An Analysis of Mathematics Achievements Based on Student Engagement and Attitude in ASEAN Countries Compared with TIMSS 2011 and TIMSS 2015

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Abstract. The Trends in International Mathematics and Science Study (TIMSS) is the largest and most ambitious study undertaken by the International Association for the Evaluation of Educational Achievement. About forty-two countries involved in TIMSS 2011 and thirty-nine countries involved in 2015. The 8th grade Mathematics Question are based on four content areas: (1) number; (2) algebra; (3) geometry; (4) data and chance. Investigating this particular issue through the TIMSS data files seems to provide a comprehensive source to analyse mathematics achievement of students from various angles. The aim of this paper is to analyse the mathematics achievement of 8th grade Mathematics Questions for ASEAN countries compared to TIMSS 2011 and 2015 by classifying them based on Student Engagement and Attitude. As the outcome measure, this paper used the set of four index values of student engagement and attitudes towards learning mathematics and average achievement in mathematics for TIMSS 2011 and TIMSS 2015. The ASEAN countries that involves both in TIMSS 2011 and TIMSS 2015 are Malaysia, Singapore and Thailand. Besides, the study also seek for significant value between each content areas with student perception and valuing of mathematics. All differences described in this study are statistically significant at the 0.05 level. Results from the TIMSS have recently captured the attention of the government and once again focused the nation on matters of mathematics teaching and learning. In general, the TIMSS results indicate a pervasive and intolerable mediocrity in mathematics teaching and learning in the middle grades and beyond.

1. Introduction

Trends in International Mathematics and Science Study (TIMSS) is an international assessment of mathematics and science at the fourth and eighth grades that has been conducted every four years since 1995. TIMSS 2019 is the recent evaluation, but the findings have not yet been released. This paper therefore takes into account the primary outcomes of the evaluation of TIMSS 2011 and TIMSS 2015. Over 580,000 students from 57 nations participated in TIMSS 2015. In TIMSS 2015, the highest countries on the TIMSS scale scored around 600 points, while the lowest countries scored around 370 points. Malaysia participated in TIMSS started from 1999 until present. Nor et al. [1] showed the trends in overall average mathematics achievement for eighth grade students from 1995 to 2011 for selected countries including Malaysia and Singapore.

Many studies have been conducted regarding the TIMSS data. Awang and Ismail [2] discussed about gender differences in learning mathematics in Malaysia. The result showed that girls score better that
boys in mathematics. The findings in [2] agreed with [3]. Studies conducted by Chen and Tam [4] found that there is a positive relationship between students’ achievement and self-perceptions in mathematics and science. Results in [4] are contrast with studies by Mohd et al. [5]. Caliskan et al. [6] had analyzed the mathematics questions of Transition from Primary Education to Secondary Education (TPESE) Exam according to cognitive level of TIMSS 2015. They discovered that there was a substantial difference between all the mathematics issues submitted by TPESE from 2013 to 2016 and the mathematics questions requested by TIMSS 2015. In other words, in terms of the cognitive domain, mathematics issues of the TPESE tests did not overlap with those of TIMSS.

Rosairo et al. [7] concentrated their research on the sixth grade level in the Portuguese education scheme, which is the final grade level of primary school. Sixth graders each have three classes in mathematics for 90 minutes per week. Every year, primary schools are ranked according to the outcome of their learners. Thus, the mathematics department's school administrators and educators seek to comprehend methods that could improve the test outcomes of their learners. They discovered out that homework was the most efficient form of homework for extension purposes. However, educators should recognize that homework for extension purposes is complicated as there are some significant variables in justification for not more often assigning this sort of homework. Therefore, to support the effectiveness of this form of homework purpose, educators should provide particular guidance, sound rules, and adequate time for completion in order to avoid burdening learners with additional educational duties or unrealistic deadlines. A student may have a positive attitude towards mathematics even if the mathematics teacher does not teach values [8].

The aim of this paper is to analyse the mathematics achievement of 8th grade Mathematics Questions for ASEAN countries compared to TIMSS 2011 and 2015 by classifying them based on Student Engagement and Attitude. Figure 1 shows the number of students assessed TIMSS 2011 and TIMSS 2015 in three different countries which are Malaysia, Singapore and Thailand. Malaysia shows an increase of 3993 students from 2011 to 2015 while the other 2 countries show only a slight increase of less than 400 number of the students.
Figure 2 represents the overall average mathematics achievement for eighth grade students in 2011 and 2015 for Malaysia, Singapore and Thailand. Malaysia achieve 465 points in 2015, an increase of 5.7% compared to 2011. Singapore still ahead, attain 621 points in 2015, which is 10% more than the achievement in 2011. While Thailand achieve 4% in average achievement in 2015 compared to 2011.

Limbaco [8] compares student engagement and attitudes overview towards eighth grade students’ learning mathematics in ASEAN countries participating in both TIMSS 2011 and TIMSS 2015. This paper examines four factors that affect in mathematics achievement in these countries. The factors are:

1. Time spent on mathematics homework.
2. Students like learning mathematics.
3. Students’ confidence with mathematics.
4. Students value learning mathematics.

Common perception among students that mathematics is a very difficult subject. Thus, they try to avoid taking mathematics courses. Avoiding mathematics courses will restrict them getting a job. However, according to Espinosa et al. [9] people have realized the importance of mathematics. Thus, students have to perform at their best towards mathematics.

Besides, homework-achievement relationship has also been scrutinized. Completed homework and time spent on homework affect school grades much more than standardized test scores [10]. Furthermore, there is a positive relationship between the amount of time spent on homework and achievement [11].

2. Data and methodology
Data used is from the international eighth grade TIMSS studies of 2011 and 2015 [12]. These datasets include three ASEAN countries that participated in both TIMSS 2011 and TIMSS 2015 which are Malaysia, Singapore and Thailand.

TIMSS uses an elaborate method in order to measure student achievement [13]. In short, the evaluation of mathematics is based on approximately 200 items. Each student, following a rotating matrix-sampling model, only reacts to a subgroup of these products. An imputation technique is used to achieve similar performance ratings for all learners. As the outcome measure, this paper used the set of
four index values of student engagement and attitudes towards learning mathematics and average achievement in mathematics for TIMSS 2011 and TIMSS 2015.

In addition to assessing student achievement, according to Pierre et al. [14], TIMSS includes questionnaires to students, teachers, and school leaders. For this paper, the eighth-grade student questionnaires of TIMSS 2011 and TIMSS 2015, student engagement and attitudes were used. The average reaction, percentage and standard deviation in each participating class was calculated for each of the focal items. Finally, the significant values of index between 2011 and 2015 for each countries were evaluated.

3. Results and discussions
This paper used the set of four index values of student engagement and attitudes towards learning mathematics and average achievement in mathematics for TIMSS 2011 and TIMSS 2015. In addition to the overall average results achieved across three countries, this paper discussed four factors that influence learning mathematics.

3.1. Time spend on mathematics homework
Homework meant for improving the quality of teaching by giving students tasks which enable them to exercise and build up their previously developed abilities and skills especially in mathematics. Moreover, the frequency of homework tasks had a beneficial impact on math achievement gains, while lengthy homework assignments had an adverse impact on progress gains.

Table 1. Percentage, mean and standard deviation of time spent on mathematics homework scale.

| Country | Year | 3 Hours or More | More Than 45 Minutes But Less Than 3 Hours | Less Than 45 Minutes |
|---------|------|-----------------|------------------------------------------|----------------------|
|         |      | %   | Mean   | SD | %   | Mean   | SD | %   | Mean   | SD |
| Malaysia| 2011 | 20  | 440.70 | 83.55 | 46  | 447.37 | 90.41 | 34  | 431.97 | 97.05 |
|         | 2015 | 17  | 467.13 | 80.74 | 51  | 478.41 | 82.57 | 31  | 452.17 | 91.06 |
| Singapore| 2011 | 16  | 627.87 | 72.21 | 57  | 622.38 | 76.46 | 27  | 583.72 | 93.04 |
|         | 2015 | 22  | 632.73 | 68.44 | 55  | 631.50 | 76.10 | 23  | 586.47 | 96.22 |
| Thailand| 2011 | 22  | 444.91 | 92.08 | 52  | 429.59 | 82.47 | 26  | 410.64 | 82.90 |
|         | 2015 | 23  | 453.98 | 84.72 | 49  | 439.23 | 87.43 | 28  | 401.95 | 87.55 |

Table 1 above shows the percentage, mean and standard deviation of time spent on mathematics homework scale. The mean for all the three countries increased. For Malaysia, the percentage of students who spend time more than 3 hours decreased by 3% while increased by 6% and 3% for students spend less than 3 hours but more than 45 minutes and less than 45 minutes respectively. The results above show that students who spent time doing homework more than 45 minutes score better. 2-2.3 points gained by increasing the length of the class by 10 min [15]. Considering that the average class length for the sample is 53 minutes, a 10 minutes increase is possible. Therefore, it is reasonable to increase of 1 or 2 hours per week for mathematics homework.

3.2 Students like learning mathematics
Student engagement and attitude towards mathematics plays an important role in students’ achievement. Attitude meaning is discussed in [16]. It is common to describe a person’s attitude as either positive or negative thus supporting [17]. One scale of students’ attitude that TIMSS administered was students like
learning mathematics. The scale is based on the mean of nine statements with which students rate their agreement. Students with positive attitude towards mathematics will gained more compared to negative attitude towards mathematics [18].

Table 2. Percentage, mean and standard deviation of students like learning mathematics scale.

| Country | Year | Very Much Like Learning Mathematics | Like Learning Mathematics | Do Not Like Learning Mathematics |
|---------|------|------------------------------------|--------------------------|----------------------------------|
|         |      | %   | Mean      | SD       | %   | Mean      | SD       | %   | Mean      | SD       |
| Malaysia| 2011 | 39  | 463.45    | 90.83    | 46  | 429.74    | 88.04    | 15  | 412.86    | 91.00    |
|         | 2015 | 28  | 497.10    | 88.03    | 56  | 458.82    | 83.48    | 16  | 433.29    | 76.44    |
| Singapore| 2011| 32  | 637.55    | 77.52    | 44  | 609.77    | 82.40    | 23  | 578.24    | 84.02    |
|         | 2015 | 24  | 653.90    | 71.01    | 42  | 624.58    | 79.99    | 33  | 592.20    | 82.38    |
| Thailand| 2011 | 26  | 455.77    | 89.22    | 57  | 420.50    | 82.95    | 16  | 407.87    | 78.68    |
|         | 2015 | 20  | 465.70    | 98.91    | 58  | 425.35    | 85.88    | 23  | 417.57    | 81.01    |

Table 2 showed the mean and standard deviation of students like learning mathematics scale. Overall, the mean for very much like learning mathematics and like learning mathematics increases from 2011 to 2015 in all three nations, as well as the percentage of students who like mathematics. These findings indicate that student who loves mathematics will perform better. These results are therefore in line with the work undertaken by [18-20] which stated that students with a positive attitude towards mathematics achieve a higher score.

3.3 Students confidence with mathematics

There is positive relationship between self-confidence and value in mathematics achievement [21, 22]. Thus, self-confidence towards mathematics plays a significant role to success in mathematics achievement.

Students’ confidence with mathematics is one of the factors that could affect the students’ achievement in mathematics. Table 3 shows the percentage of students, mean and standard deviation of students’ confidence in mathematics scale.

Table 3. Percentage, mean and standard deviation of students’ confidence in mathematics scale.

| Country | Year | Very Confident in Mathematics | Confident in Mathematics | Not Confident in Mathematics |
|---------|------|------------------------------|--------------------------|------------------------------|
|         |      | %   | Mean    | SD       | %   | Mean    | SD       | %   | Mean    | SD       |
| Malaysia| 2011 | 3.0 | 532.18  | 92.41    | 39.0 | 452.73  | 98.52    | 58.0 | 427.16  | 82.59    |
|         | 2015 | 4.0 | 568.14  | 74.92    | 42.0 | 485.37  | 89.69    | 54.0 | 444.19  | 75.53    |
| Singapore| 2011| 14.0| 662.40  | 70.69    | 46.0 | 628.14  | 76.75    | 40.0 | 574.30  | 80.70    |
|         | 2015 | 13.0| 675.08  | 57.06    | 41.0 | 641.52  | 72.53    | 46.0 | 587.88  | 82.00    |
| Thailand| 2011 | 2.0 | 508.58  | 101.79   | 44.0 | 434.05  | 90.85    | 54.0 | 420.07  | 78.18    |
|         | 2015 | 3.0 | 559.94  | 94.40    | 29.0 | 456.08  | 96.97    | 69.0 | 415.97  | 78.46    |
It is interesting to see from the table 3 that all three countries have increased in their average achievement from year 2011 to year 2015. Although the average achievement in mathematics is increasing, but the three countries have the highest percentages of students who are not confident in mathematics. In TIMSS 2015, for Malaysia, 54% of students who involved in TIMSS are not confident in mathematics, 42% of students are confident in mathematics and only 4% of students having a very confident in mathematics. This situation is also happens in Singapore and Thailand where the majority of students are not confident in mathematics. This indicates that students’ confidence in mathematics are not the main reasons in determining a performance in mathematics.

3.4 Students value learning mathematics

Students were scored on the scale of students’ value mathematics based on their degree of agreement with nine statements. Strongly value mathematics had a score corresponds to agreeing a lot, agreeing a little and disagreeing a little.

| Table 4. Percentage, mean and standard deviation of students value learning mathematics scale. |
|-----------------------------------------------|
| Country | Year | % | Mean | SD | % | Mean | SD | % | Mean | SD |
| Malaysia | 2011 | 49 | 452.69 | 90.82 | 40 | 433.14 | 90.42 | 11 | 411.02 | 91.29 |
| | 2015 | 39 | 486.69 | 84.72 | 53 | 457.60 | 84.92 | 8 | 424.83 | 79.49 |
| Singapore | 2011 | 43 | 618.63 | 80.70 | 47 | 608.33 | 84.61 | 10 | 591.50 | 90.90 |
| | 2015 | 34 | 629.33 | 80.69 | 58 | 620.64 | 80.65 | 8 | 590.29 | 89.51 |
| Thailand | 2011 | 51 | 441.87 | 86.17 | 42 | 416.39 | 81.98 | 7 | 391.84 | 84.20 |
| | 2015 | 50 | 445.76 | 90.17 | 45 | 421.20 | 85.44 | 5 | 389.76 | 82.05 |

From Table 4, in 2015, majority of the eighth grade students from Malaysia agree that mathematics is valuable (92%), and they had higher average achievement than those that do not value mathematics (8%) had the lowest average achievement. As well as the results is the same for Singapore and Thailand. The eighth grade students with more positive attitudes had higher mathematics achievement. It follows the research by Seah and Ngai [23], they investigate the harnessing of relevant values to optimize school mathematics teaching and learning.

| Table 5. p-values between overall mathematics and students’ achievement and attitudes. |
|-----------------------------------------------|
| Overall Mathematics Scale: Grade 8 | p-value |
| | Malaysia | Singapore | Thailand |
| Index time spend on math homework | 0.0001 | 0.039 | 0.1436 |
| Index of students like learning math | 0.0001 | 0.0007 | 0.291 |
| Index of student's confidence with math | 0.0041 | 0.015 | 0.0102 |
| Index of students value learning mathematics | 0.0001 | 0.0466 | 0.5775 |
Table 5 shows the p-value between overall mathematics and students’ achievement and attitudes according to Malaysia, Singapore and Thailand. Prior to this, only male-female comparisons within a jurisdiction were treated as dependent. Comparisons of achievement across years are made using independent t-tests with a linking error taken into account. Comparisons between jurisdictions are also treated as independent. The alpha level for all t-tests is 0.05. From this result, eighth grade students from Malaysia and Singapore had significant value between all factors that could influence mathematics achievement.

4. Conclusion
Parental involvement is one of the factors that contributes to ensuring that students do their homework. Thus parents have to support the development of their children's academic skills. Middle childhood is an ideal time to investigate children’s experiment of homework interactions [24].

Given the relationship between the conduct of homework and the academic achievement of students, assigning more homework does not lead to better homework quality if teachers do not take into account other homework features, specifically the purpose of each homework task [7]. This proves that doing homework in less than 3 hours also has a positive effect on the result as long as the homework task has a clear goal of homework. TIMSS provide an opportunity for educational policy makers to realize the educational phenomenon of their countries. The data released from the studies are valuable research resources.

Achievement significantly increases with students’ aspiration, self-confidence in learning mathematics and time spent on mathematics homework [25]. This study does not include the differences of curriculum or contents of mathematics taught. Furthermore, this study investigated the role of only one characteristic which is the student’s engagement and attitude. However, this limitation does not deny the fact that findings in this study give an important contribution to understand the mathematics performance.

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