PUPILS ACHIEVEMENT TOWARDS HIGHER ORDER THINKING SKILL MATHEMATICS QUESTIONS WITH BAR MODEL METHOD

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ABSTRACT: *This study aims to review on the effects of the student's achievement on Higher Order Thinking Skill (HOTS) type of Mathematics questions with the application of the Bar Model method. Two main aspects studied were the students' capacity in answering Mathematics questions with HOTS level and the effectiveness of the Bar Model method in enhancing the student's achievements in answering HOTS level Mathematics questions. Quasi-experimental quantitative methods were used to answer the research questions. A total of 70 students from Year 5 of a primary school in the District of Kinta, Perak are involved in this study. The students were divided into a control group and a treatment group. The control group uses the teaching and learning process (TnL) with conventional method, while the treatment group runs the TnL using the Bar Model Method. Descriptive statistical analysis was used to assess the students' existing capabilities while inferential statistical analysis of t-test was used to assess the effectiveness of Bar Model Method in improving the students' achievement. The findings revealed that the current ability of pupils in Year 5 in answering mathematics questions with HOTS level did not reached the minimum grade E. The mean scores of students in the treatment group in a post test were found to overcome their mean scores in pre-test significantly. The findings also showed that the mean scores of post test, the treatment group students tackle the mean post test scores of students in the control group significantly. In conclusion, the students who attend the TnL Bar Model Method perform better than the students in the conventional group. The implications of this study showed that the use of Bar Model Method have improved the performance of pupils in Year 5 in answering HOTS level mathematics questions.*

Keywords: HOTS, Bar Model, Teaching and Learning , Effectiveness, Pupils Achievement.

1. INTRODUCTION

A review on the education system as a whole by the Ministry of Education in 2011 has resulted in a transformation known as the Malaysian Education Development Plan (MEDP) 2013 - 2025. The transformation of the curriculum implemented in the MEDP focuses on the concept of Higher Order Thinking Skills (HOTS) which emphasize in producing a generation with creative and critical thinking skills. This has been a priority in the MEDP [1]. HOTS is a high-level thinking skill involving a variety of complex thought processes, having multiple variables and is activated when people have difficult problems, questions or dilemmas and promote continuous intellectual improvements [2]. A student will be qualified to have HOTS when he has managed to dominate four of the top levels of Bloom's taxonomy and can associate with existing knowledge to solve complicated situations [3-5]. Students who have mastered all levels of the Bloom's taxonomy can be classified as a student who has HOTS in themselves [6].

The application of the HOTS requirements to students in school will serve as a milestone that must be addressed in order to produce human capital that are intelligent, creative and innovative to meet the challenges of the 21st century so that the country can compete in the world arena [3]. Among the main focus of it is to increase the number of questions that test higher-order thinking skills in assessments. Moreover, questions with HOTS levels are now actively expanding in the course of teaching and learning in schools, providing also the marking scheme that is modified according to the method of valuation with HOTS levels [7]. The percentage of HOTS exam questions increases year by year, especially in the public examinations. In addition, the ability of students to answer the questions in the form of HOTS will also be an educational performance benchmark for Malaysia internationally. Over the past two decades, international assessments such as the Programme for International Student assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) are used as a method of direct comparison of the quality of educational outcomes of various education systems [1].

However, the increase in HOTS implemented questions in teaching and learning activities (TnL) and public examinations so far are seen as an element of surprise to the students and cannot be accepted with consent yet. Students seemed to not willing to answer the questions in the form of HOTS leading to a decline in their performances in public examinations such as Primary School Achievement Test (UPSR) which is for Year 6 pupils in Malaysia. A decreasing point of 0.02 in the average grade of the UPSR examination has been shown because the HOTS questions have challenged the candidates. Based on the analysis, this decline is due to the existence of such questions. Many mistakes made by the candidates in HOTS questions compared to other questions [8]. The existence of HOTS questions are also among the causes of the poor performance of students in assessments at the international level, especially in the TIMSS and PISA. Analysis of the achievements of science and mathematics in TIMSS indicates that the students in Malaysia are weak in answering questions that require HOTS [9]. This finding is further proven with the research needs report by the Kestrel Education consultants (UK) and the 21st Century Schools (USA) which was presented on 2 November 2011 with a conclusion that HOTS among teachers and students in Malaysia are very low [10]. An analysis of the findings of the TIMSS exam in 1999 and 2007 also showed that the achievement of students in the country in which the item involves solving problems are below average of the international score. By comparison, the 15-year-olds in Singapore, South Korea, Hong Kong and Shanghai seems to have three or more years of schooling ahead compared with the achievements of pupils aged 15 in Malaysia [1].

In addition, most of the HOTS questions were tested in the form of a mathematical word problems or problem solving skilled questions. This is because in mathematics, one of the most important skills is problem solving skills. These conditions cause the pupil hard to understand the needs of HOTS level questions and are not able to finish them well. A strategy or method need to be identified to help the students to deal with the difficulties in solving mathematical word problems [11]. With addition to the existing perception of students towards mathematics which considers mathematics as a subject that is difficult and tedious [12]. For these requirements, this research was conducted to examine the effectiveness of using the Bar Model Method to help the students to master the HOTS concepts well and this might improve their performance in answering math questions with HOTS level. Bar Model Method was chosen because it is the best method which has been adopted by Singapore. Bar modeling methods is the main model for solving mathematical problems in Singapore and students began using it since the beginning of the school in the process of completing the various levels of the problems starting from addition to division [13]. Singapore was chosen because it is a country that has the highest achievement in international assessments such as TIMSS and PISA. Singapore version of the mathematics text book is used in many schools in the United States and other countries such as Canada, Israel and Britain [13,14]. Teaching using Bar Model Method has run by 86% of primary schools in Singapore where it can help improve the understanding and provide an overview of the problems easily and thus solve the problem [15].

BAR MODEL METHOD

In the early stages, students are introduced to this method by representing some or all circumstances to use a rectangular box known as a bar. These representatives can provide an overview of the operations to be carried out either add, subtract, multiply, divide or merge operations. To understand the use of Bar Model, we refer some fairly simple math problem as *"Aiman has 14 pencils. His friend has 17 pencils. How many pencils do they have?"* To solve this problem, students will draw a bar and then divides the bar into two parts where one side is longer than the other side. One side is labeled as 14 while a further portion is labeled as 17 as shown in Figure (1) below:

Fig(1) representation Model Bar for Addition Operation

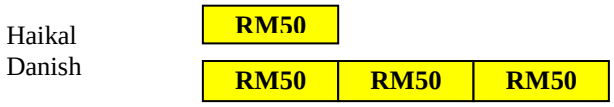
From Figure (1) above, students can learn that to find the total of the pencils, they need to perform the addition operation, where 14 + 17 = 31 pencils.

Let us refer the following problems: "*There are 40 students in a class. 25 of them are boys and the rest are girls. How many girls are in the class?"*To solve such problem, the bar will be drawn as shown in Figure (2) below:

Fig(2) representation Model Bar for Subtraction Operation

Based on Figure (2), students will get the impression that the operation that is carried out is subtraction. To find the number of girls, we have to minus the number of boys from the total number of students in the class where 40−25 = 15 girls.

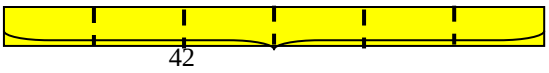
For the use of Model Bar in the operation of multiplication, we refer the following problem statement: "*Within a week, Haikal can save as much money as RM50. Danish can save three times that of Haikal. How much money can be saved by Danish within a week?"*. To represent the money saved by Haikal in a week, one bar will be drawn with the 'RM50' label. Because Danish can save three times more than Haikal, 3 bars of the same as of Haikal will be drawn for Danish. The model bar for solving the above problem is shown in Figure (3).



Fig(3) representation Model Bar for Multiplication Operation

The drawn model bar will help us decide that an operation that is necessary to calculate the amount of money that can be saved by Danish is multiplication. So the amount of money that can be saved by Danish is RM50 x 3 = RM150 or RM50 + RM50 + RM50.

To see the use of a model bar for problems involving operations division, we refer to the following problems: "*Miss Putri bought 42 apples. She gave the apples equally to six of her students. How many apples will be received by each of the students?"* To solve this problem, the bar will be drawn to represent the number of apples purchased by Miss Putri. Then the bar will be divided into six equal parts using a dotted line representing the six students who received the apples. The model bas is drawn for solving the above problem is shown in Figure (4)



Fig(4) representation Model Bar for Division Operation

Based on Figure (4), the bar model can help us overview the operations to be performed that is the division operation. To find the number of apples received by each student, we need to divide 42 by six where 42 ÷ 6 = 7 apples.

2. EXPERIMENTAL DETILES

This study was conducted to determine the effectiveness of the use of Bar Model Method in improving the performance of Year 5 pupils in answering math questions based on HOTS. This study aims (1) to review the existing capacity of students to answer each mathematics question with HOTS level. (2) To review the effectiveness of Bar Model Method in improving the performance of pupils in Year 5 in answering mathematics questions with HOTS level.

The research questions to be studied are: (1) what is the level of ability of students' to answer any mathematical questions in the form of HOTS? (2) Is there a difference in score of pupils in Year 5, before and after exposure to the Bar Model Method? (3) Is there differences between the scores of pupils in Year 5 that were exposed to the Bar Model Method with the students who learn in the conventional way? The null hypothesis for research question 2 (H_{01}) is that there are no significant difference to the scores of pupils in Year 5 before and after the exposure to the Bar Model Method. The null

hypothesis for the research question 3 (H_{02}) is that there are no significant difference in scores between pupils in Year 5 that were exposed to Bar Model Method with Year 5 pupils who studied conventionally.

The designs used by the researchers in this study are a quasi-experimental design through a quantitative approach. Quasi-experimental design is done when researchers cannot make a random selection as they are bounded by certain regulations [16]. Pure experimental study involving school children is difficult to implement due to logistical factors where the students are in the same classroom. This approach consists of a control group and a treatment group. Both groups occupy the same pre-test and post-test HOTS Mathematics Achievement Test instrument. The control group using conventional learning methods, while the treatment group using Bar Model Method. The dependent variable is the student's achievements while the dependent variable is the method of teaching. The study was conducted in a school that achieved among the best performance in North Kinta District in Perak. Respondents were 70 students from Year 5 of 138 pupils. The selection of school and 70 students who participated in this study was by random sampling method.

The instrument used is the HOTS Mathematics Achievement Test in the pre-test and post test. The pre test used in this study is to answer the first research question, while the post-test in this study were to answer the second and third research questions. Pre exam will be administered in the early stages of the data collection process while post-test will be conducted in both groups after the treatment group completed the guidance of the Model Bar Method. The question sets for HOTS Mathematics Achievement Test consists of 12 questions or HOTS solving mathematical word problem. This set of questions encompasses all units in the standard curriculum and assessment documents (SCAD) of Mathematics Year 4 [17]. This question must be answered within one hour and thirty minutes. This question is constructed with reference to SCAD mathematics Year 4 and also the Primary National School Mathematics textbook Year 4 [18]. For the pre-test, the student's achievement scores are categorized based on the percentage. The guidelines used are from the school grading guide that was issued at the School Examination Analysis System (SEAS) Ministry of Education Malaysia site as in Table (1) below:

Table(1) : Primary School Grading and Scoring

Score	Grade	Achievement
80 – 100	A	Excellent
65 – 79	B	Good
50 – 64	C	Satisfaction
40 – 49	D	Achieve Minimum Level
0 – 39	E	Not Achieve minimum Level

Reference :https://sapsnkra.moe.gov.my/dokumen/GRED.pdf

Statistical inference parametric t test was used. Paired t test is used to compare the mean pre-test and post-test treatment group while the independent t test is used to compare the mean post-test between the control group and the treatment group. Before the testing, the inference is made assuming that the data is a normal review. The basic condition for majority statistical inference techniques is assumption that the data is normal [19].

Items in the HOTS Mathematics Achievement Test has been verified the face validity and content validity by three experts; two Expert Mathematics Teachers and the Malay Language Committee Chairperson. In addition, a pilot test was administered to 33 respondents from the same population which exclude the participants in this study. This pilot study is administered by means of test and retest reliability. With this concept, the respondents were given the first test at the end of the school term, two weeks before the 2015 end of year school holidays and then re-sit the same test in the first week of school reopened in 2016. From the analysis, it was found that the Cronbach's alpha coefficient value is 0.994, and this shows the items built has high reliability. A questionnaire with Cronbach's alpha value above 0.7 indicates that the questionnaire is acceptable in terms of reliability [16].

3. RESULTS AND DISCUSSION

The student's marks for mathematics of the Year End Examination were analyzed to examine the equality of achievements between the grades of the control group and the treatment group. Levene's test shows PAT scores variance of both groups were homogeneous ($p > 0.05$), thus the assumption that the variance is the same (homogenous) is met [20].

4.1 Pre-Test Results

For the control group, all the 35 students (100%) has obtained grade E, which has not achieved the minimum level. The mean score of the control group is 8.06 with a standard deviation of 2.920. For the treatment group, all 35 students obtained grade E (100%), which has not reached the minimum level Mean marks of the treatment group was 9.74 with a standard deviation of 5.392. None of the respondents of the control group and the treatment group pre-test passed.

4.2 Post Test Results

Before inference testing was made, the data is checked to be assumed in the normal form by using the Kolmogorov-Smirnov test. From the test, the findings of the post-test treatment group is [$D(35) = 0.200$, $p > 0.05$], the post-test control group is [$D(35) = 0.145$, $p > 0.05$], the pre-test treatment group was [$D(35) = 0.043$, $p > 0.05$] and so is the pre-test control group [$D(35) = 0.137$, $p > 0.05$]. This finding indicates that the distribution of the sample data is normal where Kolmogorov-Smirnov test results for the two groups in pre-test and post test was not significant ($p > 0.05$) [19].

From the paired t test, the student's achievements in the post test treatment group (mean = 47.29, standard deviation = 8.757) was better than their achievement in pre-test (mean = 9.74, standard deviation = 5.392). The results showed this difference was significant [$t(34) = -52.493$, $p < 0.05$]. Due to the significance of differences in scores, then the null hypothesis for the research question 2 (H01) stated that there was no significant difference on scores pupils in Year 5 before and after exposure to the Bar Model Method, is rejected. Independent t tests were conducted to show student achievements showed that in Post-test treatment group (mean = 47.29, standard deviation = 8.757) was better than the control group students (mean = 21.49, standard deviation = 3.311). A total of 29 students passed the Post-test treatment group compared to none passed the post test in the control

group. The difference was significant [t (43.527) = 16.304, p <0.05]. Since the Levene test was significant (p <0.05), the null hypothesis for the research question 3 (H02) that there is no significant difference of scores between pupils in Year 5 that were exposed to Model Bar Method with pupils in Year 5 that learned conventionally, is denied.

4. CONCLUSION

The current ability levels of the students in answering HOTS mathematics questions are very weak, where it has not reached the minimum level. This is because all students are either in the control group and the treatment group with grade E and failed in the pre-test. The highest score obtained was 27% while the lowest was 2%. These findings confirmed that school children in Malaysia are weak in answering questions that require HOTS [9] and proved the statement that the high level thinking skills among teachers and students in Malaysia is very low [10]. The scores of the students in treatment groups for the post test increases and are different significantly compared with their scores in pre-test. These findings show that there is a difference and a significant increase in the student's achievements after exposure with Bar Model Method. Students from the treatment group scored higher and vary significantly compared to the control group students scores in the Post test. This indicates that the Model Bar method effectively helped to improve the student's scores in mathematics and in answering questions in *KBAT* level than the existing conventional methods. This is consistent with what the Clark (2010) and Cris (2004) refereed about the usefulness and effectiveness of Bar Model Method.

5. REFERANCE

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