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MALAYSIAN STUDENTS' ACHIEVEMENT IN TIMSS 2011: DOES SCIENCE INQUIRY REALLY MATTER?

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ABSTRACT

Purpose – This study investigates the relationship of student and teacher level variables on Trend for International Mathematics and Science Study (TIMSS) 2011 Science achievement among Malaysian students. Specifically, it aims to examine the effect of students' achievement when a science inquiry approach is considered.

Method – Thirteen educational context variables were selected from the teacher and student questionnaires and were tested on the TIMSS 2011Science achievement. The data were retrieved from the IEA official website and consisted of 177 Science teachers and 5,549 Grade Eight students. A secondary data analysis was employed to examine the relationships between the variables from the perspective of the Dynamic Model of Educational Effectiveness Research. A two-level model of the Hierarchical Linear Modelling (HLM) consisting of Teacher-Student Level was employed. The 13 independent variables are: student gender, parents' education level, home educational resources, liking Science, valuing Science, teacher gender, class size, teacher who emphasises on academic success, inquiry approach,

science assessment, frequency of science test, teacher experience and teacher qualification. The nested data of students and teachers were analysed using Hierarchical Linear Modelling 6.0 statistical software.

Findings – The study finds that teacher differences between schools account for 70% variation in the students' achievement due to factors, such as teacher gender, enthusiasm of teacher in emphasising the academic success of students and class size. However, Science Inquiry is not a contributor to students' achievement in Science; it has only a moderating effect on students' achievement to value Science learning.

Significance – The findings have important implications for stakeholders, specifically to Teachers' Training Institutions, Curriculum Development Centres and the Teachers' Development Division, on the Science teachers' quality in Malaysia. Affective domain of the students is equally important as the cognitive domain and should not be ignored.

Keywords: Science, TIMSS, secondary data analysis, dynamic model of Educational Effectiveness Research (EER), Hierarchical Linear Modelling.

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INTRODUCTION

Of late, the science inquiry approach is being associated with the teaching of Science in schools. According to Gillis and Nicholas (2015), science inquiry makes students think critically, use their intuition to solve problems and challenge their current conceptual understanding so that they can construct new understanding. In Malaysia, the Curriculum Development Division (CDD) emphasises on the importance of the science inquiry approach to teach Science. Teachers are encouraged to use this approach to attract more students to like Science as well as to promote science literacy (Ahmad Rafee, 2015; Sharifah Maimunah, 2000). Because of this, this approach has been infused into the Science curriculum and it is clearly stated in the science syllabus of the primary and secondary schools (Ahmad Rafee, 2015, CDD, 2002).

To ensure that the quality of the Science curriculum in Malaysia is on par with the international standards, Malaysia has been participating in the Trends in International Mathematics and Science Study (**TIMSS**) assessment for Grade Eight students since 1999 to assess the achievement of Form 2 students in Science and Mathematics (Ministry of Education Malaysia, 2013). In its first attempt, Malaysia achieved a moderate ranking with an average score of 492 points in TIMSS 1999 for the Science assessment (Martin et al., 2000; Mohammadpour, 2012). In 2003, the average mean score increased
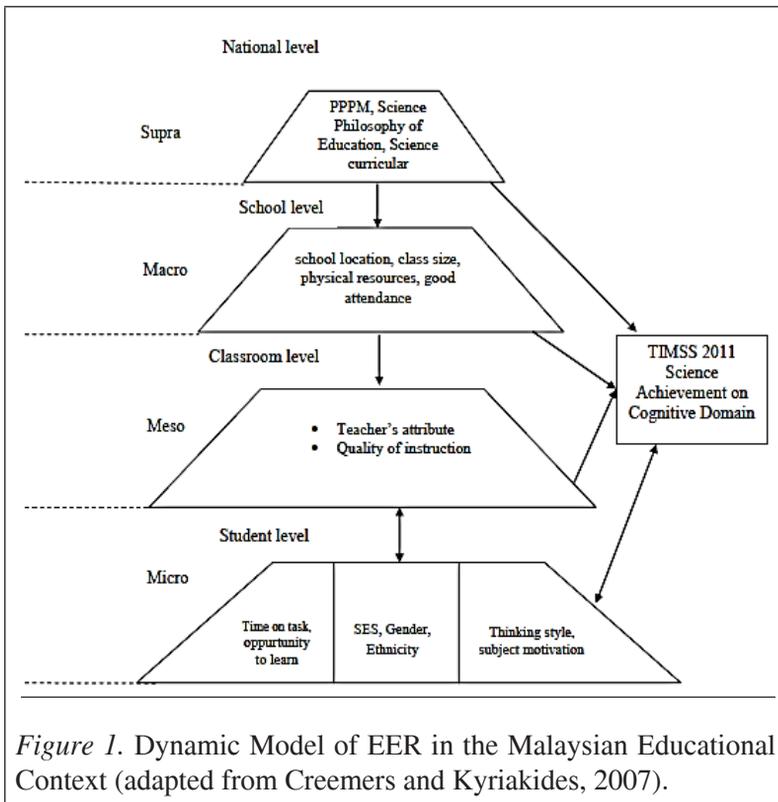
to 510 points which is above the international average (Martin et al., 2004). However, its performance was hauled down (TIMSS 2007) to an average score of 471 points (Martin, Mullis, & Foy, 2008; Mohammadpour, 2012; Ng, 2012) and continued to drop to 426 points in TIMSS 2011 (Ng, 2012; Ministry of Education (MoE), 2013b; Zabani, 2012).

The decline in this assessment internationally signifies that the Science curriculum in Malaysia must be thoroughly reviewed and improved (MoE, 2013a). One possible explanation regarding the decline in TIMSS 2011 results can be found by examining the factors related to the students, teachers and school levels. Since TIMSS 2011 provides information on how teachers conducted science inquiry in the classroom (Foy, Arora & Stanco, 2013), this study is deemed necessary. According to Scheerens and Bosker (1997) and Creemers and Kyriakides (2007), factors related to students' academic achievement are best investigated from the perspective of the Educational Effectiveness Research (EER) framework. Creemers and Kyriakides (2007) proposed that some of the student-related factors can be categorised either as amenable or non-amenable. The amenable factors are factors that may change over time, such as subject motivation, expectation and thinking style, while the non-amenable factors are factors that are unlikely to change, such as gender, ethnicity, socio-economic status and personality trait. Previous studies by Mokhsein (2002), Hamidah (2009) and Mohammadpour (2012) on TIMSS Science have not emphasised on how the teaching approach and students' attitude can be associated with Science achievement. As such, this paper focuses on the student and teacher level factors based on the TIMSS 2011 data. It is hoped that studying the selected factors of Science Inquiry approach and students' amenable factors, such as Liking Science and Valuing Science, can improve the science achievement of Malaysian students for future TIMSS.

Dynamic Model of Educational Effectiveness

A school is an organisation that may contribute greatly to students' academic achievement. According to Kozlowski and Klein (2000), achievement is affected by numerous factors at the school, teacher or student level factors or the inter-relationships of the factors in these levels. Creemers and Kyriakides (2007) advocated the existence of

multilevel relationships in the school; they proposed the Dynamic Model of EER. However, the variations in each level which contribute to the students' achievement are different between developing and developed countries. Studies conducted in the developed countries, such as Australia, the United States of America (USA) and Japan (Hojo and Oshio, 2010; Lamb and Fullarton, 2002) show that 60 % of the variation in students' performance is explained by the student level factors. Meanwhile, studies in the developing countries, such as Indonesia (Werf, Creemers, Jong, and Klaver, 2000) and Cyprus (Kyriakides, Campbell, and Gagatsis, 2000) have found that most of the variations in students' performance are at the teacher and school levels. This indicates that students in developed countries have achieved a higher degree of independent learning compared to students in developing countries.

Figure 1. Dynamic Model of EER in the Malaysian Educational Context (adapted from Creemers and Kyriakides, 2007).

The EER model serves as a point of departure which is commonly used in the western countries (Reezigtet et al.,1999; Creemer and

Kyriakides, 2006; 2007; 2009). This model which has proven to be useful in educational research is also used in this study with some modification to suit the Malaysian context. In this conceptual model, students' achievement is the outcome of the study and it is situated at the micro-level (student level), while the teacher level is situated at the meso-level and the school level is placed at the macro-level. However, for this study, we focus on the micro- (student level) and meso- (teacher level) levels only. The roles of the two main actors (namely student and teacher) are analysed.

In this study, 13 variables situated at the student and teacher levels are chosen and discussed. The respective directional hypotheses are also constructed and tested through the two-level hierarchical model.

Variables and Hypotheses Development

The main aim of this analysis is to measure the relationships between students' achievement in Science and the contributing factors at the student and teacher levels. The student level variables selected in this study are student gender (STUGEN), parents' education level (PAEDU), home educational resources (BSBGHER), liking science (BSBGSLV) and valuing science (BSBGSVS). On the other hand, the teacher level variables comprise teacher gender (TEAGEN), teacher qualification (TEA_QUA), teacher experience (TEA_EXP), science assessment (SC_ASSESS), test frequency (TEST_FRE), class size (CLASS_SZ), teachers who emphasise on academic success (BTBGEAS) and the science inquiry approach (BTBSESI). Details of the variables used in the study are discussed in the following sections.

Student Gender (STUGEN)

In TIMSS Science assessment, the achievement of male and female students has varied considerably from country to country and year to year. For example, Amelink (2009) reported that in science, the learning outcomes between genders has been varied. Some studies have indicated that male students perform better than female students but others have indicated the opposite findings. In TIMSS 1999 and 2003, Malaysian male students outperformed the females by nine and 10 points, respectively. However, the result shows a notable

change in Malaysia TIMSS 2007 and 2011 when the female students outperformed the males by nine and 15 points, respectively (Mullis et al., 2009; 2011). This pattern of findings is also highlighted by Bang and Baker (2013), where their study indicates that female students from the co-ed schools in Korea have significantly higher science achievement compared to male students and a positive attitude towards science. The gender differences in Science could be the result of factors, such as cultural stereotypes of roles in Science (Nosek, Smyth, Sriram, Lindner, Devos, Ayala, and Kesebir, 2009; Osborne, Simon, and Collins, 2003), lack of exposure to Science-related activities (Lee and Butler, 2003) and teachers' characteristics (Arbaa and Razak, 2010). As a result, Hypothesis 1 is proposed:

Hypothesis 1: Girls outperformed boys in TIMSS 2011 Science achievement.

Parents' Education Level (PAEDU)

One may agree that various familial factors may affect students' achievement (Garg, Melanson, & Levin, 2007; Sánchez, Reyes, & Singh, 2006) and this has been of interest to many researchers. These factors, to name a few, include parents' occupation, educational attainment, socioeconomic status, family composition and parental involvement, which are among the variables included in TIMSS. In TIMSS 2011, the education of parents was investigated in the questionnaire given to students where they had to identify the highest formal education of their parents or guardians. Mohammadpour (2012), supported by Azina and Halimah (2012), revealed that the education level of parents was a significant predictor for the TIMSS studies in 1999, 2003 and 2007 for the Malaysian students' achievement. Reardon (2011) suggested that highly educated parents with a higher income could better support the academic achievement of their children. However, a longitudinal study conducted by Dubow, Boxer and Huesmann (2009) has indicated that the education level of the parents has no direct effect on the level of achievement of their children. Therefore, it is important to examine and test this variable and Hypothesis 2 is thus presented:

Hypothesis 2: Parents' level of education has a positive and direct effect on TIMSS Science achievement.

Home Educational Resources (BSBGHER)

There is widespread agreement, especially in meritocratic society, that achievement in schooling is one of the important social mobility factors. Due to its importance, there is rigorous debate on how the achievement can be advanced, especially the factors that may contribute, like school and family factors. One of these factors is the Home Educational Resources which can be a proxy variable for family capital. In TIMSS 2011, Home Educational Resources was measured based on the responses given by the students in the form of a scale of scores for the items on the number of books at home, the amount of home study support and the highest level of education of their parents (Martin et al., 2012). Eighth graders who have more than 200 books in their homes had an average score of 506 points on the Science scale which was 68 points higher than the students who reported to have at the most 10 books (Martin et al., 2000). A study conducted by Mokshein (2002), and supported by Mohammadpour (2012), using TIMSS 1999 data, has revealed that home resources have a significantly positive effect on students' Science achievement. Other empirical evidence has also revealed that students who have more educational resources (computers, books, and study desks) outperform other students (Azina and Halimah, 2012; Mullis et al., 2009; Nordin et al., 2014). Based on the results of these studies, Hypothesis 3 is advanced:

Hypothesis 3: Home Educational Resources have a positive and direct relationship with TIMSS Science achievement.

Liking Science (BSBGSLS)

The responses to several variables related to students' attitude towards Science were investigated in TIMSS 2011, such as Students' Liking Learning Science, Student Value on Science and Attitude to Science. In TIMSS, students liking learning Science is defined as the extent to which they like the science subject and a scale was created based on students' responses to five statements about science: *I enjoy learning science, I wish I did not have to study science (reverse score Science is boring (reverse score), I learn many interesting things in science,* and *I like science.* Students who responded with the highest liking in Science performed better in science (Martin et al., 2008; Mohammadpour, 2012). Students who had the highest interest in Science increased by 15% from TIMSS

1999 to TIMSS 2003 but decreased by 12% from TIMSS 2003 to TIMSS 2007 (Mohammadpour, 2012). In addition, a meta-analysis study conducted by Phang et al. (2014) proposed that the interest of Malaysian students in Science has deteriorated due to negative perceptions of the subject as it has a more rigid assessment compared to art subjects, greater anxiety, low expectations on Science-based job opportunities and mundane teaching style in Science classes. Based on the importance of Liking Science in this study, Hypothesis 4 is proposed:

Hypothesis 4: Liking Science has a positive and direct effect on TIMSS Science achievement.

Valuing Science (BSBGSVS)

TIMSS 2011 measured valuing Science based on the perceptions of students on the importance of Science. The Value of Science scale was formed based on Year 8 students' responses to six statements about science: *I think learning science will help me in my daily life; I need science to learn other school subjects; I need to do well in science to get into the university of my choice; I need to do well in science to get the job I want; I would like a job that involves using science; and It is important to do well in science.* Creemers and Kyriakides (2007) advocated that the achievement of students is greatly influenced by what they perceive as important in their lives and it is not affected much by their self-confidence. The finding of TIMSS internationally also indicates that Science achievement is higher among students who place more value on the subject (Martin et al., 2008). The trend of Malaysian students in Valuing Science at the highest level has slightly decreased across the TIMSS assessments from 2003 to 2011 but it was still considerably high in TIMSS 2011 (Martin, Mullis, and Foy, 2008; Martin, Mullis, Foy, and Stanco, 2012). Based on the importance of valuing Science to the Science achievement in TIMSS 2011, Hypothesis 5 is formulated:

Hypothesis 5: Valuing Science has a positive and direct effect on the achievement of TIMSS Science 2011.

Teacher's Gender (TEAGEN)

Nordin et al. (2014), Mohammadpour (2012) and Ismail (2008) discovered that female teachers affected the achievements of

students in TIMSS Mathematics. Their research indicates that students obtained higher scores in Mathematics and Science when female teachers taught them. The Malaysia 2011 Statistics Handbook (Ministry of Education Malaysia, 2012) states that the teaching profession is dominated by female teachers in the ratio of 2:1 for female to male teachers. In addition, a study conducted by Dee (2007) has reported that students who are taught by a teacher of a suitable gender would perform better. As mentioned in those studies, it is assumed that teacher's gender is related to the achievement of students and leads to Hypothesis 6:

*Hypothesis 6***:** Female teachers influence the achievement of students in TIMSS for the Science subject.

Teacher's Experience (TEA_EXP)

Ismail (2008) studied the TIMSS 2003 and found that more than 60% of Malaysian students were taught by experienced teachers with more than five years teaching experience. The experience in teaching is one of the predictors that affects students' achievement (Darling-Hammond 2000). Teachers with more than seven years of working experience have been identified as having higher self-confidence in dealing with students, conduct teaching strategy effectively and manage classroom efficiently (Johari, Ismail, Osman and Othman, 2009) and have higher pedagogical content knowledge (Phang et al., 2014). Therefore, Hypothesis 7 is advanced:

*Hypothesis 7***:** Teachers' experience has a positive and direct effect on the achievement of TIMSS Science.

Teacher's Qualification (TEA_QUA)

In TIMSS 2011, the qualification of teachers was identified through their highest level of formal education. A highly qualified teacher is defined as fully certified, possesses a bachelor's degree and demonstrates competence in subject knowledge and teaching (Akiba et al., 2000; Darling-Hammond, 2000). The analysis of variance (ANOVA) conducted by Johari et al. (2009) on 928 secondary teachers in Sabah shows that teachers who graduated with a bachelor's degree and have a diploma in education obtained the highest level of efficacy compared to the teachers from other

programmes. Moreover, the Malaysian Teachers' Education Division has initiated a policy for upgrading teachers' profession by having in-service teachers to pursue their studies from diploma to a degree level (MoE, 2006). Based on the previous findings, Hypothesis 8 is as follows:

*Hypothesis 8***:** Teacher's qualification has a positive and direct effect on TIMSS Science achievement.

Science Assessment (SC_ASSESS)

In the TIMSS 2011 teacher's questionnaire, teachers were asked to indicate the level of difficulty of questions asked in the Science assessment based on Bloom's taxonomy to determine students' thinking levels in an assessment (Anderson, Krathwohl, and Bloom, 2001). Effective questioning and appropriate level of questions asked by teachers (Creemers and Kyriakides, 2007) enable students to build and gain new understanding by constructing mental scaffoldings within the classroom. By accepting the speculation of a direct relationship between scientific question approach and TIMSS Science achievement, Hypothesis 9 is advanced:

*Hypothesis 9***:** Science assessment has a positive and direct effect on TIMSS Science achievement.

The Frequency of Science Test (TEST_FRE)

In TIMSS 2011, the frequency of teachers conducting science test was measured by how often science test was conducted in the class. Higher frequency of conducting tests could lead to students' higher achievement (Creemers and Kyriakides, 2008). Studies conducted by Stohr-Hunt (1996) on Grade Eight students in the the USA confirms this relationship. Another study conducted by Bangert-Drowns et al. (1991) proves that students who took at least one test during a period of 15 weeks of study term scored 50% higher standard deviation than students who did not take any test. Nevertheless, the percentage of improvement in their achievement disappeared as the test frequency was increased. Based on those studies, Hypothesis 10 is put forth:

*Hypothesis 10***:** The frequency of science test positively and directly affects the TIMSS Science achievement.

Class size (CLASS_SZ)

TIMSS 2011 measured the class size through the teachers' response regarding Science instructions given to several students in a class. The class size is an indicator for a classroom composition. Variable code (BTBG12) requires the teachers to respond to the number of students in their Science classes. For example, some studies have indicated that there is a positive correlation between class size and students' achievement in Malaysia, in which the students in small-sized classrooms are observed to perform better than the ones in larger-sized classrooms (Muhammadpour, 2012). The number of students in a class has the potential to affect students' learning in many ways, such as the level of social engagement, disruptive behaviour, grouping procedure, allocation of time to student activities and method of teaching and assessment (Ehrenberg et al., 2001). Based on the importance of class size to students' achievement, Hypothesis 11 is proposed:

Hypothesis 11: Class size has a direct relationship with TIMSS Science achievement.

Teacher Emphasis on Academic Success (BTBGEAS)

The emphasis on the academic success of the students by their teachers has a psychological impact on the students (Schaps, 2003). TIMSS 2011 measured teacher emphasis on the academic success of students by using item coded as BTBGEAS. The scale scores are based on the teachers' agreement to five items: *the understanding of the curriculum goal of school; success level in implementing the school curriculum; the expectation of teachers of students; parental support for their children's achievement; and the students' desire to do well in school.* Previous studies on TIMSS and PIRLS 2011 have indicated that students with the highest achievement typically attended schools that emphasised on academic success. Teachers, school administrators as well as parents,who consistently emphasised on academic success to the students, would show greater academic achievement (Martin, Mullis, Foy, and Stanco, 2012). Therefore, Hypothesis 12 is advanced:

Hypothesis 12: The emphasis of teachers on the students' academic success has a positive and direct effect on TIMSS Science achievement.

Scientific Inquiry Approach (BTBSESI)

TIMSS 2011 evaluated the scientific inquiry learning in the classroom based on 11 items in the TIMSS questionnaire, i.e.,. how often the teachers ask their students to observe and describe new phenomena; observing teacher's demonstration; designing experiment; conducting experiment; using scientific formulae and laws; solving routine problems; explanation on the related subjects; applying the knowledge obtained into their daily lives; doing field work; searching for information from resource materials; and answering Science quizzes. The scientific inquiry approach then was measured through a scale of scores (BTBSESI) which was estimated by the IEA. Inquiry-based Science education in Malaysia aims to enable students to learn scientific concepts, principles and theories in meaningful ways and develop scientific process skills and attitude for scientific inquiry (Ahmad Rafee, 2015). Claims have been made by studies that the scientific inquiry approach on the secondary school students encourages a fun learning environment and improves students' attitude and achievement in Science (Gibson and Chase, 2002; Wolf and Fraser, 2008; Zarini and Salmiza, 2012). From the results of these studies, the scientific inquiry approach is expected to have a positive and moderating effect on Liking Science and TIMSS 2011 Science achievement. Therefore, Hypothesis 13 is presented.

Hypothesis 13: The scientific inquiry approach has a positive and moderating effect on Liking Science and TIMSS 2011 Science achievement.

METHODOLOGY

This study employed a quantitative approach to secondary data analysis from large datasets of TIMSS 2011. A survey was conducted on a sample of 177 Science teachers and 5,549 Grade Eight students. A Science test was also administrated to the same sample to measure students' attainment in science. Based on the model proposed in this study, 13 independent variables were chosen for the teacher and student levels. The dependent variable is the TIMSS Science 2011 Achievement Score (SCACH). The data were analysed using Hierarchical Linear Modeling (HLM) software version 6.01 and SPSS version 19. The missing data were retrieved by performing a list-wise deletion and mean imputation. According to Woltman et al. (2012), HLM is the best way to analyse

the variance in the dependent variable (SCACH) when the predictors (independent variables) are from various levels. The multi-level model analysis as shown in Table 1, started with a null model which contained only the dependent variable in the form of five plausible values, the Level-1 model of student level variables and Level-2 model containing teacher level variables. The null model was used to calculate the Intra-class Correlation Coefficient (ICC) by decomposing the total variance between student within-teacher level variance and between-teacher level variance by employing Equation [I]:

$$\text{ICC } (\rho, \text{ between teachers}) = \frac{\tau_{00}(BetweenTeacherVariance)}{\tau_{00}(BetweenTeacherVariance) + \sigma^2(WithinTeacherVariance)} \quad [\text{I}]$$

In this study, Level 1 Model consisted of students' background factors of student gender (STUGEN), liking science (BSBGSLS), valuing science (BSBGSVS), parents' education level (PAEDU) and home educational resources (BSBGHER). Meanwhile, Level 2 Model was developed by adding teacher level factors, namely teacher gender (TEAGEN), qualification (TE_QUA), experience (TEAEXP), science inquiry approach (BTBSESI), frequency of science test (TEST_FRE), science assessment (SC_ASSESS), teacher who emphasises on students' academic success (BTBGEAS) and class size (CLASS_SZ). The proportional reduction in the variance of the final model was calculated by using Equation [II] to determine the proportional reductions of Level 2 predictors after considering the inclusion of Teacher-Level variables of TEAGEN, TEA_QUA, TEA_EXP, SC_ASSESS, TEST_FRE, CLASS_SZ, BTBGEAS and BTBSESI:

$$p \text{ (within teacher)} = \frac{\sigma^2(Unconditional\_Model) - \sigma^2(Final\_Model)}{\sigma^2(Unconditional\_Model)} \quad [\text{II}]$$

RESULTS

Student and Teacher Variance in Science Achievement

The result of the unconditional model is tabulated in Table 1. The findings indicate that between-student within-teacher or Level-1

variance (σ^2) is estimated to be 3229.09 and variance of between teachers (τ_{00}) is 7677.86. The reliability estimation of Level- 1 coefficient β_{0k} is 0.986, indicates that the measure of the mean of SCACH scores is an estimation of its true mean scores. Table 1 simplifies the effect of variables on Science achievement. Based on the HLM analysis, ICC shows that 70% of the total variance in Science is attributed to between teachers. The result indicates that Level-2 (teacher-level) shows that the degree of variability of average Science performance is greater than at the student-level (Aguinis et al., 2013). Therefore, the teacher level variables made a greater contribution to the variation in TIMSS 2011 Science achievement among Malaysian students. Only 30% of variances are situated at the Student level.

Table 1

Result of Teacher-Student Level Model analysis

Type of Effect	Unconditional Model		Level-1 Model		Level -2 Model	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Fixed Effects Intercept, γ_{00}(SCACH)	418.61**	6.83	420.22**	6.35	421.25	5.56
Student level						
BSBGHER			4.38**	.82	4.07**	.78
BSBGSLS			7.33**	.78	7.32**	.79
BSBGSVS			2.87**	.85	2.78**	.86
STUGEN			6.65**	2.58	6.61**	2.56
PAEDU			-1.31	1.33	-	-
Teacher Level						
TEAGEN					-27.67**	14.61
TEA_QUA					14.37	10.30
TEA_EXP					.19	.77
SC_ASSESS					3.72	5.5
TEST_FRE					-5.25	7.48
CLASS_SZ					2.91**	.88
BTBGEAS					10.43**	3.43
BTBSESI					-0.14	3.09

(continued)

Type of Effect	Unconditional Model		Level-1 Model		Level -2 Model	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
BTBSESI*BSBGSVS					0.63**	0.33
Between Teacher, τ_{00}	7677.86		6587.48		5395.48	
Within Teacher, σ^2	3229.09		2824.30		2831.43	
Total variance			9411.78		8226.91	
Between- teacher variance explained			14.20 %		29.72 %	
Within- teacher variance explained			12.56 %		12.31 %	
Total variance explained			13.72 %		24.48 %	

Intra-class correlation coefficient, ICC= 0.70

** p< .05

Level 1 Model

Five variables, namely BSBHER, BSBGSLS, BSBGSVS, STUGEN and PAEDU, were added to this model by using the step-up technique. Based on the test, only the parents' level of formal education (PAEDU; β= -1.31, p=.337) is found to be insignificant with SCACH. This model is estimated to have an overall mean of the SCACH score, γ_{00} of 420.22 after controlling five Student-Level variables, namely BSBHER, BSBGSLS, BSBGSVS, STUGEN, and PAEDU. As shown in Table 1, Liking Science (BSBGSLS) appears to be the most influential student variable (β_1=7.33, p=.000) on SCACH, followed by student gender (STUGEN; β_2=6.65, p=.019), home educational resources (BSBHER; β3=4.38, p=.000) and students valuing science (BSBGSVS; β4=2.87, p=.004). Student gender is statistically significant to TIMSS 2011 Science achievement in Malaysia (β=6.27, p=.018). The predictor has a positive and direct relationship with SCACH. The relationship suggests that male students outperformed females in schools. Based on this, **Hypothesis 1** is not supported. However, the parents' level of education is found to have an insignificant effect on SCACH (β= -1.31, p=.337). Therefore, **Hypothesis 2** is not supported. Home educational resources show a positive and direct relationship with SCACH, (β=4.38, p=.000), implying that larger number of

books and study support provided at home and a higher level of education of parents influenced the students to achieve better score in TIMSS Science 2011. As such, the result supports **Hypothesis 3.** The Science achievement score is seen to be associated with Liking Science (β=7.33, *p=.000*). The association reflects a positive and direct association with SCACH. The result suggests that students who like Science subject would perform better in the assessment. Therefore, **Hypothesis 4** is supported. In addition, the students' attitude in valuing Science is an important factor in this research. The association is reflected by (β=2.87, *p=.000*) for the Science achievement in schools. The result indicates that students who value Science would have scored higher marks in the assessment. Therefore, this result supports **Hypothesis 5**. Overall, home educational resources, liking science, valuing science and student gender have a significantly direct effect on TIMSS Science achievement.

Level 2 Model (Final Model)

Based on Table 1, eight Teacher-Level predictors, namely teacher gender (TEAGEN), teacher's qualification (TEA_QUA), teacher's experience (TEA_EXP), Science assessment (SC_ASSESS), the frequency of Science test (TEST_FRE), class size (CLASS_SZ), teacher's emphasis on academic success (BTBGEAS) and Science inquiry (BTBSESI) were added to the intercept and slope of the Level 2 Model. The result shows that only the teacher's gender, class size and teachers who emphasise on students' academic success are found to be significant to Science achievement. Teacher gender is found to have a negative and direct association with the Science achievement of students (TEAGEN; β= -27.67, *p*=.05) which indicates that female teachers are associated with the achievement of the students. This finding supports **Hypothesis 6**. Class size is found to have a positive and direct effect on Science achievement (CLASS_SZ; β= 2.91, *p*=.002). This explains that a class with a bigger size produced a higher level of Science achievement by 2.91 points. Therefore, it supports **Hypothesis 11.** The analysis on teachers who emphasise on academic success of the students also has a positive and direct effect (BTBGEAS*;* β= 10.43, *p*=.003). This shows that the teachers who emphasise on their students' academic success contributed to their students' achievement by 10.43 points higher than the less enthusiastic ones. This finding therefore supports **Hypothesis 12.**

However, teacher's qualification is found to have an insignificant influence on TIMSS Science achievement (TEAEXP; β= .19, p=.774). Therefore, **Hypothesis 7** is not supported. Similarly, teaching experience has an insignificant relationship with SCACH (TEAQUA; β= 14.37, p=.165). Therefore, **Hypothesis 8** is rejected. The result also shows that the Science assessment does not have significant influence on TIMSS Science achievement (SCASSESS; β= 3.72, p=.499). Consequently, this result does not support **Hypothesis 9.** The frequency of conducting Science test in the classroom also does not have any significant effect on students' Science achievement (TEST_FRE; β= -5.25, p=.483). Therefore, this finding does not support **Hypothesis 10.** Scientific inquiry approach also does not have a significant effect on SCACH (BTBSESI; β= -0.14, p=.965). Consequently, Hypothesis **13** is not supported.

Unexpectedly, the Science Inquiry predictor (BTBSESI) has a significant interaction effect on the slope of Student Valuing Science (BSBGSV). The interaction between SCACH and BSBGSV is positively moderated by BTBSESI ($\tau 33$= 0.63, SE= 0.33). However, no other teacher variable that was tested is found to have a significant effect on the slopes of STUGEN, BSBGHER, BSBSLS and BSBSVS. To summarise, three teacher-level predictors are found to have a significant effect on the intercept of Science achievement SCACH, π_{0j} in the final model, which are the teacher's gender (TEAGEN), class size (CLASS_SZ) and teacher emphasis on academic success (BTBGEAS). Unexpectedly, Science inquiry is found to moderate the relationship of valuing Science and Science achievement with minimal effect (BTBSESI*BSBGSVS; $\square$= -0.63, p=.33).

The proportional reduction, p within and between teachers was calculated by using Equation [II]. It shows that adding selected teacher variables as Level-2 predictors would help to explain about 12.31% of the within-teachers between students variance in SCACH score. Therefore, by adding Level-2 predictors, it helped to explain the 29.72% of between teachers' variance in SCACH scores. This finding shows that only three Teacher-Level variables, i.e., TEAGEN, CLASSSZ and BTBGEAS have significant effects on TIMSS 2011 Science achievement and science inquiry approach (BTBSESI) did not support Science achievement in TIMSS 2011.

DISCUSSION

The findings show that amenable factors involving student's attitudinal factors, such as liking Science and valuing science, have a moderate influence on students' achievement. The liking Science predictor shows a higher effect than valuing Science. Therefore, students who are positive in liking Science would substantially achieve higher scores in Science. Nevertheless, the non-amenable factors, such as the socio-economic status (which includes the home educational resources) and education of parents' contributed to their achievement but with minimum effect. However, the level of formal education of their parents (PAEDU) alone was not one of the variables associated with TIMSS Science achievement in Malaysia. This finding supports the multi-level effect analysis carried out by Reardon (2011) who stated that the level of education of the parents alone is not sufficient to influence students' achievement. Instead, it must be accompanied by home study support and family income. Another factor to be considered is the student's gender. Male students were found to perform better than females in the school with a very low effect size. Overall, the finding of this study supports the hypothesised student-level model.

The second part of the analysis examined the effect of teacher-level factors on students' achievement at the meso-level. This study examined teaching practices, such as the usage of scientific inquiry approach, the frequency of Science assessment and the level of cognitive questions asked in the classroom. Nevertheless, these variables are insignificant to the Science achievement in Malaysia. The results contradict the recommendations made by Sharifah Maimunah (2000), Ahmad Rafee (2015) and the CDD of Malaysia that science inquiry, frequency of assessment and level of cognitive questions asked in the classroom contribute to students' achievement. However, the science inquiry approach moderates the relationship of valuing Science and Science achievement with minimal effect. The finding was found discrepant from the early part of the literature that science inquiry moderates students' attitude to liking Science. Therefore, conducting this approach enhances students' perception of the importance of Science and contributes to their achievements in Science. This finding also contradicts the results obtained by Gibson and Chase (2002); Wolf and Fraser (2008) and Zarini and Salmiza (2012). Female teachers are found to contribute more to

students' Science achievement than the male teachers. Additionally, a teacher is a contributor to the affective domain of the students as they emphasise on their students' academic success, being directly involved in the students' learning. Therefore, it is crucial for them to emphasise on the academic success as it could psychologically impact the students. However, the qualities of teachers, such as their experience and qualification, were found to be not related to students' achievement in TIMSS 2011. This study also suggests that 70% of the variances in TIMSS Science 2011 achievement in Malaysia are situated at the teacher level. This could be explained by the various types of schools that exist in Malaysia, which might give a higher proportion of differences between schools. This finding also implies that majority of the Malaysian students have yet to become independent learners.

IMPLICATIONS AND CONCLUSION

The findings of this study imply that teachers may modify or improve their instructional strategies to influence more students to like and value the Science subject. According to Bell et al. (2009), informal science activities, such as science awareness week, science camps or science fairs, would scaffold their Science concepts. Therefore, teachers and school managers should organise more activities that can help students to build their beliefs towards Science which may finally lead them to have future careers that are related to Science. The Science inquiry approach should properly be implemented in the teaching of Science so that more students would value Science in their learning process. Therefore, the academic authority should revisit and examine how the science inquiry approach has been implemented in Malaysian schools. Besides the cognitive domain, teachers and the CDD should equally emphasise on the affective domain. Additionally, the study reveals that the student and teacher affective domain, such as liking Science, valuing Science and teachers who emphasise on students' academic success, affected students' achievement in Science TIMSS 2011. These findings support the role of the teachers and students, as well as teaching and learning situations, which are essential for ensuring the effectiveness of education as claimed in the EER (Creemers & Kyriakides, 2009) and TIMSS studies (IEA, 2012).

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