THE EFFECTIVENESS OF BAR MODEL FRACTION KIT IN SOLVING HIGHER ORDER THINKING SKILLS MATHEMATICS WORD PROBLEMS

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ABSTRACT: *This study aims to determine the effectiveness of Bar Model Fraction Kit based on students' achievement in answering Higher Order Thinking Skills (HOTS) word problems. A total of 48 Year 5 students from Batang Padang District, Perak were involved in a quasi-experiment using pre-test and post-test. The students were divided into a control group and a treatment group. The control group(n=23) uses the teaching and learning process (TnL) with the conventional method, while the treatment group (n=25) runs the TnL using the Bar Model Fraction Kit. Data were analyzed using the Mann-Whitney Test. The results indicated that during post-test, students who used Bar Model Fraction Kit showed significant improvement in their HOTS level (p=0.000). In conclusion, the students who undergone TnL using Bar Model Fraction Kit performed better than the students in the conventional group. Bar Model Fraction Kit has effectively improved the performance of students in answering HOTS word problems involving addition and subtraction of fraction.*

Keywords: Bar Model Fraction Kit, Effectiveness, Higher Order Thinking Skills, Pupils Achievement, Word Problems

1. INTRODUCTION

The Mathematics Curriculum (KSSR) at the upper primary level encompasses four main areas, which are Numbers and Operations, Measurement and Geometry, Relationship and Algebra, and Statistics and Probability. The curriculum gives a great emphasize on problem-solving [1]. Problem-solving is an activity which encourages students to use HOTS [2]. Therefore, mathematics is no longer the task of mastering basic mathematical skills like addition, subtraction, multiplication or division. Pupils these days are assessed not only on basic mathematical operations but also on how well they understand the concepts, transform the mathematical operations correctly, apply the mathematical procedures and solve the problem [3].

Transition in mathematics education from understanding concepts and basic skills to higher order thinking skills (HOTS) has affected the implementation of the teaching and learning of mathematics. Thinking skills is one of the six main characteristics required by each student to be globally competitive [4]. In today's education, students must be able to think critically outside the routine academic context. They should be able to connect pieces of knowledge and solve a problem. Thus, learning with understanding is more effective than simply memorizing the facts [5]. Students should be given opportunities to engage in the learning process. Through this, students will be able to explain "how" to do the mathematics and state "why" the mathematics works the way it does.

HOTS is the ability to use the maximum level of thinking to meet challenges in order to solve a problem [6]. HOTS involves a variety of complex process and is activated when people face difficult questions and eventually improves the intellectual [7]. This is aligned with [2] whereby HOTS demand for more complex thinking in dealing with situations or solving a problem. On the other hand, problem-solving is used to develop Higher Order Thinking Skills (HOTS) [8]. Based on the opinions, HOTS involves the learning of complex skills such as critical and creative thinking in solving various problems.

HOTS is initiated by Bloom Taxonomy. A student is considered to have HOTS if managed to solve problems involving four of the top level of Bloom's taxonomy [9]. This study referred HOTS to the higher division of Revised Bloom Taxonomy (RBT) which includes creating, evaluating, analyzing and applying [1].

Facts in the field indicate that HOTS of students in Malaysia is still low based on the performance of Malaysian students in TIMSS and PISA. Both Singapore and Malaysia have participated in TIMSS 2015 assessment. However, Singapore, our neighbouring country is in the top world rank and Malaysia is placed below the international average.

In order to achieve better performance, the teaching approach of thinking skills is vital. Lessons that are planned should consist of aspects such as concepts, schemes, metaphors, similes, and analogies, visualization or inference [10]. In this study, the researcher will be using the visualization approach to enhance students HOTS.

This research was conducted to examine the effectiveness of using the Bar Model Fraction Kit to help the students to master the fractions concepts and improve their performance in answering HOTS word problem questions involving addition and subtraction of fraction.

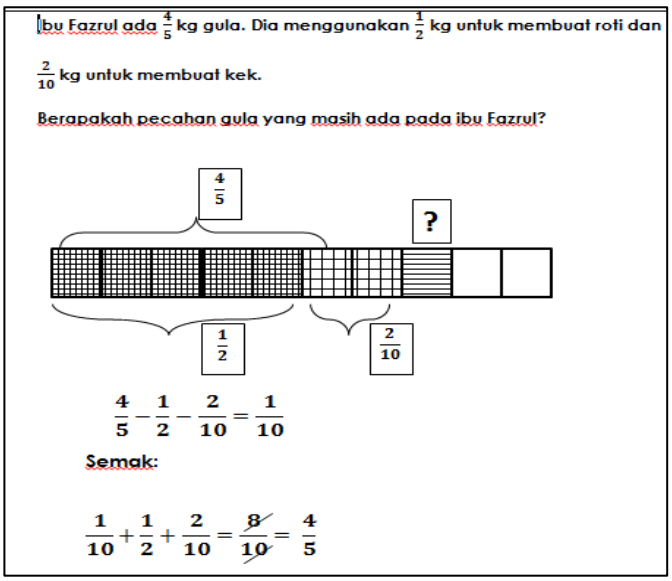
BAR MODEL FRACTION KIT

Bar Model Fraction Kit is a tool or manipulative adapted from Singapore Bar Model Method. Bar Model method is the main model for solving mathematical problems in Singapore. Singapore method has been chosen for its great achievement in international assessments such as TIMSS and PISA. 86% of primary schools in Singapore use Bar Model Method where it helps to understand the problems and thus solve the problem easily [11]. However, there are some difficulties commonly faced by primary school teachers and pupils in drawing models although it has been well accepted by most countries. Among the difficulties are (1) difficulty to draw an "accurate diagram", (2) dividing the block diagrams into an equal number of divisions, (3) inappropriate use of the model method [12].

The developed Bar Model Fraction Kit able to overcome those difficulties. It is focused in facilitating both teachers and students to solve fraction word problems. It comprises Concrete-Pictorial-Abstract (CPA) instructional approach. CPA instructional sequence has it roots from Bruner's theory [13]. According to Bruner, learning should use concrete material, followed by representation and manipulation of symbols.

Bar Model Fraction Kit is used along with Polya's problem-solving approach. Firstly, students have to read and understand the word problem. In the second stage, students will use the Bar Model Fraction Kit to draw what they know and what they are attempting to solve. Then, carry out the plan which relates to mathematics computation. The last step is look back. Students will recheck the answer by using work backward strategy.

Example 1:



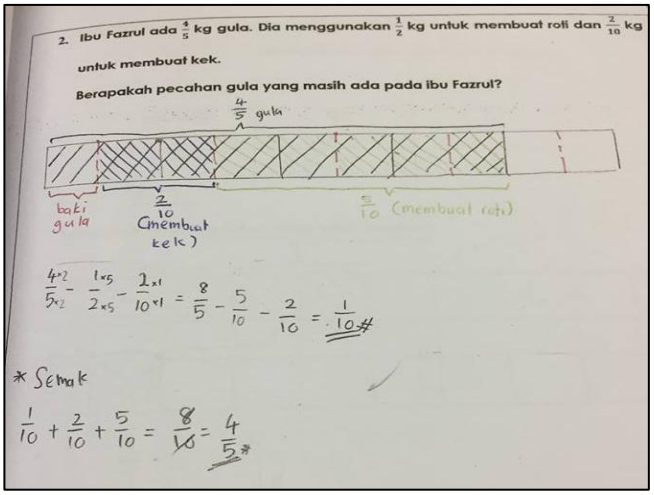


Figure 1: Student's Sample Answer

2. EXPERIMENTAL DETAILS

This study employed a quasi-experimental design through a quantitative approach. Purposive sampling was used to select the schools based on the homogeneity score in the year-end examination. The Year End Examination marks for mathematics were analyzed to examine the equality of achievements between the respondents in the two groups. Both schools administered similar test questions as the test specification is given by the district education department. The Year End Exam Marks indicated that both groups were homogeneous ($p > 0.05$), thus the assumption of variance homogenous is met [14].

A total of 48 Year 5 students from Batang Padang District, Perak were involved in this study. The students were divided into a control group and a treatment group. The control group (n=23) uses the teaching and learning process (TnL) with the conventional method, while the treatment group (n=25) runs the TnL using the Bar Model Fraction Kit. Before the TnL, both groups were given a pre-test.

In the next lesson, the teacher started to teach fraction using the traditional method for the control group while for the treatment group the teacher used Bar Model Fraction Kit. Twelve lesson plans were provided. The teacher used the lesson plans in teaching and learning. The teaching and learning sessions for both groups took take 720 minutes over 6 weeks. The students from both groups sat for the post-test after the 6th week of TnL.

The pre and post-test consist of the same test items. The test consist 12 HOTS word problem questions. It covers Mathematics Fraction Year 4 curriculum. Pupils are allocated one hour to answer the questions which are aligned with the time allocated in Mathematics Paper 2, UPSR.

Table 1: Items based on HOTS level

Item	Level of higher order thinking skills
1,2,3	Apply
4,5,6	Analyze
7,8,9	Evaluate
10,11,12	Create

The students' achievement scores from the pre-test and post-test are categorized based on percentage and thinking ability. The guidelines used as in Table 2 [15].

Table 2: Level of Higher order thinking skills

Student's mark	Level of higher order thinking skills
100-76	Excellent
75-51	Good
50-26	Satisfactory
25-0	Poor

RESEARCH QUESTIONS

i. Are there any significant differences between the pre and post-test scores in solving the addition and subtraction of fractions in the control group?

ii. Are there any significant differences between the pre and post-test scores in solving the addition and subtraction of fractions in the treatment group?

iii. Are there any significant differences between the control group and the treatment group in the pre-test scores in solving the addition and subtraction of fractions?

iv. Are there any significant differences between the control group and the treatment group in the post-test scores in solving the addition and subtraction of fractions?

3. RESULTS AND DISCUSSION

For normality, in the Shipiro-Wilk test, the obtained values (Sig.) were 0.019 (post-control), 0.019 (post-treatment), 0.018 (pre-control), and 0.014 (pre-treatment). These indicate that the data collected in this study were found to be non-normally distributed.

Mann-Whitney Test

To answer the research question, the researcher used the Mann-Whitney test to show the significant difference between the treatment group and the control group.

For the pre-test, Table 3 shows that the Z value = -9.86 with significant level at 0.324 where p (0.324) > α (0.05). This result indicates that there is no significant difference between the two variables; so, the null hypothesis is accepted.

Table 3:Pre-test

	PRETEST
Z	-.986
Asymp. Sig. (2-tailed)	.324

For the post-test, Table 4 shows that Z = -5.914 with significant level at 0.000 where p (0.000) < α (0.05). This indicates that there is a significant difference between the two variables; therefore, the null hypothesis is rejected.

Table 4: Post-Test

	POSTTEST
Z	-5.914
Asymp. Sig. (2-tailed)	.000

Wilcoxon Signed Ranks Test

On the other hand, the researcher used the Wilcoxon Signed Ranks Test to compare two related samples.

For the control group, Table 5 shows that Z = -0.061 with significant level at 0.951 where p (0.951) > α (0.05). This indicates that there is no significant difference before and after being taught using the conventional method. Therefore, the null hypothesis is accepted.

Table 5: Control Group

	POSTTEST - PRETEST
Z	-.061[b]
Asymp. Sig. (2-tailed)	.951

For the treatment group, Table 6 shows that Z = -4.375 with significant level at 0.000 where p (0.000) < α (0.05). This indicates that there is a significant difference before and after being taught using the Bar Model Fraction Kit. Therefore, the null hypothesis is rejected.

Table 6: Treatment Group

	POSTTEST - PRETEST
Z	-4.375[b]
Asymp. Sig. (2-tailed)	.000

The intervention using Bar Model Fraction Kit for the treatment group is found to be able to assist the students in solving HOTS fraction word problem involving addition and subtraction. Students from the treatment group answered the post-test problems by using the Bar Model Fraction Kit. The students drew the rectangular bars to represent the problem. Using the rectangles which represent the fraction, students were able to understand the problem and operation involved. The usage of Bar Model Fraction Kit can improve HOTS. Previously, the students seem to have difficulties to understand the problem given and translate the problem into a mathematical sentence.

However, with the help of Bar Model Fraction Kit, the students were able to transfer all the information into a representation model which will assist them to solve the problems easily. Therefore, the intensive treatment given to the students in the treatment group helped them to answer the HOTS questions well compared to the pre-test.

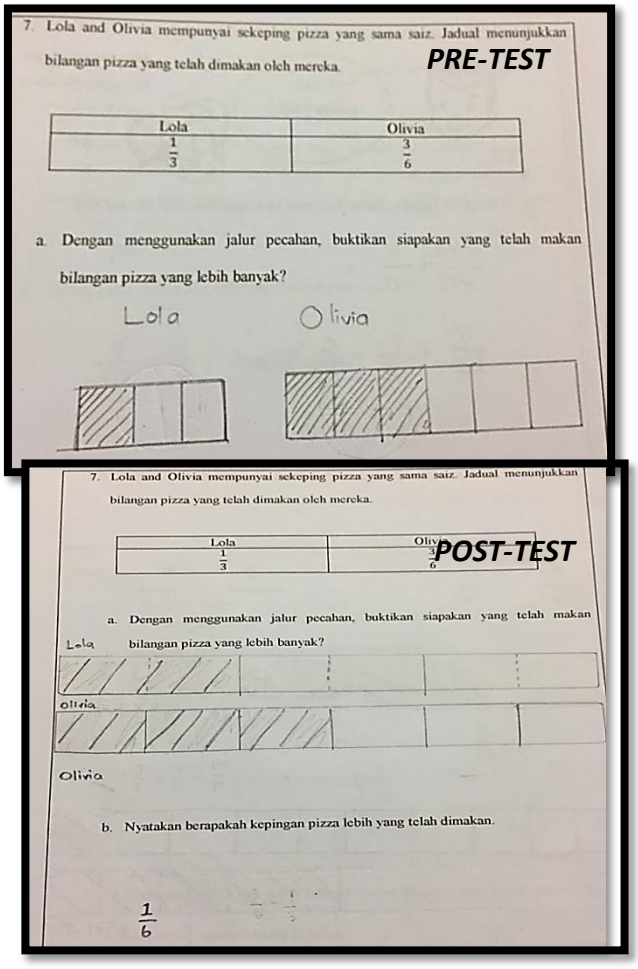


Figure 2: Student's Sample Answer (Treatment Group)

On the other hand, the control group who were practicing the conventional method of teaching and learning did not show any improvement in the students' performance. This shows that the students were not engaged in the learning process. Teachers can provide steps for students to memorize, but conceptualization of concepts is equally important. Commonly, teachers use base equalization technique whereby the denominator is multiplied to a common factor. The trick looks easy and simple but it an ineffective way. Fraction is about understanding the concepts. For an example, using Bar Model Fraction Kit, students will be exposed to partitioning strategy. The partitioning will lead to the students' conceptual development of common denominators.

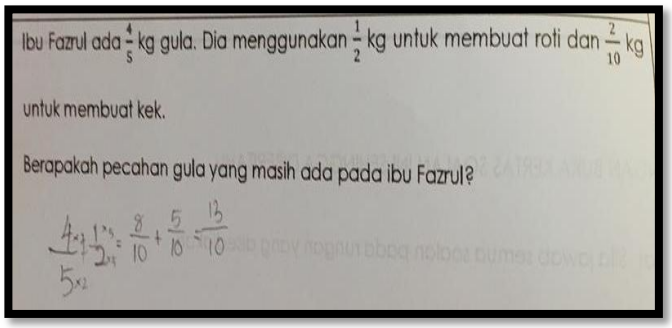


Figure 3: Student's Sample Answer (Control Group)

The result of this study is aligned with the findings of studies that have been conducted [16], [17]. According to [17], visualization helps the students to understand the problem in order to solve them. While [17] found that representation model helps the students in solving routine and non-routine mathematical problems. Moreover, [18] stated that mathematical problem can be solved using Representation Model which helps students to develop their mathematical thinking.

Fractions are considered to be difficult by students and teachers [19, 20]. Students not only have to conceptualize fractions, but also calculate and solve word problems. Through the usage of Bar Model Fraction Kit, students were able to explore the concept of fraction.

4. CONCLUSIONS

The use of Bar Model Fraction Kit during the learning process can promote student growth. Lessons taught using the manipulative produce students' with better achievement in mathematics compared to lessons taught without using manipulatives. The scores of the students in the treatment group for the post-test increases and are significantly different compared to pre-test. These findings show that there is a significant increase in the students' achievements after being exposure with Bar Model Fraction Kit compared to the control group.

Bar Model Fraction Kit is capable to facilitate students in addition and subtraction of fraction involving word problems and builds pupils' understanding of fractions. It underpins the Concrete - Pictorial - Abstract (CPA) instructional sequence for Mathematics.

"I hear and I forget. I see and I remember. I do and I understand". - Confucius

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