

Determining the Effect of Bar Model Technique on Students' Mathematical Word Problem Solving Skills

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Abstract

The study aims at probing the effect of Bar Model Technique on the word problem solving skills of primary level students in the subject of mathematics. Following were the objectives (i) to determine the effect of Bar Model Technique on student's mathematical word problem solving skills; (ii) to compare the academic achievements of male students and female students by using Bar Model Technique. It was experimental study and pretest-posttest equivalent group design was used as a tool for data collection in this study. Sample of the study was 40 students (Male & Female) of Government Primary School District Nowshera, Khyber Pakhtunkhwa. The sample students were divided in two group control and experimental on the base of pretest score by using paired random technique. Data were analyzed by mean, SD and t-test. Results of the study show that Bar Model Technique had significant effect on Mathematical word problem solving skills. It was also concluded that with visualization technique the learners had better understanding of word problem question and they participate in the activities. In the comparison of boys and girls, the girls had performed better than the boys. This study can be helpful for the students to develop their mathematical word problem solving skills. It provides alternative method for teachers to teach mathematics.

Keywords: Bar Model Technique, Mathematical word problem, Elementary level, Problem solving skills.

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Introduction

Mathematics is precisely considered as the science which mainly concerns the logic of arrangement, character, shape and quantity. We are surrounded all around by Mathematics in our daily life happenings. Mathematics is considered as the basic building block for the daily happenings of our lives, such as: money, architecture (ancient and modern), mobile devices, computers, art, engineering, different measurements, offices, in sports and many other aspects of life. The importance of mathematics is not only limited to technological and scientific development but it has also got a great importance in daily interactions at the dealings performed by both literate and illiterate citizens of any community, transportation and market places etc. (Golji & Dangpe, 2016).

According to Skovsmose (2013) the view point of educating learners in mathematics can be taken as narrowly and widely. Assumed the philosophy narrowly in some of the tasks of mathematics is considered as its aim. So it can be said that in this sense of mathematical philosophy i.e, narrow sense, the concern of education aims besides the way of its teaching.

According to Ali (2011) these mathematical standards included in the national curriculum are not present in subject of mathematics, which enable the leaners to utilize mathematical knowledge for the dire demand to live in a society surrounded by technology.

Jan and Rodrigues (2012) added that problem solving is one of the critical mechanisms in mathematics at all levels and in all mathematical activities in education. Almost all the learners of mathematics around the globe consider this word problem as a boring task and they feel difficulty in solving such questions. At elementary level Mathematics, Science, English, Urdu are the important subjects and Mathematics is one of them but students find it difficult to solve numbers, algebra and geometry.

The curriculum for the subject of mathematics should be offered in multiple ways in order to make the teaching of mathematics understanding and interesting. These multiple ways may include virtual (dynamic electronic) representation, pictorial (static visual) representation and physical (concrete) representations. Such representations could be used by mathematics educators for manipulative purposes to enhance the abstract contents or symbolic contents for modelling the concepts of mathematics. He further cited that in the late 1800s, it was used for the first time in mathematics education formally, the learners of mathematics and educators used concrete manipulative in those old days, but in the modern

classroom the use of pictorial and virtual manipulative is in practice for teaching of mathematics (Cope, 2015).

Bar Model is particular model which provides them well to the idea of equality. "In the subject of mathematics, bar model indicates to some extent long or short size stripe on which different scales are represented at the identical time, by the use of bar mode, a quantity of amount can be conveyed through a different quantity or amount". Three types of bar models are widely in practice: the first one in them is part-part-whole, the second type of bar model is comparing, and the third type of bar model is multiplication or division (Tanujaya, Prahmana & Mumu, 2017).

According to Azizah, Rohani and Mokhtar (2010) one of the important aspects of mathematics is word problem solving. It joins day to day and real life problems and applications.

The difficulties felt by the students in problem-solving can be easily tackled by the means of numerous activities and strategies. Of among those strategies is the use of bar model strategy, which is suitable enough for the learners to enhance their way of understanding, related to questions like word problem-solving. Bar model was introduced in Singapore Education. This strategy in teaching of mathematics is one of the visualization ways of learning. Problem-solving skills enable the learners of mathematics to be more independent in solving the problems (Vula & Kurshumlia, 2015).

Bar model strategy enable the learners to be more constructive their own knowledge. Bar Model strategy is a strategy that promotes understanding of the learners regarding problem-solving questions. Piaget's constructivist theory has a close relation with the strategy of bar model, which enable the school learners to build their personal knowledge by practice (Hofer, 2015).

The visualization happening the minds of the learners can be transported by the means of the bar model more effortlessly, simply, naturally and smoothly as compare to symbols (Fong Ng & Lee, 2009).

Clements and Sarama (2014) found that the learners were well able to express their thinking and overcome a much comfortable knowledge of equality, when they were provided a problem without symbolic contexts. Possibly the learners may show more improvement and they may enjoy the problem solving if bar model is used.

Statement of the Problem

Bar Model is an effective technique for students to acquire Math. Goal of the study is to practice this technique for primary level students, work

together to achieve the objectives of the learning subject. The study was intended at examining the effect of Bar Model Technique on the word problem solving skills of elementary level learners in the subject of mathematics.

Objectives

Research objectives were:

- To determine the effect of Bar Model Technique on students' mathematical word problem solving skills.
- To compare the academic achievements of male students and female students by using Bar Model Technique.

Hypotheses

The hypotheses were:

H₀₁ There is no significant difference between the mean score of control and experimental group in post-test.

H₀₂ There is no significant difference between the mean score of male students and female students of post-test control group

H₀₃ There is no significant difference between the mean score of male students and female students of post-test experimental group.

H₀₄ There is no significant effect of Bar Model Visualization Technique on student's mathematical word problem solving skills.

Method and Procedure

Population

All the students studying in Grade-V in all Government Primary Schools of Nowshera District were the population of the study.

Sample

Forty students of Grade-V of a Government Primary School Tehsil Pabbi District Nowshera were selected as sample of the study for the conduction of experiment. These forty students were separated in two different groups by paired random sampling technique. There were 15 male and 5 female students in each group.

Research Design

The research was experimental. Pretest-posttest equivalent group design was used to measure the effectiveness of treatment that involved two equivalent groups; the following was the symbolic representation of research design (Farooq & Tabassum, 2017).

$R_E = O_1$	T	O_2
$R_C = O_3$		O_4
$d R_E = O_2 - O_1$		
$d R_C = O_4 - O_3$		
$D = d R_E - d R_C$		

R_E = Experimental Group Selected Randomly

R_C = Control Group Selected Randomly

O_1 & O_3 = Observations of pretest

O_2 & O_4 = Observations of posttest

T = Treatment

d = difference between mean scores

Research Instrument

The instruments used for the collection of data are as follows:

A Pre-test was administered to evaluate the educational performance at the start of treatment. A post-test was directed to evaluate the educational performance of learners after the completion of treatment. Both tests were established on the basis of lesson plan objectives as well as study objectives.

Validity and Reliability

The research instrument for this study was further improved by the professional input of three experts in the field of Mathematics and Educational research. The research instrument was administered to twelve students of Grade-V for pilot study. Split half method was used to

determine reliability with the help of Karl Pearson's coefficient of correlation and Spearman's rank difference method. The values of reliability score for test were 0.87 which is high positive correlation. It shows that the test was reliable.

Treatment

Teacher developed lesson plans for delivering the lecture. Control group were taught with lecture demonstration method. While experimental group were taught with Bar model visualization technique which include book, chalk/marker, blackboard or whiteboard, flash cards and Bar models (developed from packing foam and drawing on charts).

Three chapters Numbers and Arithmetic Operations, Unitary Method and Fractions were taught to the Grade-V students by two different teachers, one teacher for control and other one for experimental group.

Procedure

The researcher for this research study developed sixteen sets of lesson plans from Grade-V Mathematics Text Book. Duration of the study was six weeks. Each class lasted thirty-five minutes in duration. The subject students were introduced to mathematical words question and teacher converted word problem into an internal depiction. During this stage actions were also taken to move to an external representation from the internal representation. For instance, a diagram was drawn by the teachers related to the elements of the problem on black/white board and also presented charts and models (made of packing foam/ clipboard). These diagrams were rectangular in shape. Different strategies (operations) were applied in order to achieve the desired numerical solution. Groups were formed and blocks were distributed among them. Different sizes of blocks (models) were used. Students practiced independently to solve words problem questions using bar models.

The Part Whole Method

Part Whole Method is also called as the 'part part whole' method. In this method, bar models are used for representation of the known and unknown quantities as parts of a whole. It helps the learners of mathematics to represent the very common 'missing number' problems. This can be done in two ways.

Data Collection

Pre-test was given to the sample student of the study in order to divide them into two equal groups based on their pre-test scores using paired random sampling technique. Three chapters were taught to the experimental group through experiential learning, whereas the control

group was taught using the traditional (lecture demonstration) method. The treatment was continued for a total of six weeks. The post-test was given after the six-week treatment to assess the effectiveness of the treatment. The data was collected by instructors (research assistants) using a test (posttest) which was delivered to the sample learners.

Data Analysis and Findings

For analyzing data mean, standard deviation and t-test were applied. The mean scores were used to determine the overall performance of the groups, and the t-test was used to measure whether there was significant difference between the groups of experimental and control.

H₀₁.

Table 1

Significance of difference between the mean score of control and experimental group in post-test

Group	N	Mean	SD	V	df	t-value	Effect
Control	20	23.05	3.60	12.99	38	4.084	Significant
Experimental	20	29.15	5.62	31.60			

Degree of freedom=38 Significance level = 0.05 Table Value =2.024

First table indicates calculated t-value was 4.084 which were significant at significance level (0.05) because t-value (4.084) is larger than table (critical) value (2.024), hence the null hypothesis rejected. It means there was significant difference between the mean score of post control group and post experimental group.

H₀₂.

Table 3

Significance of difference between the mean score of male students and female students of post-test control group

Group	N	Mean	SD	V	df	t-value	Effect
Male	15	23.73	3.63	13.20	9	1.701	Not Significant
Female	5	21	2.91	8.5			

Degree of freedom=9 Significance level = 0.05 Table Value =2.262

Second table shows calculated t-value was 1.701 which was not significant at significance level (0.05) because t-value (1.701) was less than table (critical) value (2.262); hence the null hypothesis was accepted. It depicts that after receiving traditional method of teaching mean scores of male and female learners of control group were at identical level and had no significance difference.

H₀₃.

Table 3

Significance of difference between the mean score of male students and female students of post-test experimental group

Group	N	Mean	SD	V	df	t-value	Effect
Male	15	27.33	4.60	21.23	6	2.812	Significant
Female	5	34.6	5.12	26.3			
Degree of freedom=6		Significance level = 0.05			Table Value =2.446		

Third table illustrate that calculated t-value 2.812 which was significant at significance level (0.05) because calculated t-value (2.812) was greater than table (critical) value (2.446); hence the null hypothesis was rejected. It shows that after receiving bar model method of teaching mean scores of male and female learners of experiment group was at different level and had significance difference.

H₀₄.

Table 4

Significance effect of Bar Model Visualization Technique on student's mathematical word problem solving skills

Group	N	Mean	SD	V	df	t-value	Effect
Pre-Experimental	20	22.9	3.14	9.88	19	5.375	Significant
Post-Experimental	20	29.15	5.62	31.60			
Degree of freedom=19		Significance level = 0.05			Table Value =2.093		

Fourth table depicts that calculated t-value 5.375 which were significant at significance level (0.05) because calculated t-value (5.375) was greater than table (critical) value (2.093); hence the null hypothesis was rejected.

This shows that there was significant outcome of Bar Model Technique on students' mathematical word problem solving skills.

Discussion

The present study was undertaken to analyze the effect of Bar Model Technique on mathematical word problem solving skills of Grade-V students in the subject of mathematics. The study objectives were (1) to determine the effect of Bar Model Visualization Technique on students' mathematical word problem solving skills, (2) to compare the academic achievements of male students and female students by using bar model technique. Forty students studying in primary school were taken randomly as sample of the study. Teacher made test that were developed for collection of data. For analyzing acquire data statistical techniques mean standard deviation and t-test was used. The study was significant for students, teachers, curriculum developers and future researchers.

On the basis of findings of post-test score, the t-value (4.084) reject the null-hypothesis, it illustrates that experimental learning of students' achievement is significantly improved than traditional learning and results of the study supported the findings of the studies reported by Rau (2017) that experiential learning had significant effect on the increasing students' conceptual knowledge and achievement.

On the basis of findings of post-test score, at t-value (1.701) the null-hypothesis was accepted, it shows there was no significance difference between the mean score of female and male students of post-test control group.

On the basis of findings of post-test score, at t-value (2.812) the null hypothesis was rejected, it depicts that there was significance difference between the mean score of female and male students of post-test experimental group.

On the basis of findings of pre-experimental and post-experimental score, the t-value (5.375) reject the null-hypothesis, it illustrates that there was significant outcome of Bar Model Visualization Technique on student's mathematical word problem solving skills. Osman et al. (2018) determine that bar model enriches learners' understanding about problem solving as it helps to visualize and solve it.

Conclusions

- It was concluded from the results that the lecture demonstration method of teaching had no effect on Mathematical word problem solving skills and the learner cannot take interest in the subject.
- The results of the study show that Bar Model Technique had significant effect on Mathematical word problem solving skills and also the learner take interest in the subject.
- It was concluded that the current traditional methods of teaching were neither according to the needs of our society nor according to the needs of the learners.
- It was also concluded that with visualization technique the learners had better understanding of word problem question and they participate in the activities.
- In the comparison of boys and girls both performed same. Though after treatment the girls had performed better than the boys.

Recommendations

- It was concluded from the results that the traditional way of teaching has no effect on Mathematical word problem solving skills and the learner cannot take interest in the subject. Hence it is recommended that teachers should stop traditional methods to teach mathematics and government should arrange teacher training with visualization technique.
- The results of the study show that Bar Model Technique has significant effect on Mathematical word problem solving skills and also the take interest in the subject. Hence it is recommended that government should introduce the Bar Model Visualization Technique in the textbook of Mathematics.
- It was also concluded that with visualization technique the learners have better understanding of word problem question and they participate in the activities. Hence it is recommended that teachers should use visualization technique in Mathematics as well as in Science for better understanding of problem and teacher should motivate the learner to participate in the activities.
- In the comparison of boys and girls both performed same. Though after treatment the girls have performed better than the boys. However, it is recommended that the Bar Model Technique should be used for both male students and female students.

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