 meta-analyses determined that computer use in the classroom has a significant positive effect on achievement at all grade levels and in all subjects (Tamim, Bernard, Borokhovski, Abrami, & Schmidt, 2011).

Research Methodology

Research Design

This is a non-experimental quantitative research. Non-experimental research is a systematic empirical inquiry in which the researcher does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Hence, inferences about the relations among variables are made, without concomitant variation of independent and dependent variables (Johnson & Christensen, 2000). Survey method with questionnaires will be used to collect the intended data in this study.

Population, Samples, and Sampling Techniques

442 mathematics teachers were selected using multi-stage cluster random sampling techniques from the rural secondary schools of Sabah, Malaysia.

Questionnaires

i. Mathematics Teachers' Formal Education

Mathematics teachers were asked to report their highest level of formal education (i.e., "Completed Postgraduate University Degree", "Completed Bachelor's Degree or Equivalent but Not a Postgraduate Degree", "Completed Post-secondary Education but Not a Bachelor's Degree", or "No Further than Upper-secondary Education").

ii. Teachers Majoring in Education and Mathematics

Mathematics teachers were asked to report their specialization in mathematics education and mathematics (i.e., "Major in Mathematics and Mathematics Education", "Major in Mathematics Education but No Major in Mathematics", "Major in Mathematics but No Major in Mathematics Education", "All Other Majors", or "No Formal Education Beyond Upper-secondary").

iii. Teachers' Years of Teaching Experience

Mathematics teachers report their years of experience in teaching mathematics (i.e., "20 Years or More", "At Least 10 but Less than 20 Years", "At Least 5 but Less than 10 Years", or "Less than 5 Years").

iv. Teachers' Professional Development

Mathematics teachers report their areas of professional development in mathematics in which they had participated in the past two years for the eighth grade TIMSS assessment (i.e., "Mathematics Content", "Mathematics Pedagogy/Instruction", "Mathematics Curriculum", "Integrating Information Technology into Mathematics", "Improving Students' Critical Thinking or Inquiry Skills", or "Mathematics Assessment").

v. Teachers' Preparation to Teach the TIMSS Mathematics Topics

Mathematics teachers were asked whether they felt "Very Well Prepared", "Somewhat Prepared", or "Not Well Prepared" to teach the mathematics content topics assessed by TIMSS. All items were rated on a 3-point Likert type scale, ranging from '1' (Not Well Prepared), '2' (Somewhat Prepared), and '3' (Very Well Prepared). Four content domains covered by the eighth grade mathematics assessment are Number, Algebra, Geometry, and Data and Chance with 19 topics were grouped by content domain (Figure 1).

1	Computing, estimating, or approximating with whole numbers
2	Concepts of fractions and computing with fractions
3	Concepts of decimals and computing with decimals
4	Representing, comparing, ordering, and computing with integers
5	Problem solving involving percent and proportions
6	Numeric, algebraic, and geometric patterns or sequences
7	Simplifying and evaluating algebraic expressions
8	Simple linear equations and inequalities
9	Simultaneous (two variables) equations
10	Representation of functions as ordered pairs, tables, graphs, words, or equations
11	Geometric properties of angles and geometric shapes
12	Congruent figures and similar triangles
13	Relationship between three-dimensional shapes and their two-dimensional representations
14	Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes
15	Points on the Cartesian plane
16	Translation, reflection, and rotation
17	Reading and displaying data using tables, pictographs, bar graphs, pie charts, and line graphs
18	Interpreting data sets
19	Judging, predicting, and determining the chances of possible outcomes

Fig.1 Mathematics topics covered in TIMSS 2011 eighth grade assessment

vi. Teachers' Confidence in Teaching Mathematics

To investigate teachers' confidence in teaching mathematics, teachers of students taking the eighth grade TIMSS assessments were asked to indicate how confident they feel about doing each of the following: "Answer students' questions about mathematics", "Show students a variety of problem solving strategies", "Provide challenging tasks for capable students", "Adapt teaching to engage students' interest" and "Help students appreciate the value of learning mathematics". All items were rated on a 3-point Likert type scale, ranging from '1' (Not Confident), '2' (Somewhat Confident), and '3' (Very Confident).

vii. Teachers' Career Satisfaction

To investigate teachers' career satisfaction, teachers of students taking the eighth grade TIMSS assessments were asked to indicate how much they agreed with each of the following six statements: "I am content with my profession as a mathematics teacher", "I am satisfied with being a mathematics teacher at this school", "I had more enthusiasm when I began teaching mathematics than I have now", "I do important works as a mathematics teacher", "I plan to continue as a mathematics teacher for as long as I can", and "I am frustrated as a mathematics teacher". All items were rated on a 4-point Likert type scale, ranging from '1' (Disagree a lot) to '4' (Agree a lot).

viii. Collaborate to Improve Science/Mathematics Teaching

The Collaborate to Improve Teaching Scale was designed to focus on the idea of collaboration for the purpose of improving teaching. Hence, the scale was based on how often teacher interacted with other teachers regarding each of the following areas: "Discuss how to teach a particular topic", "Collaborate in planning and preparing instructional materials", "Share what I have learned about my teaching experiences", "Visit another classroom to learn more about teaching", and "Work together to try out new ideas". All items were rated on a 4-point Likert type scale, ranging from '1' (Never or Almost Never) to '4' (Daily or Almost Daily).

ix. Instruction to Engage Students in Learning Mathematics

To measure aspects of student content engagement, a teacher scale called the Engaging Students in Learning Scale was developed. The scale contains four items related to teachers' instructional practices intended to interest students and reinforce learning: "Summarize what students should have learned from the lesson", "Use questioning to elicit reasons and explanations", "Encourage all students to improve their performance", and "Praise students for good effort". All items were rated on a 4-point Likert type scale, ranging from '1' (Never) to '4' (Every or Almost Every Lesson). Students were scored according to their teachers' responses to how often they used each of four instructional practices on the Engaging Students in Learning scale.

x. Teachers Relate Lessons to Students' Daily Lives / Bring Interesting Materials to Class

Mathematics teachers report about how often they relate their lessons to student' daily lives. The item was rated on a 4-point Likert type scale, ranging from '1' (Never) to '4' (Every or Almost Every Lesson). Mathematics teachers report about how often they bring interesting materials to class. The item was rated on a 4-point Likert type scale, ranging from '1' (Never) to '4' (Every or Almost Every Lesson).

xi. Resources Teachers Use for Teaching Mathematics

Mathematics teachers report about the classroom materials used for teaching mathematics at the eighth grade (i.e., "Textbooks", "Workbooks or Worksheets", "Concrete Objects or

Materials that Help Students Understand Quantities or Procedures", or "Computer Software for Mathematics Instruction").

xii. Mathematics Teachers' Instructional Activities in Mathematics Class

Mathematics teachers were asked to report how often, in teaching mathematics, teachers ask students to engage in the following six activities: "work problems individually or with peers with teacher guidance", "work problems together in the whole class with direct teacher guidance", "work problems individually or with peers while teacher occupied by other tasks", "memorize rules, procedures, and facts", "explain their answers", and "apply facts, concepts, and procedures". All items were rated on a 4-point Likert type scale, ranging from '1' (Never) to '4' (Every or Almost Every Lesson).

xiii. Computer Activities during Mathematics Lessons

Mathematics teachers' reports about the prevalence and types of computer-based activities used as part of mathematics instruction at the eighth grade (i.e., to explore mathematics principles and concepts, to look up ideas and information, to process and analyze data, to practice skills and procedures).

xiv. Mathematics Classroom Assessment

Mathematics teachers' reports about how often they give eighth grade students mathematics tests or examination (i.e., "Every 2 Weeks or More", "About Once a Month", or "A Few Times a Year or Less") and the purpose of giving the test questions (i.e., involving application of mathematical procedures, involving searching for patterns and relationships, or requiring explanations or justifications).

Data Collection Procedures

Before administering the instruments, formal permission from the related authorities (e.g., Educational Planning and Research Division, Sabah State Education Department) were sought and obtained. The questionnaires were personally-administered by the researchers. Mathematics teachers of the chosen rural secondary schools were informed about the nature of the instruments and how the instruments should be answered.

Data Analysis Procedures

Descriptive statistics (i.e., measures of central tendency and measures of dispersion) were used to describe teacher-level characteristics of those who taught mathematics at rural secondary schools in Sabah, Malaysia. These teacher-level characteristics include teachers' formal education, teachers' major in education and mathematics, years of teaching experience, teachers' participation in professional development, preparation to teach the TIMSS mathematics topics, confidence in teaching mathematics, career satisfaction, teacher collaboration to improve mathematics teaching, instruction to engage student in learning mathematics, relate lessons to students' daily lives, bring interesting materials to class, resources teachers use for teaching mathematics, instructional activities during mathematics class, computer activities during mathematics lesson, and mathematics classroom assessment.

Results and Discussions

i. Mathematics Teachers' Formal Education

Teacher preparation is a powerful predictor of students' academic achievement as compared to socioeconomic and language background factors (e.g., Darling-Hammond, 2000; Lay, Areepattamannil, Ng, Karnasih, & Kaur, 2014; Nur Jahan, Hazura, Corrienna, & Ng, 2014).

Table 1 Mathematics teachers' formal education

Completed postgraduate university degree	Completed bachelor's degree or equivalent but not a postgraduate degree	Completed post-secondary education but not a bachelor's degree	No further than upper-secondary education	Total
136	287	4	6	433
(31.4)	(66.3)	(.9)	(1.4)	(100.0)

Note Reported by teachers. Percentages appear in parentheses.

Table 1 shows the distribution of rural schools mathematics teachers in Sabah according to their highest level of formal education. More than half (66.3%) of the mathematics teachers had completed bachelor's degree (or equivalent), about one-third (31.4%) had completed postgraduate university degree. Only 1.4% had an upper secondary education and the remaining 0.9% had completed post-secondary education.

Table 2 presents mathematics teachers' reports about their highest level of formal education for the TIMSS 2011 eighth grade assessment.

Table 2 Mathematics teachers' formal education (TIMSS 2011)

Country	Percent of Students by Teacher Education Level			
	Completed Postgraduate University Degree	Completed Bachelor's Degree or Equivalent but Not a Postgraduate Degree	Completed Post-secondary Education but Not a Bachelor's Degree	No Further than Upper-secondary Education
Malaysia	4	86	8	2
	(1.5)	(2.7)	(2.2)	(1.0)
International Average	24	63	11	3
	(0.4)	(0.5)	(0.3)	(0.1)

Note Reported by teachers. Standard errors appear in parentheses.

For the TIMSS 2011 eighth grade assessment, only 4% of the Malaysian students had mathematics teachers with a postgraduate university degree, 86% had teachers with a bachelor's degree, 8% had teachers who had completed post-secondary education, and 2% had teachers with an upper secondary degree.

On average, internationally, across the TIMSS 2011 eighth grade participating countries, 24% of the students had mathematics teachers with a postgraduate university degree, 63% had teachers with a bachelor's degree, 11% had teachers who had completed post-secondary education (usually a 3-year teacher education program), and 3% had teachers with an upper secondary degree.

ii. Teachers Majoring in Education and Mathematics

In addition to the importance of a college or university degree or advanced degree, the literature reports widespread agreement that teachers should have a solid mastery of the content in the subject to be taught (e.g., Darling-Hammond, 2000; Kaur, Areepattamannil, & Boey, 2013; Lay, Areepattamannil, Ng, Karnasih, & Kaur, 2014; Nur Jahan, Hazura, Corrienna, & Ng, 2014). For example, in a review of teacher quality research, Rice (2003) examined the relationship between teachers' advanced degrees with student achievement and found a positive relationship between subject-specific advanced degrees and student achievement in mathematics and science.

Table 3 Teachers majored in education and mathematics

Major in mathematics and mathematics education	Major in mathematics education but no major in mathematics	Major in mathematics but no major in mathematics education	All other majors	No formal education beyond upper-secondary	Total
187	80	40	98	23	428
(43.7)	(18.7)	(9.3)	(22.9)	(5.4)	(100.0)

Note Reported by teachers. Percentages appear in parentheses.

Table 3 shows the distribution of rural schools mathematics teachers in Sabah according to their specialisation in mathematics and mathematics education. Less than half (43.7%) of the mathematics teachers had a major in mathematics and mathematics education, about one-fifth (18.7%) had a major in mathematics education but no major in mathematics, 9.3% had a major in mathematics but no major in mathematics education. Surprisingly, about one-fifth (22.9%) had a specialisation in all other majors and 5.4% of the mathematics teachers had no formal education beyond upper-secondary.

Table 4 shows the percentages of students in the TIMSS 2011 eighth grade assessment whose teachers had a major or specialization in mathematics education and if they also had a major or specialization in mathematics.

Table 4 Teachers majored in education and mathematics (TIMSS 2011)

Country	Major in Mathematics and Mathematics Education		Major in Mathematics Education but No Major in Mathematics		Major in Mathematics but No Major in Mathematics Education		All Other Majors		No Formal Education Beyond Upper-secondary	
	% of Students	Average Math Achievement	% of Students	Average Math Achievement	% of Students	Average Math Achievement	% of Students	Average Math Achievement	% of Students	Average Math Achievement
Malaysia	31	432	10	419	36	453	20	444	2	467
	(3.9)	(9.9)	(2.3)	(13.6)	(3.6)	(8.3)	(3.5)	(13.2)	(1.1)	(35.7)
Internatio-nal Average	32	471	12	470	41	468	12	462	3	418
	(0.5)	(1.3)	(0.3)	(3.0)	(0.5)	(1.1)	(0.4)	(2.4)	(0.1)	(7.0)

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

For the TIMSS 2011 eighth grade assessment, on average, majority of the Malaysian eighth grade students were taught mathematics by teachers who had a major in mathematics but not in mathematics education (36%), or who had a major in both (31%). Average mathematics achievement was only slightly different for these students (453 and 432, respectively) than for the students taught by teachers majoring in mathematics education but not mathematics (419).

Internationally, on average, majority of the eighth grade students were taught mathematics by teachers who had a major in mathematics but not in mathematics education (41%), or who had a major in both (32%). Average mathematics achievement was only slightly different for these students (468 and 471, respectively) than for 12% of students taught by teachers majoring in mathematics education but not mathematics (470), though higher than the students taught by teachers with other majors (462). Almost all of the eighth grade students were taught mathematics by teachers with college degrees.

iii. Teachers' Years of Teaching Mathematics Experience

It is difficult to examine the effects of teacher experience on student academic achievement because sometimes more experienced teachers are assigned to students of higher ability and with fewer discipline problems, and 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).

Table 5 Teachers' years of teaching mathematics experience

20 years or more	At least 10 but less than 20 years	At least 5 but less than 10 years	Less than 5 years	Total
58	144	157	78	437
(13.3)	(33.0)	(35.9)	(17.8)	(100.0)

Note Reported by teachers. Percentages appear in parentheses.

Table 5 shows the distribution of rural schools mathematics teachers in Sabah according to their respective years of teaching experience. More than one-third (35.9%) of the mathematics teachers with at least 5 but less than 10 years of teaching experience, one-third (33.0%) with at least 10 but less than 20 years of teaching experience. About one-fifth (17.8%) with less than 5 years of teaching experience. About one-tenth (13.3%) with 20 years or more of teaching experience.

Table 6 presents teachers' reports about their years of teaching mathematics experience in the TIMSS eighth grade assessment.

Table 6 Teachers' years of teaching mathematics experience (TIMSS 2011)

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 Math Achievement	Percent of Students	Average Math Achievement	Percent of Students	Average Math Achievement	Percent of Students	Average Math Achievement	
Malaysia	18 (3.0)	446 (12.2)	31 (3.4)	446 (9.5)	21 (3.0)	426 (11.4)	30 (3.3)	441 (10.5)	11 (0.7)
International Average	36 (0.5)	474 (1.3)	28 (0.5)	470 (1.2)	19 (0.4)	463 (1.7)	18 (0.4)	458 (1.8)	16 (0.1)

Note Reported by teachers. Standard errors appear in parentheses.

On average, the Malaysian eighth grade teachers were slightly less experienced (11 years), leading to lesser percentages of students taught by experienced teachers – 49% taught by teachers with at least 10 years of experience. The relationship between teacher experience and average student achievement was less pronounced among the eighth grade students, rising from 441 points for students taught by teachers with less than five years of experience to 446 points for students taught by teachers with more than twenty years of experience.

Internationally, on average, the eighth grade teachers were slightly less experienced leading to lesser percentages of students taught by experienced teachers – 64% taught by teachers with at least years of experience. The relationship between teacher experience and average student achievement was more pronounced among the eighth grade students, rising from 458 points for students taught by teachers with less than five years of experience to 474 points for students taught by teachers with more than twenty years of experience. With more use of tracking and streaming of students by the eighth grade, this may be symptomatic of the

more experienced teachers receiving preferred assignments. However, this gap also could reflect the fact that the newer teachers still are learning the most effective instructional approaches.

iv. Teachers' Professional Development in Mathematics

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

Table 7 Teacher participation in professional development in mathematics in the past two years

Math. content	Math. pedagogy/ instruction	Math. curriculum	Integrating information technology into mathematics	Improving students' critical thinking or inquiry skills	Math. assessment	Others	Total
79	43	47	11	54	25	129	388
(20.4)	(11.1)	(12.1)	(2.8)	(13.9)	(5.7)	(34.0)	(100)

Note Reported by teachers. Percentages appear in parentheses.

Table 7 shows the distribution of mathematics teachers according to their participation in professional development in mathematics in the past two years. About one-fifth (20.4%) had participated in professional development in mathematics content, 13.9% in improving students' critical thinking or inquiry skills, 12.1% in mathematics curriculum, and 11.1% in mathematics pedagogy/instruction. Less than one-tenth of the mathematics teachers had participated in professional development in mathematics assessment (5.7%), and integrating information technology into mathematics (2.8%). However, 34.0% of the mathematics teachers had attended professional development courses with other combinations.

Table 8 presents teachers' reports about areas of professional development in mathematics in which they had participated in the past two years, in the eighth grade TIMSS assessment.

Table 8 Teacher participation in professional development in mathematics in the past two years (TIMSS 2011)

Country	Percent of Students by Teacher's Area of Professional Development					
	Mathematics Content	Mathematics Pedagogy/ Instruction	Mathematics Curriculum	Integrating Information Technology into Mathematics	Improving Students' Critical Thinking or Inquiry Skills	Mathematics Assessment
Malaysia	40 (4.2)	42 (4.1)	35 (3.7)	41 (4.1)	36 (3.8)	46 (4.2)
International Average	55 (0.5)	58 (0.6)	52 (0.5)	48 (0.5)	43 (0.6)	47 (0.5)

Note Reported by teachers. Standard errors appear in parentheses.

On average, less than half of the Malaysian students were taught by mathematics teachers who had participated in professional development in mathematics assessment (46%), mathematics pedagogy/instruction (42%), and integrating information technology into mathematics (41%). Furthermore, about one-third of the students had mathematics teachers who had participated in professional development in improving students' critical thinking or inquiry skills (36%), and mathematics curriculum (35%), respectively.

As shown in Table 8, mathematics teachers of students in the TIMSS eighth grade assessment reported somewhat higher levels of participations in mathematics professional development. On average, across the eighth grade countries, the majority of students were taught by mathematics teachers who had participated in professional development in mathematics instruction or pedagogy (58%), content (55%), or curriculum (52%) in the past two years. Furthermore, almost half of the students had teachers with professional development in integrating information technology into mathematics (48%), mathematics assessment (47%), or improving students' critical thinking or problem solving (43%), respectively.

v. Teachers' Preparation to Teach the TIMSS Mathematics Topics

Recognising a sound knowledge of science would seem to be a prerequisite for effective science teaching, evidence directly linking teacher preparation in science to students' science achievement is scarce (e.g., Darling-Hammond, 2000; Lay, Areepattamannil, Ng, Karnasih, & Kaur, 2014; Nur Jahan, Hazura, Corrienna, & Ng, 2014). A meta-analysis of the effects of teachers' subject matter preparation on their students' achievement in mathematics and science found that some studies showing a positive effect, but in general results were mixed (Wilson, Floden, & Ferrini-Mundi, 2002).

Table 9 Teachers feel "very well" prepared to teach TIMSS mathematics topics

		Very Well Prepared	Somewhat Prepared	Not Well Prepared
1	Computing, estimating, or approximating with whole numbers	262 (60.0)	159 (36.4)	16 (3.7)
2	Concepts of fractions and computing with fractions	280 (63.8)	146 (33.3)	13 (3.0)
3	Concepts of decimals and computing with decimals	286 (65.0)	141 (32.0)	13 (3.0)
4	Representing, comparing, ordering, and computing with integers	265 (60.4)	165 (37.6)	9 (2.1)
5	Problem solving involving percentages and proportions	244 (55.7)	180 (41.1)	14 (3.2)
6	Numeric, algebraic, and geometric patterns or sequences	260 (59.2)	170 (38.7)	9 (2.1)
7	Simplifying and evaluating algebraic expressions	281 (64.0)	143 (32.6)	15 (3.4)
8	Simple linear equations and inequalities	287 (65.2)	140 (31.8)	13 (3.0)
9	Simultaneous (two variables) equations	270 (61.4)	154 (35.0)	16 (3.6)
10	Representation of functions as ordered pairs, tables, graphs, words, or equations	227 (51.6)	192 (43.6)	21 (4.8)
11	Geometric properties of angles and geometric shapes	230 (52.3)	191 (43.4)	19 (4.3)
12	Congruent figures and similar triangles	220 (50.0)	199 (45.2)	21 (4.8)
13	Relationship between three-dimensional shapes and their two-dimensional representations	202 (46.0)	207 (47.2)	30 (6.8)
14	Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes	257 (58.4)	167 (38.0)	16 (3.6)
15	Points on the Cartesian plane	252 (57.4)	161 (36.7)	26 (5.9)
16	Translation, reflection, and rotation	242 (55.0)	170 (38.6)	28 (6.4)
17	Reading and displaying data using tables, pictographs, bar graphs, pie charts, and line graphs	258 (58.8)	162 (36.9)	19 (4.3)
18	Interpreting data sets	249 (56.6)	164 (37.3)	27 (6.1)
19	Judging, predicting, and determining the chances of possible outcomes	180 (41.2)	222 (50.8)	35 (8.0)

Note Reported by teachers. Percentages appear in parentheses.

Table 9 shows the distribution of mathematics teachers according to their preparedness to teach TIMSS mathematics topics. More than half of the mathematics teachers were well-prepared to teach TIMSS mathematics topics: 'Simple linear equations and inequalities' (65.2%), 'Concepts of decimals and computing with decimals' (65.0%), 'Simplifying and evaluating algebraic expressions' (64.0%), 'Concepts of fractions and computing with fractions' (63.8%), 'simultaneous (two variables) equations' (61.4%), 'Representing, comparing, ordering, and computing with integers' (60.4%), 'Computing, estimating, or approximating with whole numbers' (60.0%). On the other hand, mathematics teachers were

somewhat prepared to teach the rest of the TIMSS mathematics topics: 'Judging, predicting, and determining the chances of possible outcomes' (50.8%) and 'Relationship between three-dimensional shapes and their two-dimensional representations' (47.2%).

To provide information about how well prepared teachers feel they are to teach mathematics, TIMSS asks the teachers of the students participating in each assessment to indicate whether they felt very well prepared, somewhat prepared, or not well prepared to teach the mathematics content topics assessed by TIMSS.

Table 10 Teachers feel "very well" prepared to teach TIMSS mathematics topics (TIMSS 2011)

Country	Percent of Students Whose Teachers Feel "Very Well" Prepared to Teach TIMSS Mathematics Topics				
	Overall Mathematics (19 Topics)	Number (5 Topics)	Algebra (5 Topics)	Geometry (6 Topics)	Data and Chance (3 Topics)
Malaysia	83 (1.7)	93 (1.5)	85 (2.2)	85 (2.2)	60 (2.4)
International Average	84 (0.3)	92 (0.3)	87 (0.3)	85 (0.3)	62 (0.4)

Note Reported by teachers. Standard errors appear in parentheses.

Table 10 presents reports of how teachers felt about their level of preparation to teach the nineteen mathematics topics in the eighth grade assessment. The nineteen mathematics topics are grouped by content domain which are number, algebra, geometry, and data and chance. The results are averaged across all nineteen topics for a perspective on mathematics overall, as well as separately by content domain: five topics in number, five topics in algebra, six topics in geometry, and three topics in data and chance.

In Malaysia, 83% of the eighth grade students were taught by teachers who felt very well prepared to teach the TIMSS mathematics topics. Across the content domains, most students had teachers very well prepared to teach the number topics (93%), with a relatively fewer well-prepared in algebra (85%) and geometry (85) topics. Only 60% of students, on average, had teachers who felt very well prepared to teach the data and chance topics.

Internationally, on average, 84% of the eighth grade students were taught by teachers who felt very well prepared to teach the TIMSS mathematics topics. Across the content domains, most students had teachers very well prepared to teach the number topics (92%), with a relatively fewer well prepared in algebra (87%) and geometry (85%) topics. Only 62% of students, on average internationally, had teachers who felt very well prepared to teach the data and chance topics.

vi. Teachers' Confidence in Teaching Mathematics

Previous studies (Bandura, 1997; Henson, 2002) 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. In this regards, teachers with a strong sense of personal ability to organise and execute their teaching are more open to new ideas and less likely to experience emotional burnout (e.g., Arends, 2016; Ford, 2012).

Table 11 Confidence in teaching mathematics

		Very Confident	Somewhat Confident	Not Confident
1	Answer students' questions about mathematics	345 (78.1)	95 (21.5)	2 (.5)
2	Show students a variety of problem solving strategies	282 (63.8)	155 (35.1)	5 (1.1)
3	Provide challenging tasks for capable students	230 (52.0)	201 (45.5)	11 (2.5)
4	Adapt my teaching to engage students' interest	224 (50.7)	210 (47.5)	8 (1.8)
5	Help students appreciate the value of learning mathematics	253 (57.2)	179 (40.5)	10 (2.3)

Note Reported by teachers. Percentages appear in parentheses.

Table 11 shows the distribution of mathematics teachers according to their confidence in teaching mathematics. More than half of the mathematics teachers were very confident in answering students' questions about mathematics (78.1%), showing students a variety of problem solving strategies (63.8%), helping students appreciate the value of learning mathematics (57.2%), providing challenging tasks for capable students (52.0%), and adapting their teaching to engage students' interest (50.7%).

To investigate teachers' confidence in teaching mathematics to the TIMSS class, teachers were asked to indicate how confident they feel about doing each of the item. Students were scored according to their teachers' responses to how confident they felt in using five instructional strategies on the Confidence in Teaching Mathematics scale. Students with "Very Confident" teachers had a score on the scale of at least 9.2, which correspond 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.

Table 12 shows results for the Confidence in Teaching Mathematics Scale for the eighth grade TIMSS assessment.

Table 12 Confidence in teaching mathematics (TIMSS 2011)

Country	Very Confident		Somewhat Confident		Average Scale Score
	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	
Malaysia	77 (3.2)	432 (7.1)	23 (3.2)	410 (13.3)	10.1 (0.17)
International Average	76 (0.5)	470 (0.7)	24 (0.5)	456 (1.7)	

Note Reported by teachers. Standard errors appear in parentheses.

On average, the majority (77%) of the Malaysian eighth grade students had teachers very confident in teaching mathematics to the class, and their mathematics achievement was somewhat higher on average than the 23% of students whose teachers were only somewhat confident (432 vs. 410).

On average, internationally, the majority of eighth grade students (76%) had teachers very confident in teaching mathematics to the class, and their mathematics achievement was

somewhat higher on average than the 24% of students whose teachers were only somewhat confident (470 vs. 456).

Table 13 provides further information about the components of the Confidence in Teaching Mathematics Scale, by showing the percentage of students whose teachers reported feeling very confident in using each of the five instructional strategies.

Table 13 Components of confidence in teaching mathematics scale (TIMSS 2011)

Country	Percent of Students Whose Teachers Feel Very Confident to				
	Answer Student Questions About Mathematics	Show Students a Variety of Problem Solving Strategies	Provide Challenging Tasks for Capable Students	Adapt Teaching to Engage Student Interests	Help Students Appreciate the Value of Learning Mathematics
Malaysia	88 (2.4)	80 (3.1)	62 (3.8)	63 (3.8)	72 (3.4)
International Average	87 (0.4)	77 (0.5)	65 (0.5)	62 (0.5)	65 (0.5)

Note Reported by teachers. Standard errors appear in parentheses.

Malaysian teachers most often very confident about answering student questions about mathematics (88% of students taught by such teachers), showing students a variety of problem solving strategies (80%), and helping students appreciate the value of learning mathematics (72%), but less often very confident about the other components.

Internationally, on average, the components of the Confidence in Teaching Mathematics Scale at the eighth grade followed a similar pattern in terms of teacher confidence as at the fourth grade, with teachers most often very confident about answering student questions about mathematics (87% of students taught by such teachers) and showing students a variety of problem solving strategies (77%) but less often very confident about the other components.

vii. Mathematics Teachers' Career Satisfaction

Previous studies (e.g., Ford, 2012; Lay, Areepattamannil, Ng, Karnasih, & Kaur, 2014; Nur Jahan, Hazura, Corrienna, & Ng, 2014) have found that teachers who are satisfied with their profession and the working conditions at their school are more motivated to teach and prepare their instruction.

Table 14 Mathematics teacher career satisfaction

		Agree a lot	Agree a little	Disagree a little	Disagree a lot
1	I am content with my profession as a mathematics teacher.	260 (59.0)	166 (37.6)	15 (3.4)	0 (.0)
2	I am satisfied with being a mathematics teacher at this school.	272 (61.7)	156 (35.4)	12 (2.7)	1 (.2)
3	I had more enthusiasm when I began teaching mathematics than I have now.*	146 (33.2)	186 (42.3)	65 (14.8)	43 (9.7)
4	I do important works as a mathematics teacher.	256 (58.2)	168 (38.2)	15 (3.4)	1 (.2)
5	I plan to continue as a mathematics teacher for as long as I can.	288 (65.3)	132 (29.9)	19 (4.3)	2 (.5)
6	I am frustrated as a mathematics teacher.*	28 (6.4)	61 (13.9)	81 (18.4)	270 (61.4)

Note Reported by teachers. Percentages appear in parentheses.

Table 14 shows the distribution of mathematics teachers according to their level of career satisfaction. More than half of the mathematics teachers agreed with the statement which stated that 'I plan to continue as a mathematics teacher for as long as I can' (65.3%), 'I am satisfied with being a mathematics teacher at this school' (61.7%), 'I am content with my profession as a mathematics teacher' (59.0%), and 'I do important works as a mathematics teacher' (58.2%). On the other hand, 61.4% of the mathematics teachers disagreed that 'I am frustrated as a mathematics teacher'. However, 42.3% of the mathematics teachers also agreed that 'I had more enthusiasm when I began teaching mathematics than I have now'.

Teachers who are satisfied with their profession and the working conditions at their schools are more motivated to teach and prepare their instruction (e.g., Ford, 2012; Lay, Areepattamannil, Ng, Karnasih, & Kaur, 2014; Nur Jahan, Hazura, Corrienna, & Ng, 2014). Further, having teachers that can provide leadership is a dimension of teacher quality. However, developing master teachers requires retention in the profession. Teachers need to be committed to the profession and like it enough to continue teaching. It may be that some subject areas and locales would benefit from policies to reduce teacher attrition in order to improve student achievement (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009).

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 15 shows the eighth grade TIMSS assessment results for the TIMSS 2011 Teacher Career Satisfaction Scale.

Table 15 Mathematics teacher career satisfaction (TIMSS 2011)

Country	Satisfied		Somewhat Satisfied		Less Than Satisfied		Average Scale Score
	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	
Malaysia	61 (4.3)	441 (6.6)	38 (4.4)	439 (9.1)	0.5 (0.5)	424 (8.2)	10.4 (0.13)
International Average	47 (0.6)	473 (0.9)	45 (0.6)	464 (1.0)	7 (0.3)	462 (2.4)	

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

In Malaysia, the eighth grade mathematics teachers reported somewhat higher levels of career satisfaction with 61% of students taught by satisfied teachers. However, taken together, almost all of the eighth grade students (99%) were taught mathematics by satisfied or somewhat satisfied teachers. On average, students taught by satisfied teachers had higher mathematics achievement than those taught by somewhat satisfied teachers (441 vs. 439).

Internationally, the eighth grade mathematics teachers reported somewhat lower levels of career satisfaction with 47% of students taught by satisfied teachers. However, taken together, almost all of the eighth grade students (92%) were taught mathematics by satisfied or somewhat satisfied teachers. On average, students taught by satisfied teachers had higher mathematics achievement than those taught by less satisfied teachers (473 vs. 464 and 462, respectively).

viii. Collaborate to Improve Mathematics Teaching

Part and parcel of creating a school learning environment focused on academic success involves a staff that collaborates on curricular activities. Teacher collaboration with colleagues is important in building a professional community. A study including a comprehensive theoretical review and a meta-analysis of studies about professional communities indicated a small but positive effect of professional communities on student achievement (Lomos, Roelande, & Bosker, 2011).

Table 16 Collaborate to improve mathematics teaching

		Daily or almost daily	1-3 times per week	2 or 3 times per month	Never or almost never
1	Discuss how to teach a particular topic	51 (11.5)	193 (43.7)	185 (41.9)	13 (2.9)
2	Collaborate in planning and preparing instructional materials	30 (6.8)	153 (34.6)	204 (46.2)	55 (12.4)
3	Share what I have learned about my teaching experience	47 (10.6)	137 (31.0)	223 (50.5)	35 (7.9)
4	Visit another classroom to learn more about teaching	15 (3.4)	66 (14.9)	187 (42.3)	174 (39.4)
5	Work together to try out new ideas	31 (7.0)	118 (26.7)	231 (52.3)	62 (14.0)

Note Reported by teachers. Percentages appear in parentheses.

Table 16 shows the distribution of mathematics teachers according to their level of collaboration to improve their mathematics teaching. 52.3% of the mathematics teachers worked together to try out new ideas 2 or 3 times per month, shared what they have learned about their teaching experience 2 or 3 times per month (50.5%), collaborated in planning and

preparing instructional materials 2 or 3 times per month (46.2%), visited another classroom to learn more about teaching 2 or 3 times per month (42.3%). On the other hand, 43.7% of the mathematics teachers discussed how to teach a particular topic 1-3 times per week.

In TIMSS, students were scored according to their teachers' responses to how often they interacted with other teachers in each of the five teaching areas on the Collaborate to Improve Teaching Scale. Students with "Very Collaborative" teachers had a score on the scale of at least 11.4, which corresponded to their teachers having interactions with other teachers at least "one to three times per week" in each of three of the five areas and "two or three times per month" in each of the other two, on average. Students with "Somewhat Collaborative" teachers had a score no higher than 7.5, which corresponded to their teachers interacting with other teachers "never or almost never" in each of the three of the five areas and "two or three times per month" in each of the other two, on average. All other students had "Collaborative" teachers.

Table 17 presents the teacher collaboration results for the eighth grade in TIMSS 2011 assessment.

Table 17 Collaborate to improve mathematics teaching (TIMSS 2011)

Country	Very Collaborative		Collaborative		Somewhat Collaborative		Average Scale Score
	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	
Malaysia	28	431	64	448	7	411	10.2
	(3.5)	(10.4)	(4.0)	(5.9)	(2.3)	(19.6)	(0.12)
International Average	28	467	57	468	15	465	
	(0.5)	(1.2)	(0.6)	(0.8)	(0.4)	(1.9)	

Note Reported by teachers. Standard errors appear in parentheses.

In Malaysia, on average, more than one-quarter 28% of the eighth grade students had very collaborative teachers and another 64% had collaborative teachers, with 7% having only somewhat collaborative teachers. The eighth grade students with collaborative teachers had somewhat higher average mathematics achievement than students with somewhat collaborative teachers (448 vs. 411).

Internationally, on average, more than one-quarter 28% of the eighth grade students had very collaborative teachers and another 57% had collaborative teachers, with 15% having only somewhat collaborative teachers. However, the eighth grade students had essentially the same average mathematics achievement whether their teachers were very collaborative or collaborative (467 vs. 468, respectively). According to TIMSS 2011 reports from mathematics teachers, almost all students have the benefit of teachers who collaborate with other teachers to improve instruction.

In TIMSS 2011, mathematics teachers were asked how often they interacted with other teachers in each of the five teaching areas on the Collaborate to Improve Teaching Scale. Generally, Malaysian science teachers interacted more frequently with other teachers in discussing how to teach a particular topic and sharing what they have learned from their teaching experiences as compared to their Singaporean counterparts.

ix. Instruction to Engage Students in Learning Mathematics

To build a better bridge between curriculum and instruction, TIMSS 2011 collected information about the concept of student content engagement as described by McLaughlin et al. (2005). Student content engagement focuses on the importance of the teaching and learning

activity that brings the student and the subject matter content together. Engagement refers to the cognitive interaction between the student and instructional content, and may take the form of listening to the teacher or providing an explanation of a problem solution. It is the student's in-the-moment cognitive interaction with instructional content.

Table 18 Instruction to engage students in learning mathematics

		Every or almost every lesson	About half of the lessons	Some lessons	Never
1	Summarize what students should have learned from the lesson	253 (57.4)	131 (29.7)	56 (12.7)	1 (.2)
2	Use questioning to elicit reasons and explanations	219 (49.7)	175 (39.7)	46 (10.4)	1 (.2)
3	Encourage all students to improve their performance	284 (64.4)	133 (30.2)	23 (5.2)	1 (.2)
4	Praise students for good effort	310 (70.3)	103 (23.3)	28 (6.3)	0 (.0)

Note Reported by teachers. Percentages appear in parentheses.

Table 18 shows the distribution of mathematics teachers according to instructional practices intended to interest students and reinforce learning. More than half of the mathematics teachers praised students for good effort (70.3%), encouraged all students to improve their performance (64.4%), summarized what students should have learned from the lesson (57.4%), and used questioning to elicit reasons and explanations (49.7%) every or almost every lesson.

To measure aspects of student content engagement, TIMSS 2011 developed both a teacher scale, called the Engaging Students in Learning Scale, and a student scale called the Engaged in Mathematics Lessons scale. The Engaging Students in Learning Scale contains four items related to teachers' instructional practices intended to interest students and reinforce learning. At the eighth grade, two items were removed from the scale because relatively small percentages of students had teachers that frequently related lessons to students' daily lives, and even smaller percentages had teachers that routinely brought interesting materials to class. Perhaps eighth grade teachers should make greater efforts to make mathematics relevant to students' daily lives and provide interesting materials, especially in light of the drop by the eighth grade in students' liking mathematics learning. On the other hand, teachers in some of the highest achieving countries reported the least use of these instructional practices.

In TIMSS 2011, students were scored according to their teachers' responses to how often they used each of four instructional practices on the Engaging Students in Learning Scale. Students whose teachers who used engagement practices in "Most Lessons" had a score on the scale of at least 8.7, which corresponds to their teachers using two of the four practices "every or almost every lessons" and using the other two in "about half the lessons" , on average . Students with teachers who used engagement practices in "Some Lessons" had a score no higher than 5.7, which corresponds to their teachers using two of the four practices in "some lessons" and using the other two in "about half the lessons", on average. All other students had teachers who used engagement practices in "About Half the Lessons".

Table 19 presents the eighth grade results based on a somewhat shorter Engaging Students in Learning Scale.

Table 19 Instruction to engage students in learning mathematics (TIMSS 2011)

Country	Most Lessons		About Half the Lessons		Some Lessons		Average Scale Score
	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	Percent of Students	Average Mathematics Achievement	
Malaysia	73	448	22	421	5	417	9.5
	(3.6)	(5.8)	(3.2)	(12.3)	(1.6)	(25.1)	(0.16)
International Average	80	469	17	459	3	484	
	(0.4)	(0.7)	(0.4)	(1.8)	(0.2)	(4.5)	

Note Reported by teachers. Standard errors appear in parentheses.

On average, 73% of the eighth grade students in Malaysia had teachers that reported using engaging practices in most lessons, and almost all of the rest had teachers that reported using engaging practices in about half of the lessons. Across the eighth grade, students often had somewhat higher average mathematics achievement if their teachers used engaging instruction in most lessons rather than about half the lessons.

Based on the shorter four-item scale, on average, 80% of the eighth grade students had teachers that reported using engaging practices in most lessons, and almost all of the rest had teachers that reported using engaging practices in about half of the lessons. Across the eighth grade, students often had somewhat higher average mathematics achievement if their teachers used engaging instruction in most lessons rather than about half the lessons.

x. Teachers Relate Mathematics Lessons to Students' Daily Lives / Bring Interesting Materials to Mathematics Class

Table 20 Teachers relate mathematics lessons to students' daily lives and bring interesting materials to mathematics class

		Every or almost every lesson	About half of the lessons	Some lessons	Never
1	Relate mathematics lessons to students' daily lives	117	187	136	2
		(26.5)	(42.3)	(30.8)	(.5)

Note Reported by Teachers. Percentages appear in parentheses.

Table 20 shows the distribution of mathematics teachers according to the frequency in relating their mathematics lessons to students' daily lives and bring interesting materials to mathematics class. About half (50.6%) of the mathematics teachers related their mathematics lessons to students' daily lives about half of the lessons.

Table 21 Teachers relate mathematics lessons to students' daily lives and bring interesting materials to mathematics class (TIMSS 2011)

Country	Relate Lessons to Students' Daily Lives				Bring Interesting Materials to Class			
	Every Lesson or Almost Every Lesson		About Half the Lessons or Less		Every Lesson or Almost Every Lesson		About Half the Lessons or Less	
	Percent of Students	Average Math Achievement	Percent of Students	Average Math Achievement	Percent of Students	Average Math Achievement	Percent of Students	Average Math Achievement
Malaysia	39 (3.9)	441 (9.6)	61 (3.9)	440 (7.0)	13 (2.4)	416 (19.2)	87 (2.4)	444 (5.2)
International Average	39 (0.5)	467 (1.2)	61 (0.5)	468 (0.8)	18 (0.4)	469 (1.8)	82 (0.4)	467 (0.7)

Note Reported by Teachers. Standard errors appear in parentheses.

39% of the Malaysian eighth grade students had mathematics teachers who reported relating lessons to students' daily lives in every lesson or almost every lesson and 61% had teachers who reported relating lessons to students' daily lives in about half the lessons or less. Eighth grade students often had somewhat similar average mathematics achievement if their teachers related lessons to students' daily lives in every lesson or almost every lesson or about half the lessons (441 vs. 440).

Internationally, on average, 39% of the eighth grade students had mathematics teachers who reported relating lessons to students' daily lives in every lesson or almost every lesson and 61% had teachers who reported relating lessons to students' daily lives in about half the lessons or less. However, eighth grade students often had similar average mathematics achievement if their teachers related lessons to students' daily lives in every lesson or almost every lesson or about half the lessons (467 vs. 468).

On the other hand, only 13% of the Malaysian eighth grade students had mathematics teachers who reported bringing interesting materials to class in every lesson or almost every lesson and 87% had teachers who reported bringing interesting materials to about half the lessons or less. Surprisingly, eighth grade students often had somewhat lower average mathematics achievement if their teachers brought interesting materials to class in every lesson or almost every lesson rather than about half the lessons (416 vs. 444).

Internationally, only 18% of the eighth grade students had mathematics teachers who reported bringing interesting materials to class in every lesson or almost every lesson and 82% had teachers who reported bringing interesting materials to about half the lessons or less. However, eighth grade students often had somewhat similar average mathematics achievement if their teachers brought interesting materials to class in every lesson or almost every lesson or about half the lessons (469 vs. 467).

xi. Resources Teachers Use for Teaching Mathematics

Previous studies (e.g., Corrienna, Hazura, & Pargunsan, 2012; Kaur, Areepattamannil, & Boey, 2013; Lay, Areepattamannil, Ng, Karnasih, & Kaur, 2014; Ng, 2011a, 2011b; Ng & Corrienna, 2013; Ng, Soon, Kim, Toh, & Lay, 2013; Nur Jahan, Hazura, Corrienna, & Ng, 2014; Reinikainen, 2007) highlighted that effective classroom environment for science learning encompasses the use of a variety of instructional approaches, capitalizing on technology, and extending instruction with homework and regularly assessing student progress.

Table 22 Resources teachers use for teaching mathematics

		%
1	Textbooks	13 (3.0)
2	Workbooks or worksheets	30 (6.9)
3	Concrete objects or materials that help students understand quantities or procedures	4 (.9)
4	Computer software for mathematics instruction	1 (.2)
5	Other combinations	305 69.8)
6	Combination of all	84 (19.2)

Note Reported by Teachers. Percentages appear in parentheses.

Table 22 shows the distribution of mathematics teachers according to the resources used for teaching mathematics. More than half (69.8%) of the mathematics teachers used other combination of resources in mathematics teaching. On the other hand, 19.2% of the mathematics teachers used the combination of workbooks/worksheets, textbooks, concrete objects or materials that help students understand quantities or procedures, and computer software for teaching mathematics.

Table 23 contains teachers' reports about the classroom materials used for teaching mathematics at the eighth grade.

Table 23 Resources teachers use for teaching mathematics (TIMSS 2011)

Country	Percent of Students Whose Teachers Use							
	Textbooks		Workbooks or Worksheets		Concrete Objects or Materials that Help Students Understand Quantities or Procedures		Computer Software for Mathematics Instruction	
	As Basis for Instruction	As a Supple-ment	As Basis for Instruction	As a Supple-ment	As Basis for Instruction	As a Supple-ment	As Basis for Instruction	As a Supple-ment
Malaysia	83 (2.8)	17 (2.8)	20 (3.0)	78 (3.2)	19 (2.9)	76 (3.2)	6 (1.8)	59 (3.7)
International Average	77 (0.4)	21 (0.4)	34 (0.5)	62 (0.5)	23 (0.5)	71 (0.5)	7 (0.3)	55 (0.5)

Note Reported by teachers. Standard errors appear in parentheses.

In Malaysia, textbooks were the most frequently used for teaching mathematics with 83% of the students, on average. Workbooks or worksheets were the next most frequently reported basis for instruction, used with 20% of the eighth grade students. Concrete objects or materials that help students understand quantities or procedures were less frequently used (19% of students, on average). Computer software was less frequently reported as a basis for instruction- only 6%, on average. All of the following materials except textbooks were popular as supplementary instructional resources at the eighth grade in Malaysia: workbooks or worksheets with 78% of students, concrete objects with 76%, and computer software with 59%.

Textbooks were the most frequent basis of mathematics instruction at the eighth grade, used with 77% of the students internationally, on average. However, in contrast, workbooks or worksheets were much less frequently reported as a basis for instruction, used with approximately one-third of eighth grade students (34%). As would be anticipated, concrete objects were less frequently used (twenty three percent of students on average). Computer software was not used with many students, on average, 7%. All of the following materials except textbooks were popular as supplementary instructional resources at the eighth grade:

workbooks or worksheets with 62% percent of students, concrete objects with 71%, and computer software with 55%.

xii. Mathematics Teachers' Instructional Activities in Mathematics Class

Table 24 Teacher instructional activities in mathematics class

		Every or almost every lesson	About half of the lessons	Some lessons	Never
1	Work problems (individually or with peers) with teacher guidance	197 (44.9)	160 (36.4)	77 (17.5)	5 (1.1)
2	Work problems together in the whole class with direct teacher guidance	189 (43.1)	178 (40.5)	69 (15.7)	3 (.7)
3	Work problems (individually or with peers) while teacher occupied by other tasks	93 (21.2)	188 (42.8)	135 (30.8)	23 (5.2)
4	Memorize rules, procedures, and facts	144 (32.8)	191 (43.5)	103 (23.5)	1 (.2)
5	Apply facts, concepts, and procedures	187 (42.6)	176 (40.1)	72 (16.4)	4 (.9)

Note Reported by teachers. Percentages appear in parentheses.

Table 24 shows the distribution of mathematics teachers according to the instructional activities used in their mathematics class. About half of the mathematics teachers asked their students to work problems (individually or with peers) with teacher guidance (44.9%), to work problems together in the whole class with direct teacher guidance (43.1%), and to apply facts, concepts, and procedures (42.6%) every or almost every lesson. On the other hand, about half of the teachers asked their students to memorise rules, procedures, and facts (43.5%) and to work problems (individually or with peers) whole teacher occupied by other tasks (42.8%) about half of the lessons.

Table 25 presents teachers reports about instructional approaches at the eighth grade.

Table 25 Teacher instructional activities in mathematics class (TIMSS 2011)

Country	Percent of Students Doing the Following Activities Every or Almost Every Lesson					
	Work Problems (Individually or with Peers) with Teacher Guidance	Work Problems Together in the Whole Class with Direct Teacher Guidance	Work Problems (Individually or with Peers) While Teacher Occupied by Other Tasks	Memorize Rules, Procedures, and Facts	Explain Their Answers	Apply Facts, Concepts, and Procedures
Malaysia	49 (4.0)	58 (3.5)	25 (3.6)	55 (3.9)	63 (3.7)	49 (3.8)
International Average	55 (0.6)	48 (0.6)	14 (0.4)	45 (0.5)	60 (0.5)	49 (0.6)

Note Reported by teachers. Standard errors appear in parentheses.

In Malaysia, on average, working problems together as a whole class with direct teacher guidance occurred in every or almost every lesson for 58%of students, working problems with teacher guidance (individually or in groups) occurred in almost every lesson for 49% of students, and working problems without teacher guidance (individually or in groups) for 25% of students. Sixty three percent of the eighth grade students in Malaysia were asked to explain their answers and 55% to memorize rules, procedures and facts, on average. At the eighth

grade, Malaysian teachers also reported on asking students to apply facts, concepts, and procedures; and just about half of the students 49% did application tasks in almost every lesson, on average.

Internationally, on average, working problems with teacher guidance (individually or in groups) occurred in almost every lesson for 55%of students, working problems without teacher guidance (individually or in groups) for 14% of students, and working problems together as a whole class with direct teacher guidance for 48% of students. Regarding the strategies, internationally, 60% of the eighth grade students were asked for explanations and 45% to memorize, on average. At the eighth grade, teachers also reported on asking students to apply facts, concepts, and procedures; and just about half of the students (49%) did application tasks in almost every lesson, on average.

xiii. Computer Activities during Mathematics Lessons

A recent study summarizing 25 meta-analyses determined that computer use in the classroom has a significant positive effect on achievement at all grade levels and in all subjects (Tamim, Bernard, Borokhovski, Abrami, & Schmidt, 2011). Availability of computers and other technology in the science classroom can facilitate successful implementation of the science curriculum. Computers and the Internet provide students ways to explore concepts in-depth, trigger enthusiasm and motivation for learning, enable students to learn at their own pace, and provide students with access to vast information sources.

Table 26 Computer activities during mathematics lessons

		Every or almost every lesson	Some lessons	Never
1	To explore mathematics principles and concepts	63 (14.4)	244 (56.0)	129 (29.6)
2	To look up ideas and information	69 (15.9)	252 (57.9)	114 (26.2)
3	To process and analyse data	50 (11.5)	228 (52.5)	155 (35.7)
4	To practice skills and procedures	58 (13.4)	238 (54.8)	137 (31.6)

Note Reported by teachers. Percentages appear in parentheses.

Table 26 shows the distribution of mathematics teachers according to the computer activities used during mathematics lessons. 57.9% of the mathematics teachers asked their students to look up ideas and information, to explore mathematics principles and concepts (56.0%), to practice skills and procedures (54.8%), and to process and analyse data (52.5%) using computers during some mathematics lessons.

Table 27 contains teachers' reports about the prevalence and types of computer-based activities used as part of mathematics instruction at eighth grade.

Table 27 Computer activities during mathematics lessons (TIMSS 2011)

Country	Computers Available for Mathematics Lessons			Percent of Students Whose Teachers Have Them Use Computers At Least Monthly			
	Percent of Students	Average Mathematics Achievement					
	Yes	Yes	No	To explore Mathematics Principles and Concepts	To Look Up Ideas and Information	To Process and Analyze Data	To Practice Skills and Procedures
Malaysia	6 (1.8)	434 (27.9)	442 (5.5)	5 (1.8)	5 (1.8)	4 (1.6)	4 (1.6)
Internation-al Average	36 (0.5)	470 (1.4)	467 (0.8)	22 (0.5)	23 (0.5)	21 (0.5)	24 (0.5)

Note Reported by teachers. Standard errors appear in parentheses.

In Malaysia, only 6% of the eighth grade students had computer available during their mathematics lessons. Students with computer available during their lessons had slightly lower mathematics achievement than students without computer available. Only four to five percent of the eighth grade students, on average, were asked to explore mathematics principles and concepts, to look up ideas and information, to process and analyze data, and to practice skills and procedures, at least a monthly basis, respectively.

Internationally, on average, about one-third (36%) of students had computers available during their mathematics lessons. Students with computers available during their lessons had slightly higher mathematics achievement than students without computers available. Approximately, twenty one to twenty four percent of the eighth grade students were asked to do the following on at least a monthly basis: explore mathematics principles and concepts, look up ideas and information, process and analyze data, and practice skills and procedures.

xiv. Mathematics Classroom Assessment

Table 28 Mathematics classroom assessment

		Every 2 weeks or more	About once a month	A few times a year or less
1	In teaching mathematics, how often do you give eighth grade students mathematics tests or examination?	56 (12.9)	272 (62.8)	105 (24.2)

Note Reported by teachers. Percentages appear in parentheses.

Table 28 shows the distribution of mathematics teachers according to the frequency in giving mathematics tests or examination to their students. More than half of the mathematics teachers (62.8%) gave their students mathematics tests or examination about once a month.

Table 29 Mathematics classroom assessment

		Always or almost always	Sometimes	Never or almost never
1	Involving application of mathematical procedures	251 (57.3)	180 (41.1)	7 (1.6)
2	Involving searching for patterns and relationships	161 (36.8)	262 (59.8)	15 (3.4)
3	Requiring explanations of justifications	140 (32.0)	270 (61.6)	28 (6.4)

Note Reported by teachers. Percentages appear in parentheses.

Table 29 shows the distribution of mathematics teachers according to the types of mathematics tests or examination given to the students. More than half of the mathematics teachers always or almost always gave mathematics tests or examination involving application of mathematical procedures (57.3%). On the other hand, more than half of the mathematics teachers sometimes gave mathematics tests or examination requiring explanations of justifications (61.6%) and involving searching for patterns and relationships (59.8%).

Table 30 presents teachers' reports about how often they give eighth grade students mathematics tests or examinations. On average, 43% of Malaysian eighth grade students were tested about monthly, and only 10% were tested at least every two weeks. Forty seven percent of the Malaysian eighth grade students were tested less often, approximately a few times a year. Internationally, on average, eighth grade students are tested regularly in mathematics – 45% at least every two weeks, and 40% about monthly. Only 15%were tested less often, approximately a few times a year, on average.

Table 30 Classroom assessment (TIMSS 2011)

Country	Percentage of Students Whose Teachers Give Mathematics Tests or Examinations			Percentages of Students Whose Teachers Give Test Questions								
				Involving Application of Mathematical Procedures			Involving Searching for Patterns and Relationships			Requiring Explanations or Justifications		
	Every 2 Weeks or More	About Once a Month	A Few Times a Year or	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never
Malaysia	10 (1.7)	43 (3.3)	47 (3.5)	58 (3.8)	42 (3.8)	0 (0.0)	26 (3.6)	71 (3.7)	2 (1.2)	11 (2.6)	71 (3.4)	18 (3.0)
Interna-tional Average	45 (0.5)	40 (0.5)	15 (0.3)	77 (0.5)	23 (0.5)	0 (0.1)	31 (0.5)	64 (0.6)	5 (0.2)	37 (0.5)	56 (0.6)	8 (0.3)

Note Reported by teachers. Standard errors appear in parentheses.

Table 30 also contains teachers' reports about the types of questions they included in their tests and examinations. In Malaysia, the test questions involved application of mathematical procedures, which were used always or almost always for 58% of the students, on average, and at least sometimes for 42% of the students. The test questions in mathematics often also required students to search for patterns and relationships- sometimes for 71% of the students, on average, always or almost always for 26% of the students, and rarely for two percent of the students. Questions requiring explanations or justifications for their answers were used less frequently- sometimes for 71% of students, never or almost never for e18%, with 11%always or almost always.

Internationally, most frequently, the test questions involved applications of mathematical procedures. This type of question was used always or almost always for 77% of the students,

on average, across the countries, and at least sometimes for the remaining 23% of the students. Test questions involving searching for patterns and relationships were used always or almost always for 31% of the students, on average, sometimes for 64% of the students, and rarely for five percent of the students. Test questions that required students to provide explanations or justifications for their answers were used almost always for 37% of the students and sometimes for 56%, with only 8% percent almost never. However, across the eighth grade, there was considerable variation in testing practices

Conclusion

In terms of formal education, more than half of the rural schools mathematics teachers in Sabah had completed bachelor's degree (or equivalent). Surprisingly, as many as one-third had even completed postgraduate university degree. On the other hand, less than half of the mathematics teachers had a major in mathematics and mathematics education, about one-fifth had a major in mathematics education but no major in mathematics, and about one-tenth had a major in mathematics but no major in mathematics education. However, it is worrying to notice that about one-fifth of the mathematics teachers had a specialisation in all other majors

In terms of years of teaching mathematics experience, one-third of the mathematics teachers with at least 10 but less than 20 years of teaching experience and more than one-third of the mathematics teachers with at least 5 but less than 10 years of teaching experience. About one-fifth of the mathematics teachers had participated in professional development in mathematics content. However, less than one-tenth of the mathematics teachers had participated in professional development in mathematics assessment, and integrating information technology into mathematics.

In terms of teachers' preparation to teach the TIMSS mathematics topics, more than half of the mathematics teachers were well-prepared to teach seven of the nineteen TIMSS mathematics topics. However, mathematics teachers were only somewhat prepared to teach 'Judging, predicting, and determining the chances of possible outcomes' and 'Relationship between three-dimensional shapes and their two-dimensional representations'. More than half of the mathematics teachers were very confident in answering students' questions about mathematics, showing students a variety of problem solving strategies, helping students appreciate the value of learning mathematics, providing challenging tasks for capable students, and adapting their teaching to engage students' interest.

In terms of career satisfaction, more than half of the mathematics teachers planned to continue as mathematics teachers for as long as they can, satisfied with being mathematics teachers at their schools, contented with their profession as mathematics teachers, and did important works as mathematics teachers. However, it is worrying to notice that about half of the mathematics teachers had more enthusiasm when they began teaching mathematics than they have now.

To improve mathematics teaching, about half of the mathematics teachers worked together to try out new ideas, shared what they have learned about their teaching experience, collaborated in planning and preparing instructional materials, visited another classroom to learn more about teaching 2 or 3 times per month. In an effort to engage students in mathematics learning, more than half of the mathematics teachers praised students for good effort, encouraged all students to improve their performance, summarized what students should have learned from the lesson, and used questioning to elicit reasons and explanations every or almost every lesson. About half of the mathematics teachers related their mathematics lessons to students' daily lives about half of the lessons.

Various resources were used to teach mathematics in rural schools. More than half of the mathematics teachers used other combination of resources in mathematics teaching. About one-fifth of the mathematics teachers used the combination of workbooks/worksheets, textbooks, concrete objects or materials that help students understand quantities or procedures, and computer software for teaching mathematics. In terms of instructional activities used in the mathematics class, about half of the mathematics teachers asked their students to work problems (individually or with peers) with teacher guidance, to work problems together in the whole class with direct teacher guidance, and to apply facts, concepts, and procedures every or almost every lesson. On the other hand, about half of the teachers asked their students to memorise rules, procedures, and facts and to work problems (individually or with peers) whose teacher occupied by other tasks about half of the lessons. Computer-based activities were also used in mathematics lessons in rural schools. More than half of the mathematics teachers asked their students to look up ideas and information, to explore mathematics principles and concepts, to practice skills and procedures, and to process and analyse data using computers during some mathematics lessons.

In terms of mathematics classroom assessment, more than half of the mathematics teachers gave their students mathematics tests or examination about once a month. In relation to this, more than half of the mathematics teachers always or almost always gave mathematics tests or examination involving application of mathematical procedures. More than half of the mathematics teachers sometimes gave mathematics tests or examination requiring explanations of justifications and involving searching for patterns and relationships.

References

Arends, F. (2016). *The good teacher: What teachers need to teach well*? Human Sciences Research Council (HSRC). Retrieved June 8, 2016 from http://www.hsrc.ac.za/en/review/hsrc-review-may-2013/the-good-teacher-what-teachers-need-to-teach-well

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

Blank, R. K. & de las Alas, N. (2009). Effects of teacher professional development on gains in student achievement: How meta-analysis provides scientific evidence useful to education leaders. Washington, DC: The Council of Chief State School Officers.

Boyd, D.J., Grossman, P.L., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis, 31*(4), 416-440. https://doi.org/10.3102%2F0162373709353129

Corrienna, A.T., Hazura, A.B., & Pargunsan, M.A. (2012). Computer use and science achievement in Malaysia: TIMSS 2007. In S. L. Ong & E. J. Gonzalez (Eds.), *TIMSS 2007: What can we learn?* Penang: SEAMEO RECSAM.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8*(1). Retrieved from http://epaa.asu.edu/epaa/vion12/

Ford, I.R. (2012). *Teacher self-efficacy and its influence on student motivation*. USA: Cleveland State University. Retrieved June 8, 2016 from http://engagedscholarship.csuohio.edu/cgi/viewcontent.cgi?article=1098&context=etdarchive

Harris, D. N. & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics, 95*, 798-812.

Henson, R. K. (2002). From adolescent angst to adulthood: Substantive implications and measurement dilemmas in the development of teacher efficacy research. *Educational Psychologist, 37*(3), 137-150.

Johnson, B., & Christensen, L. (2000). *Educational research: Quantitative and qualitative approaches*. New York: Allyn and Bacon.

Kaur, B., Areepattamannil, S., & Boey, K. L. (2013). *Singapore's Perspective: Highlights of TIMSS 2011*. Singapore: National Institute of Education (NIE), Nanyang Technological University (NTU), Singapore. Retrieved May 8, 2016 from http://www.nie.edu.sg/research/research-offices/office-of-education-research/research-development-framework/mathematics

Lay, Y. F., Areepattamannil, S., Ng, K. T., Karnasih, I., & Kaur, B. (2014). Teacher and classroom correlates of TIMSS 2011 Grade 8 mathematics achievement in Malaysia, Singapore, Indonesia and Thailand (Book chapter, pp.84-103). In S. L. Ong, E. J. Gonzalez & Kanageswari, S. Shanmugam (Eds.), *TIMSS 2011: What can we learn together? Reaching greater heights*. Penang: SEAMEO RECSAM. ISBN: 978-967-930-034-5

Leigh, A. (2010). Estimating teacher effectiveness from two-year changes in students' test scores. *Economics of Education Review*, *29*, 480-488.

Lomos, C., Roelande, H. H., & Bosker, R. J. (2011). Professional communities and student achievement – A meta-analysis. *School Effectiveness and School Improvement*, *22*(2), 121-148.

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

Ng, K.T. (2011a). *Incorporating blended learning in transforming instructional practices: A cross-case analysis of the enhanced motivation among secondary learners participated in a Problem-based Learning (PBL) programme incorporating ICT*. Paper presented in the 25th Annual Conference of Asian Association of Open Universities (AAOU)(with theme 'Transforming Asia through Open Distance Learning'), 28th to 30th September, 2011, Wawasan Open University (WOU), Penang, Malaysia.

Ng, K.T. (2011b). *Enhancing investigative skills via e-portals with capacity-building activities: A within-case analysis of secondary students participated in PBL via ICT*. Paper presented in 24th ICDE World Conference with theme 'Expanding horizons- New approaches to Open and Distance Learning (ODL)', 2nd to 5th October, 2011 at Bali, Indonesia.

Ng, K.T., & Corrienna, A.T. (2013, September- October). *Information and Communication Technology (ICT) in Education: Lessons learnt and the way forward*. Paper presented at the WorldSTE 2013 Conference organized by ICASE, 29 September to 3 October 2013 at UNIMAS, Sarawak. Paper was also selected for publication in STEMplanet 2014 volume 1. (SP20131231056). Retrieved July 2, 2014 from URL: http://stemstates.org/journal/log-in/security-page/2014-vol-11/information-communication-technology-ict-in-science-education-lessons-learnt-and-the-way-forward.html

Ng, K.T., & Kim, P.L. (2012). Incorporating e-learning portals in Problem-based Learning (PBL) for science across disciplines to promote higher order thinking among secondary learners. *Proceedings of the 'International Seminar in Science and Mathematics Education'* (ISSME 2012) from 5th to 8th September, 2012 at Senate Hall, Universiti Teknologi Malaysia (UTM), Skudai, Johor Bahru, Malaysia organized by UTM and Association of Science and Mathematics Education of Johor.

Ng, K.T., Soon, S.T., Kim, P.L., Toh, L., & Lay, Y.F. (2013, November). *Value-added science Problem-based Learning beyond the classroom with e-portal support: Evidence of its effects on secondary school students' enhanced motivation*. Paper presented in the

symposium on ‘Learning Beyond the Classroom’ during the fifth International Conference on Science and Mathematics Education (CoSMEd), November 11-14, 2013 at RECSAM, Penang.

Nur Jahan, A., Hazura, A., Corrienna, A.T., & Ng, K.T. (2014). Teachers’ preparedness in classroom teaching and learning: A descriptive study of TIMSS 2011 for Indonesia, Malaysia, Singapore and Thailand. In S. L. Ong, E. J. Gonzalez & Kanageswari, S.S. (Eds.), *TIMSS 2011: What can we learn together? Reaching greater heights*. Penang: SEAMEO RECSAM.

Reinikainen, P. (2007). *Sequential explanatory study of factors connected with science achievement in six countries: Finland, England, Hungary, Japan, Latvia and Russia: Study based on TIMSS 1999*. Research Reports 22. Jyvaskyla, Finland: Institute for Educational Research. Retrieved May 7, 2016 from https://ktl.jyu.fi/julkaisut/julkaisuluettelo/julkaisut/2007/t022

Rice, J. K. (2003). *Teacher quality: Understanding the effectiveness of teacher attributes*. Washington, D.C: Economic Policy Institute.

Tamim, R. M., Bernard, R. M. Borokhovski, E., Abrami, P. C., & Schmidt, R. F. (2011). What forty years of research says about the impact of technology on learning. A second-order meta- analysis and validation study. *Review of Educational Research*, *81*(1), 4-28.

Wilson, A. M., Floden, R. E., & Ferrini-Mundi, J. (2002). Teacher preparation research: An insider’s view from the outside. *Journal of Teacher Education*, *53*(3), 190-204.

Yoon, K. S., Duncan, T., Lee, S. W. –Y., Scarloss, B., & Shapley, K. (2007). *Reviewing the evidence on how teacher professional development affects student achievement* (Issues & Answers Report, REL 2007-No. 033). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest. Retrieved from http://ies.ed.gov/ncee/edlabs