HAND'S ON MIND'S ON APPROACH USING LOCALIZED MANIPULATIVE ENHANCED STUDENTS' ACHIEVEMENT IN MATHEMATICS WORD PROBLEMS

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ABSTRACT: *The study used a pretest-posttest quasi-experimental design. The experimental group was exposed to the hand's on and mind's on activities using indigenous materials available in the locality. The students were required to create a concrete representation of the word problem that showed the correct answer before solving it algebraically. The control group was required to solve the same word problem directly using the algebraic expression. Questions in pretest and posttest were all word problems. The data were analyzed using mean, standard deviation and ANCOVA. The analysis of the data revealed that there was a significant difference in the achievement scores of the students in math word problem in favor of the students in the experimental group. The researcher concluded that hand's on the mind's on activity in solving math word problems enhanced students critical thinking which yielded to higher achievement*.

Keywords: hand's on the mind's on, localized manipulative, achievement, junior mathematics

1. INTRODUCTION

Learning mathematics in the 21st century must have to develop a skill necessary for the learners to cope with the challenges in life [1]. Musasia, *et. al.* [2], stated that mastery of mathematical skills such as problem-solving skills and critical thinking skills are topmost required to face such challenges especially in the recent era of technology. However, the mathematics achievement level of the junior high students as reported in the national and international exams such as TIMSS [3] Trends in Mathematics and Science Survey and the National Achievement Test NAT [4] remained very low. In addition, at the school level, the mathematics achievement test of the students was revealed to be very low as transpired in the posttest given at the end of the school year. The result may be attributed to many factors that affect the learning of the students. Dewey [5], theorized that students learn best through direct personal experiences which may bring them to remember the lessons and make them learn. This theory was supported by the proverbs I see then I remember, I heard then I forgot, I do then I understand. Making the students involved in hands-on activities may fully develop his cognitive skills particularly in mathematics. Also, the theory of Zone of Proximal Development (ZPD) by Vygotsky [6] theorized that interaction with skillful peers is an effective way of developing mental skills. The theory encourages cooperative learning exercises to improved the less competent students within the zone of proximal development with the help of the skillful peers. Agot [7] claimed that the use of manipulatives in teaching mathematics was effective and contributed to a higher achievement level. Mamaclay [8], revealed that Math trail and hands-on activity improved the performance and retention rate of the students. The study of Hunt, et.al. [9], Bouck, *et. al*. [10] reported that virtual manipulative enhanced mathematics achievement. It was supported by Liggett [11], Larbi and Mavis [12], who used concrete manipulative in their study and revealed the same findings. Furthermore, Pullen, [13], used manipulative in teaching mathematics and reported that the use of manipulative was effective in facilitating learning and it improved the academic performance of the students in mathematics. Satsangi, et.al. [14], compared the effectiveness of virtual and concrete manipulative in teaching algebra to the students with disabilities. The researchers revealed that in a duration of 30 sessions of intervention, three students exhibited over 90% average accuracy in solving problems using both virtual and concrete manipulatives. Further, it was reported that 67% of the students who used the concrete manipulative earned higher scores. Uribel [15], examined the relationship between elementary students' (K-5) manipulative use and mathematics learning. Using longitudinal analysis, a positive relationship between manipulative use and student mathematics learning during their elementary school years was found. Moyer et.al .[16] conducted a quasi-experimental study in using manipulatives for teaching fraction and revealed that there was an equalizing effect on achievement in third and fourth-grade classrooms. The claimed of the mentioned study was supported by Carbonneau et.al. [17], Moyer, and Westenskow [18], who conducted a meta-analysis on the effect of using manipulative and reported that there were a statistically significant results identified with small to moderate effect sizes as measured by Cohen's "d", in favor of the use of manipulative. Further, Holmes [19], conducted a meta-analysis on the effects of manipulative use on PK-12 mathematics achievement using the studies between 1989- 2012 with a total of 856 reports. Results from the review revealed that student achievement in grades PK-12 was improved through the use of mathematics manipulatives. In view of their revelations, the researcher realizes that manipulative may play a big role in the learning process of the students to concretize abstract mathematics concepts. On the other hand, the study of Sepang and Madzorera [20], revealed that learners had the difficulty of writing a mathematical statement into an algebraic expression. An algebraic expression is necessary for solving math word problems. Solving mathematics word problems needs reading
fluency and comprehension. The situation calls for a teaching innovation that can enhance students ability to make a concrete representation of the mathematics word problems and be able to write an algebraic expression which leads to the solution of the problem. Upon the making of the concrete representation of the mathematics word problem, students will have actual manipulation of the materials, sharing of ideas with the group and thinking about the possibility of the answers. In other words, a hands-on and minds on activities is necessary. Thus researcher introduced hand's on and mind's on activity

using indigenous materials available in the locality. The local materials served as manipulative when the students make concrete representations of the word problems. Researcher aims to verify whether the approach can augment the achievement score of the students in solving a mathematics word problem.

2. METHODOLOGY

2.1 Data Gathering and statistical treatment

Two intact classes from grade 8 regular sections were randomly chosen as experimental and control groups. Pretest and posttest were given to both groups using the teacher made test with a reliability 0.68 using KR 21. The teacher made test covered the topic on solving a word problems in age, coin, work, mixture and motion problems. There were 10-word problems given with 5 points each a total of 50 points. Rubrics such as 1 as lowest, 2,3,4 was given to partially solved item depending on the progress of the solutions and 5 as a perfect score. The scores in the pretest and posttest were gathered and analyzed using mean, standard deviation and ANCOVA to determine if there is a significant difference on the achievement scores of the students as they exposed to the two methods of teaching.

2.2 Approaches of control and experimental group

The experimental group was required to bring any available materials that can be used in counting such as pebbles, coconut sticks, bamboo sticks or etc. The materials served as manipulative to be used in making a representation of the word problems in mathematics. The activities were done by the group and then by individual. The control group was exposed to traditional methods wherein students were given assignments, board and set works activities. Activities to both control and experimental groups were all word problems. Students in the control group solved the problems directly using algebraic expression while the students in the experimental group solved the problem by representation using the manipulative first then algebraic expression.

2.3 Making representation of the word problem using localized manipulative

In making representation for age, coin and numbers problem, students used pebbles or any materials as many as the absolute value of the largest number stated in the problem if available. The materials are grouped in accordance with the conditions given in the problem. For example, if the problem is "The age of Ana and Eva differs by 8. Three times Ana's age increased by Eva's age will give 32. If Eva is older than Ana, what are their present ages?". The total number of pebbles to be used for the representation is 32. So, grouping the pebbles following the condition given in the problem is illustrated in the table as follows:

Eva's Age	One column of pebbles represents Ana's age			Sum
00000-000	Ana is not yet born so zero			8
0	0	0	0	4
0	0	0	0	4
0	0	0	0	4
0	0	0	0	4
0	0	0	0	4
0	0	0	0	4
Eva is 14 yr. old	Ana is 6 years old			32

In the second row, Eva has 8 pebbles while Ana has no pebble because the problem stated that Eva is 8 years older than Ana. In the third row, one pebble is added for Eva and for Ana, however, there are three columns for Ana because the problem stated that "three times Ana's age". Continue adding until the 32 pebbles are consumed resulted to the age of Eva is 14-year-old while for Ana is 6 years old.

In cases where the largest number is not stated in the problem, representation will be directly made by grouping the materials following the conditions of the problem.

3. RESULTS AND DISCUSSION

Table 1. Mean and Standard Deviation of students' Mathematics Achievement Test Results

	Experimental group		Control group	
	Pretest	Posttest	Pretest	Posttest
Mean	10.13	37.15	10.71	31.10
Sd	2.87	5.14	3.09	3.9
N	55		41	

Table 1 showed the mean and standard deviation of the control and experimental groups. In protest, the data showed a minimal difference in mean scores in favor of the control group. The result implied that both groups had little background knowledge in solving a mathematics word problem. However, in the posttest, the result was changed. Both groups had an increase in their scores in favor of the experimental group. The result revealed that both groups learned how to solve mathematical word problems after the treatment, but students who were exposed to indigenous manipulative gained more in solving a mathematics word problem. It can be inferred that when the students are exposed to hands-on manipulation of the object, the conceptual understanding and critical thinking of the students are developed. The result in the experimental group supports the claimed of Mamaclay[8], Agot [7], Pullen, L. [13] , Hunt, A., Nipper, K,Nash, L. [9], Bouck, E.; Flanagan, S ; Bouck, M. [10], Larbi, E.,Mavis, O. [12] , Liggett, R.[11].It was also observed that students were able to give the correct answer using only the manipulative representation. Further, students had a difficulty of writing the correct algebraic expressions of the problem, thus arriving at an incorrect answer. As to the variability of the achievement scores, the data revealed that the scores of the control group were more spread compared to that of the experimental group in the pretest. However, after the treatment, the result was reversed. It revealed that while the other students in the experimental group scored higher, the others remained very low probably because of their low comprehension in the English language. To verify whether there is a significant difference in the achievement scores of the students in both groups, further analysis was done by using ANCOVA.

Table 2. Analysis of Covariance (ANCOVA) of the Student's Achievement Test Scores

Source of variation	Df	SS"	MS'	F-ratio
Treatment	1	1027.9	1027.9	4.86*
Error Within	93	1967.47	211.52	
Total	94	20699.37		

Table 2 shows the result of analysis of covariance on the achievement scores of the students in mathematics problem-solving. The analysis yielded an F-ratio of 4.86 which was greater than the critical value of 4.0 at 0.05 level of significance. It means that there was a significant difference of the achievement scores of the students in problem-solving taught with hand's on the minds on using a representation of localized manipulative than those taught in chalk and talk method in the control group. The result revealed that solving a word problems in mathematics using a concrete localized manipulative had a positive impact on the achievement scores of the students. This led the researcher not to accept the null hypothesis. The researcher claimed that hand's on the minds on the representation of a word problem in mathematics using localized manipulative enhances the students' skill in solving word problems which yielded to higher achievement.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, the researcher concluded that hand's on the mind's on approach using localized manipulative in solving a word problem in mathematics enhanced students achievement. Also, the researcher recommends the strategy to be used by mathematics teachers to augment the scores of the students in problem-solving and it is also no cost and hassle-free. Also, future researchers are encouraged to conduct a similar study with a wider scope.

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