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A Comparative Study of "Conventional," "Beads" and "Running Plot" Media Methods for Addition and Subtraction Education

Goenawan Roebyanto
Department of Primary School and Pre-School Education, Universitas Negeri Malang, Indonesia
Email: goenawan.roebyanto.fip@um.ac.id

This study aims to examine significant differences among various learning methods: (a) conventional, (b) the use of "beads" media, and (c) the use of "running plot" media. H_0 in this study suggests that through the use of these methods, no significant difference exists in the average class achievement towards the addition and subtraction of integers learning at the Elementary School of Bunulrejo 2, Malang City. The results of this study reject this initial hypothesis and rather support H_a, which states that a significant difference does exist in the average class achievement of integer addition and subtraction among the three teaching methods of beads, conventional and running plots at SDN Bunulrejo 2, Malang City.

Keyword: *Comparative study, different methods, elementary school*

1. INTRODUCTION

Improving mathematical skills of learners in Indonesia is a key component of education and should be initiated from elementary school through competent and effective teaching (Fitria, 2017). Elementary schools require educators who possess important teaching characteristics within today's society, including digital media literacy, critical skills, social awareness, an understanding of identity, and the ability to collaborate and communicate with others in a variety of contexts (Hutajulu & E.J.R, 2016). Such characteristics are outlined by the recent Indonesian Elementary school curriculum (Perdana, Zainuddin, & Yuniawatika, 2018). One of the stages is prepared through Elementary School Teacher Education, which is able to design futuristic learning that can facilitate students in creativity, critical thinking, problem solving and collaborative skills (Hawa & Yosef, 2019).

Integer addition and subtraction operations are vital to elementary education as students are often faced with problems, both at school and in everyday life, that require adequate knowledge and use of positive and negative numbers (Murti, 2018). A study conducted on an Elementary School in Malang found that many students were confused about the use of negative numbers, particularly those in the fifth grade (Wati & Supriyadi, 2017).

Current and future mathematical learning should not cease at the achievement of basic skills, but must rather be designed to continue into mastering high level mathematical competencies. One potential method of increasing these skills is through the development of students' creative abilities (Rijal, 2017). This new perspective poses challenges which must support and encourage mathematics learning for optimal competency among students. The learning model must be able to provide the widest possible space for students to build knowledge and experience ranging from basic skills to high level tasks in order to foster creativity and lateral thinking. As real world problems are generally not simple or convergent, but rather complex, divergent and even unexpected, this approach is highly relevant and potentially effective for today's learners (Rudyanto, 2016).

Mathematics is a universal science that underlies the development of modern technology and has an important role in various disciplines and advancements in human thinking (Kholiyanti, 2018). Mathematics is developing rapidly in the field of information and communication technology, data which is delivered in mathematical language through diagrams, tables and graphs (Yuliati, Siregar, & Sari, 2017). Mathematics is a science that deals with abstract forms or structures and examines the relationships between them. To understand structures and relationships, an understanding of the concepts of mathematics is therefore required (Windayana, 2016).

Elementary school-age children thrive in play activities, a fact which should be seen as an advantage to be explored in the process of learning mathematics. This exploration process aims to place mathematics into students' life experiences (Pangestu & Santi, 2016). In this way, children will learn mathematics in enjoyable and meaningful ways. Learning is said to

be meaningful if a new mathematical concept and its learning process are associated with a pre-existing structure of understanding known by the student (Yuniarti, 2016).

Children enjoy and engage in play before and when beginning formal school. The most dominant play activities occur when children are at home, for example playing games, compiling puzzles and exercising (Syamsi, 2014). Upon entering school, children therefore have experiences that are not recognised as informal mathematical concepts (Sari & Jusar, 2016). To support the development of mathematical concepts through the use of play activities requires quality teacher involvement at several levels (Shaari, Effendi, & Mohd, 2019). Teacher involvement starts from the planning phase and continues directly into the game, and encompasses the provision of required resources to stimulate learning opportunities (Bito, 2016).

The choice of a learning approach should consider the quality of learning provided, including aspects like student involvement in the learning process, the relationship between teachers and students and the learning environment. Determining the most effective learning process should strengthen these factors as well as the students' developing cognitive, affective and psychomotor skills (Bahari, 2018). The learning and training process should support, encourage and maintain the achievement of objectives through appropriate instruction and environment to make it easy for people to learn (Rahmi, 2015; Aulia & Handayani, 2018). The meaning of learning is more or less the same as instructional techniques or methods, but also refers to the teacher's instructions about subject matter knowledge, the ability to interpret student responses, and other personal competencies (Sutresna, 2015).

Through observing characteristics of students at primary school age, one of which is a strong desire to play, teachers can determine the most appropriate learning approaches to overcome potential learning obstacles (Safitri & Misyanto, 2019). Further, play activities create positive atmospheres in which students can better accept and understand content (Windayana, 2016). It is therefore important for teachers to maintain such an atmosphere in the classroom to produce optimal student learning of all skills and ideas (Kaharuddin, 2018). One such method to promote this idea of play activities and positive classroom environments is to adapt and modify learning games to suit the individual development of students (Farida, 2018).

Based on the 2013 elementary school curriculum, the purpose of learning mathematics is to develop critical numeracy knowledge and skills for students through mathematical activities (Al Faris, 2016). Mathematics is essentially an abstract science and remains a "spectre" for most students. This poses difficulties for elementary school teachers, particularly those of mathematics, in selecting the right strategies, models and learning techniques for optimal understanding of, and engagement in, important mathematical material (Nasrul, 2018).

Mathematics teachers are specified in this study in accordance with the mathematics learning guidebook and Sport education, which stated in 2017 that subjects can be separated from the

traditionally integrated thematic learning of elementary schools. This enables teachers to concentrate on specialised fields and thus provide students with more detailed and comprehensive subject matter. Students at the Elementary School of Bunul Rejo 2 were found to experience boredom due to learning from teachers who were more doctrine of knowledge or who only explained the concepts on the blackboard and ended with question work. The students seemed to pay less attention to the teachers' explanations, which caused increases in classroom noise and playing with peers rather than focusing on the lesson. Teachers were therefore forced to repeat explanations to convey understanding. Media used by teachers during such explanations also consisted of only a blackboard and ruler, and students were not provided with opportunities to explore other types of potentially useful media. Students at elementary school develop their knowledge at concrete operational stages, meaning that understanding a mathematical concept is largely based on the manipulation of concrete objects.

Based on interviews conducted with teachers in classes 5A, 5B and 5C, mathematics learning activities have proceeded as usual with ordinary media. The media used by teachers are limited to blackboards, pictures, pre-exiting media already used by students and ordinary classroom objects like books and pencils. Most teachers, however, only use the blackboard in their teaching methods. When instructing the addition and subtraction operations of integers, for example, the teachers explain these concepts using a number line image and students simply pay attention to the explanation. Teachers experience difficulty in finding suitable media on addition and subtraction operations of integers, which hinders students' understanding of the topic and decreases their ability to apply the concept of "negative numbers" to a story matter situation. Such situations might include calculating and evaluating temperatures below 0 (zero) degrees, altitude below sea level and dealing with "debt".

An integer is a combination of whole numbers, namely 0, 1, 2, 3, with numbers -1, -2, -3, -4, (versus natural numbers). Integers are therefore -4, -3, -2, -1, 0, 1, 2, 3, 4 and so on. Positive integers are 1, 2, 3, 4, whereas negative integers are -4, -3, -2, -1. Lastly, zero (0) integers are neutral numbers, referring to those that are neither positive nor negative (Kholiyanti, 2018). The order between negative, zero, and positive integers can be presented as follow: -4 , -3 , -2 , -1 , 0 , 1 , 2 , 3 , 4 etc.

Reading integers consists of certain rules, for example the integer -4 must be read as negative four rather than minus four. Within calculation operations of reduction, however, students are instructed to read the sum of 7 - 5 as seven minus five, and the sum -7 - (-)5 as negative seven minus negative five. The reading of positive integers does not require the use of the word positive and such integers are not marked by a (+) sign, meaning that the positive integer of nine is simply called nine. The (+) sign is rather used to declare the operation of addition within a sum. Examples of how to read such addition operations are: a) 5 + (-9), which reads as five plus negative nine, and b) (-5) + (-9), which reads as negative five plus negative nine. Every positive integer will have an opponent, and the opposite of a positive

integer is a negative integer. Similarly, the negative integer has the opponent of a positive integer. The opponent of a number has an opposite sign, for example -3 (negative three) has the opponent of 3 (positive three) and vice-versa (Ningrum & Leonard, 2015). The appropriate learning of such addition and subtraction of integers for elementary students therefore requires effectivemedia and teaching aids to convey their complex pictorial nature and reading rules (Arief, 2012).

Learning media for education classifies experiences according to the media level, ranging from the most concrete to the abstract. This classification is known as the Cone of Experience (V.K. Maheshwari, 2016), and is depicted in Figure 1 below.

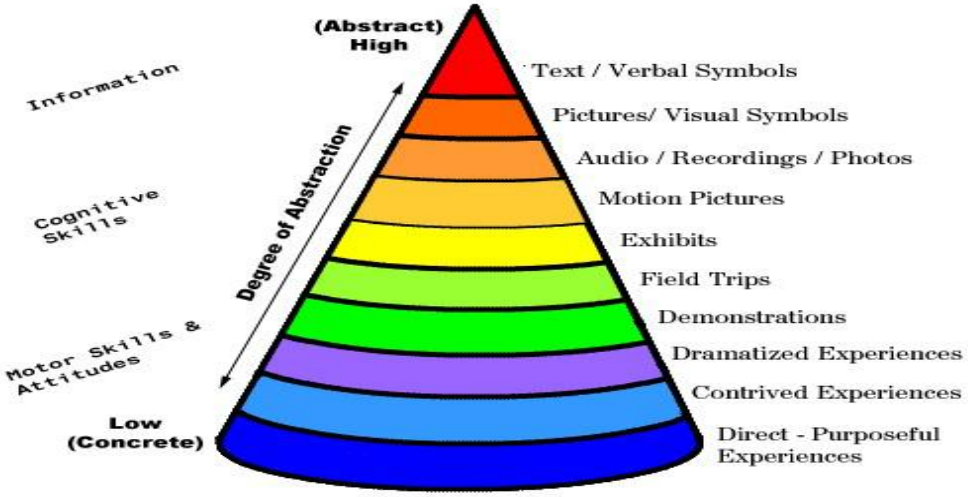


Figure 1: *Pyramid of Experience*

Learning by using "running plot" media and "beads" media in this study belongs to direct pruposeful experience (Nurulanjani, 2018). Direct purposeful experience is the active participation in an activity wherein students relate directly to the object being studied (Yuniarti, 2016). In the case of this study, the object to be studied is integers. Students in the class will be formed into groups of 4-5, with each group receiving a media to run. It is hypothesised that learning media functions as a teaching tool to generate students' interest, to provide effective learning experiences to students, and to present a message that is not verbally complex or reliant on written or oral language (Sadiman, 2010). This study will show "running plot" (Figure 2) and "beads" media (Figure 3):

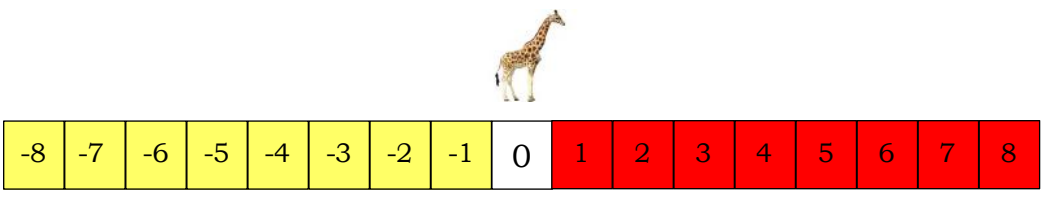


Figure 2: *Running plot*

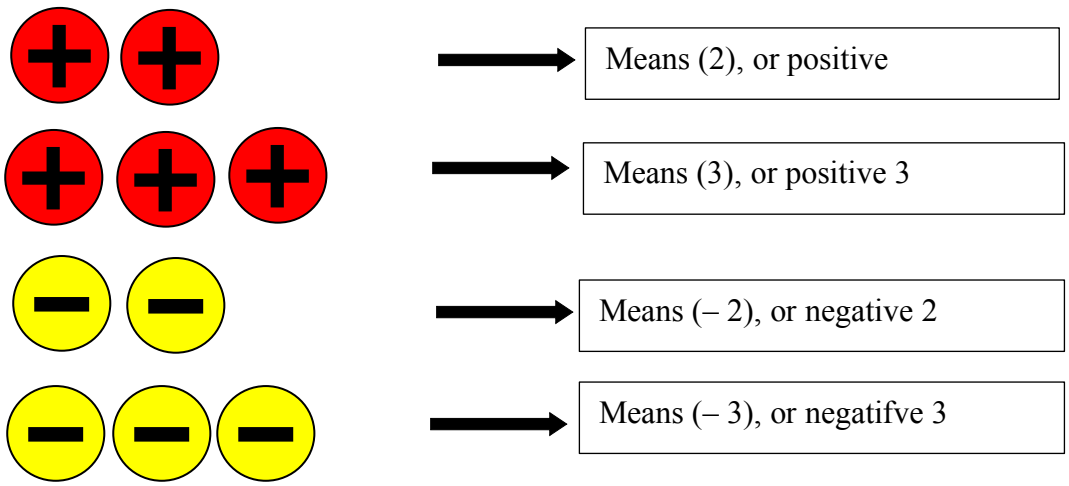


Figure 3: *Beads*

2. METHOD

This study uses a quasi-experimental research method which does not allow researchers to fully control variable or experimental conditions. The study design therefore involved experimental class 1 and experimental class 2. Both classes received the same treatment in terms of goals and subject matter, but each used differed media tools in teaching and learning methods. Class 5B was treated as a control class and delivered conventional learning and teaching techniques. To determine students' initial abilities, the value of the initial test (*pre-test*) is used regarding integer operations material. Following the delivery of each respective lesson, the post-test was administered to students to determine the final results of the two experimental classes. The researcher then compared these scores to the averages (*Gain score)*.

Prior to implementation, the instrument to be used in the study was subjected to evaluation to test validity and reliability levels. This testing was performed using the Product Moment and Alpha formulas (Arikunto, 2010).

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X^2)\}\{N \sum Y^2 - (\sum Y^2)\}}}$$

$$r_{11} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \sigma_b{}^2}{\sigma^2 t}\right)$$

Data gathered from the learning outcomes of this study were statistically analysed and consisted of the pre-test and post-test values. The data used to test the previous hypothesis must also be tested for analysis prerequisites. This testing determines whether the data

obtained is normally distributed, the variance is homogeneous and the same abilities are produced. Hypothesis testing is performed by statistical analysis through testing the null hypothesis (H_0).

3. RESULTS

Data in the form of mixed counting operation values taught in Semester 1 for the initial test from 3 groups, namely classes 5A, 5B, and 5C, tested normality using SPSS 20 for Windows (Priyatno, 2008). The results of these calculations are presented in Table 1:

Table 1: One-sample Kolmogorov-Smirnov test

		Pre-test
N		95
Normal Parameters[a,b]	Mean	8.14
	Std. Deviation	4.304
Most Extreme Differences	Absolute	.073
	Positive	.067
	Negative	-.073
Kolmogorov-Smirnov Z		.715
Asymp. Sig. (2-tailed)		.686

a. Test distribution is normal.
b. Calculated from data.

The normality test using the Kolmogorof-Smirnov method shows an Asymp. Sig. (2-tailed) value of 0.686. As this value is more than 0.05, it can be confirmed that the data is normally distributed.

Following the normality test, the data was subjected to a homogeneity check, the results of which are presented in Table 2 below. The significance level produced a value of 0.179, which is greater than the required value of 0.05. This confirms that the subject of this study has a homogeneous variance, which allows analysis to proceed to the next stage.

Table 2: Test of homogeneity of variances

Achievement

Levene Statistic	df1	df2	Sig.
1.755	2	92	.179

Pre-test data collection began on Monday, 27th August 2018 at 7:30am and involved a total of 95 students. Class 5A consisted of 35 students, and both 5B and 5C consisted of 30 students each. While 96 students were initially totalled, one student was absent from testing due to illness, producing the resultant 95-student total. Giving pre-test questions to students,

researchers were assisted with 3 graduate technicians from Elementary School Teacher Education and 3 classroom teachers in each class. 35 minutes were allocated to pre-testing, which is a similar timeframe to one lesson.

The second day of the study's implementation was held on Tuesday, 28th August 2018. Class 5A, comprising 35 students, was assigned the method of "beads" learning for 1-2 hours; Class 5B, comprising 30 students, used the "conventional" method for 3-4 hours, and lastly, 5C, also comprising 30 students, practiced the "running plot" method for 5-6 hours. Photos of each class using their respective methods are provided below, which depict the varying atmospheres and engagement elicited through each media form.

Figure 4: *Class 5A students use the "beads" method.*

Figure 5: *Class 5B students use the "conventional" method.*

Figure 6: *Class 5C students use the "running plots" method.*

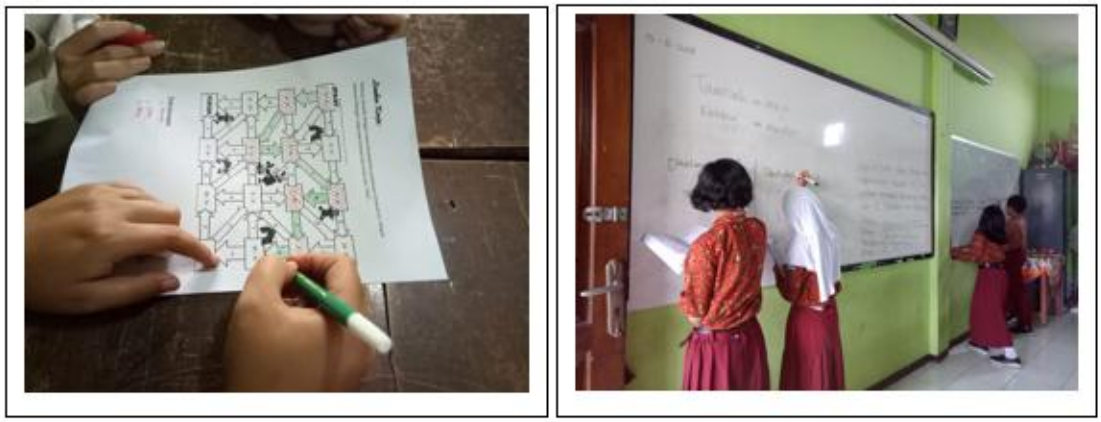


Figure 7: *Student activity when completing worksheets (LK) and answering questions.*

Post-test data collection began on Wednesday, 29th August 2018, using the "beads" media on each experimental group. Class 5A was tested first for 1-2 hours, followed by class 5B for 3-4 hours and lastly 5C for 5-6 hours. Table 3 depicts the descriptive data gathered from the post-test.

Table 3: Descriptive

Achievement

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Method of using beads	35	10.46	3.062	.517	9.41	11.51	6	18
Conventional method	30	4.00	2.586	.472	3.03	4.97	1	10
Method of running plots	30	9.60	4.031	.736	8.09	11.11	1	19
Total	95	8.15	4.315	.443	7.27	9.03	1	19

As seen in the data from Table 3 above, the average achievement in the conventional method group was 4.00, while the group that was administered the "beads" method produced the highest average of 10.46. Further analysis will investigate whether the average difference between these groups is significant. Results of the average difference based on the analysis of variance can be seen in Table 4 below.

Table 4: Analysis of variance (ANOVA)

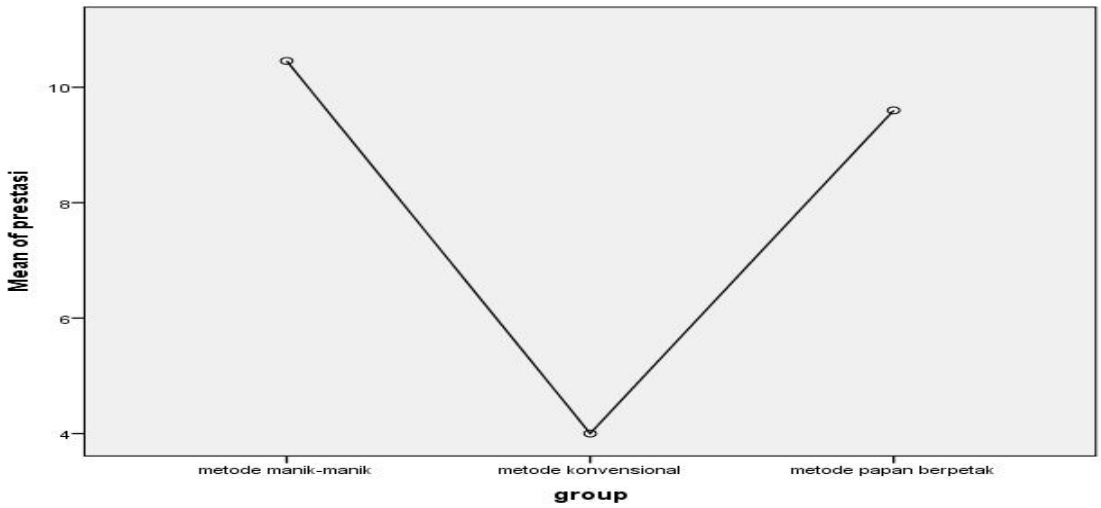
Achievement

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	766.051	2	383.026	35.815	.000
Within Groups	983.886	92	10.694		
Total	1749.937	94			

Table 4 above shows a P value of 0.00, which is below the required level of 0.05. This data rejects H_0 and suggests that there are in fact significant differences among the three groups. Due to the rejection of H_0, the next analysis involves further testing with a post-hoc test to determine which groups have significant differences. Results of the post-hoc test

indicate that the group given the "beads" and "running plot" methods did not produce a significant difference from each other. The "conventional" method produced a lower average, however, suggesting that a significant difference exists between this group and the other two experimental groups. This data is depicted in Figure 8 below.

Figure 8: *A comparison between the "Manik-manik Method", the "Conventional Method", and the "Papan Berpetak Method".*



4. DISCUSSION

A. The implementation the "conventional" method for integer addition and subtraction in class 5B.

The learning process carried out on Tuesday, 28th August 2018 in Class 5B went smoothly and was supported by the revised lesson plan. Teaching staff oriented to the 2013 curriculum which was revised in 2017. While all steps in the learning activities conducted using the "conventional" method were carried out well in this class, the implementation of the learning plan was found to be incompatible with time allocation. This occurred due to students having to ask questions more often and teachers having to move on with their explanations to adhere to time restrictions, which hindered student understanding. Students in this instance were considered as "robots" ready to receive orders from the teacher, and knowledge about integer addition and subtraction operations were deemed to be doctrine to the students.

B. The implementation of the "beads" method for integer addition and subtraction in class 5A.

The learning process carried out on Tuesday, 28th August 28 2018 in Class 5A went smoothly and was also supported by lesson plan implementation and teaching staff who adhered to the curriculum. Students of Class 5A were introduced to the new media of "beads" for mathematical learning. The beads were to be added for addition operations and removed for subtraction operations. From these learning activities, all steps in the "beads" media method were carried out effectively, although the implementation of the learning plan also found to be incompatible with time allocation.

Students in Class 5A were in a concrete operational period, which refers to logic based on the physical manipulation of concrete objects. In order to understand the concept, students were required to handle and play with the objects, which in this instance were beads. This process can be termed as learning by playing, which appeals to child enjoyment and innate sense of play while teaching important skills. The "beads" media used in Class 5A therefore assisted students in understanding and performing integer addition and subtraction.

Student engagement was evident when the "beads" media was introduced. After being distributed, each small group within the class counted the beads they had received. Students also distributed the media to all group members fairly, with each student handling the beads slightly differently. Some students arranged their beads into a long line, some stacked the beads into a building and some played carom. These actions describe the students' initial and spontaneous reactions upon accepting the new items, which can be viewed as creative handling or play.

After sharing the media, the teacher built the concept of using the "beads" media for educational purposes. Then students attempted to use the media correctly by listening to the teacher's instruction, marking the teacher as the lesson facilitator. Students were initially confused by the complex use of the "beads" media, though were eventually able to utilise

them in addition, entertainment and mixed counting operations with enthusiasm. This finding supports Sadiman (2010:17), who states that using various and appropriate learning media can solve the problem of passive students.

During the discussion activities, one group of students continued playing with the "beads" media. The teacher reprimanded this group, stating that if the they were continue to play, the media would be taken. The group finally obeyed the teacher's order to run the media according to its intended use.

Through the use of the "beads" media, students were also encouraged to learn from friends as well as the teacher. Problems that arose during counting lead students to ask the friend next to them for assistance in finding the right answer. By using this media, students were drilled to find the concepts of addition in integers and drew their own conclusions with the help of both teacher and peers. This was evidence when students were asked what happens when positive numbers are subtracted from negative numbers, to which they answered that the result would be positive.

The teacher then guided students to work on problems that symbolised numbers above 20 and to work in commutative methods both individually and in groups. If a student's answer was incorrect when writing on the board or at the time of individual work, the role of the teacher was to correct and explain such a response.

Students in 5A and 5B might make the same mistakes in answering questions through commutative methods, such as changing the form of addition to subtraction or vice-versa. Though the process was performed correctly, the results were processed incorrectly in addition, subtraction and mixed operations.

In the group work discussion activities, each group wanted to participate first and seemed unafraid of giving incorrect answers. Even in difficult commutative problems, many students were willing to offer answers. Here the teacher always provided equal opportunities to each student and awarded praise to students who answered correctly. Similarly, the teacher provided opportunities for other students to solve the problem if a given answer was initially incorrect.

The teacher also appointed active students to come forward to work on the questions commutatively. During the LKK discussion and in the discussion of individually-completed questions, some students were very noisy. They tended to talk with their peers while not paying attention to their friends. The roles of the teacher and observer here were to discipline students and to foster respect for their friends.

C. The implementation of the "running plot" method for integer addition and subtraction in class 5C.

Class 5C students were also learning in a concrete operational period as their thinking was based on the physical manipulation of concrete objects (AD, 2018). This makes it easier for students to understand and accept a concept as it requires the active manipulation of, and playing with, concrete objects (Bauer, 1973). As with the "beads" media, learning by using "running plot" media belongs to direct purposeful experience and is a concept within the aforementioned cone of Edgar Dale (V.K. Maheshwari, 2016). The "running plot" media is a game involving pawns, which students manipulated using their hands and learned while playing. During these learning activities, the teacher attempted to create an optimal learning environment for students through offering opportunties to use and think about the "running plot" media. Acting again as the facilitator, the teacher successfully provided learning resources to students during this lesson.

Students were initially silent upon the first attempt, but following an example demonstration by the teacher focused on addition, students could use the media for subtraction operations. Students shared the "running plot" in groups and received directions from their teacher to enable the correct use of the media.

As with the "beads" media, students in class 5C learned from their friends as well as their teacher. When experiencing difficulties with solving problems, students assisted each other to find the correct answer. By using the "running plot" media, students were trained to find the concept of addition and subtraction of integers.

The teacher then guided students to work on problems that symbolised numbers above 20 and to use commutative methods both individually and in groups. Incorrect answers were also directed by the teacher to provide students with the right solutions.

In contrast to the pevious class using "beads" media, many students in Class 5C were shy to offer answers, to solve questions on the board and to participate in the discussion. If not called on by the teacher, many sat passively in their seats. Despite this, some students in the class displayed positive and willing participation without being appointed by the teacher. The teacher's job here is to provide equal opportunities for each student to progress in the assignment.

Several inhibiting factors existed in the implementation of the "running plot" media, particularly the noise levels during discussions, activities and when students worked on the board in front of the class. During these instances, students tended to talk with their peers and did not pay attention to their friends. Many students were also less active and seemed to lack confidence when instructed to write answers on the board.

D. Significant differences between classes 5A, 5B and 5C.

The analysis of this study's student learning outcomes based on Table 4.6 indicate no significant difference between experimental classes 1 and 2, each of which used the "beads" media and the "running plot" media respectively. The average experimental class for Treatment 1 ("beads") was 10.46 and the average experimental class for Treatment 2 ("running plot") was 9.60.

The class which was provided with the "conventional" method, however, produced a singificantly lower achievement of 4.00, as seen in Table 5. This confirms a significant difference between learning outcomes taught through "conventional" methods and those using the newly introduced media. The study therefore shows that elementary students need media, especially in the form of props or objects like the "beads" and "running plot", to effectively learn mathematical concepts.

The results of this study are in accordance with Piaget's learning theory. To understand the mathematical concept of addition and subtraction of integers, students need to manipulate relevant concrete objects as a form of direct purposeful experience.

5. CONCLUSION

Based on the results and the discussion, this study concludes that:

1. While the implementation of "conventional" methods in class 5B for teaching addition and subtraction of integers ran smoothly, the statistical calculations from this group produced the lowest achievement.
2. The implementation of the "beads" media in class 5A for addition and subtraction of integers also ran smoothly and produced the highest student learning outcomes. Several inhibiting factors presented themselves during this learning process, however; students seemed initially confused when using the media during subtraction operations, though were able to understand the concept after engaging in further dialogue with the teacher.
3. The implementation of the "running plot" media in class 5C also ran smoothly, though some students who play its pawns, because the researchers use animal toys as the pawns. Learning achievement in this class increased quite well, though was still inferior to the use of the "beads" media. Results gained from the research conducted on the 27th, 28th and 29th August 2018 indicate that learning goals were successfully achieved. This conclusion is drawn from the increased value of learning achievements from pre-tests to post-tests conducted among students, ranging from "conventional", "beads" and "running plots" in the order of 4.00, 10.46 and 9.60 respectively.

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