Manipulative Media Technology for Addition and Subtraction of Integers in Elementary Schools

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Abstract. The purpose of this study was to produce manipulative media to understand the concept of addition and subtraction of integers in grade VI students. This research method refers to Borg and Gall’s theory in ten research steps including information gathering, research planning, initial product development, initial field trials, revision of trial results, main product field testing, revision of field product test results, large-scale field trials, final product revision. Data collection techniques were carried out through observation, interviews, and questionnaires. Data analysis used qualitative and quantitative analysis techniques including learning observations, and validation of manipulative media products. Sources of data in this study were teachers and students of grade VI SDN Sumbangrejo and SDN Segoromulyo. The results of this development research indicate that the media developed in the form of manipulative media made of wood can be said to be suitable for use in learning. Based on the validation from the expert, it was noted that the product was in the good category with an average score of 87%. whereas from the results of student responses the average percentage of responses to the media reached 90%. So that learning integers about addition and subtraction with manipulative media runs effectively.

1. Introduction

Mathematics is a universal science that underlies the development of modern technology, has an important role in various disciplines and advances human thinking. The rapid development of information and communication technology today is based on the development of mathematics in the fields of number theory, algebra, analysis, probability theory and discrete mathematics. To master and create future technology requires a strong mastery of mathematics from an early age [1].

Mathematics lessons need to be given to all students starting from elementary school to equip students with the ability to think logically, analytically, systematically, critically and creatively, and the ability to work together [2]. These competencies are needed so that students can have the ability to acquire, manage, and use information to survive in changing, uncertain, and competitive conditions.

Mathematics learning is very important because it is needed in this life. Various problems in everyday life that can be solved with mathematics. But in reality, these benefits are not what was expected because there are still many students who do not understand the importance of learning mathematics [3][4].

As knowledge, mathematics has special characteristics, including abstract, deductive, consistent, hierarchical, and logical. Mathematics is a branch of exact and organized science [5].
Mathematics is abstract because its basic objects are abstract, namely, facts, concepts, and principles. Because it is abstract and other features that are not simple it causes many students to be less interested in mathematics. The object being studied is abstracts one of the things that often causes student difficulties in learning mathematics [6]. You could say students are allergic to learning mathematics because they think mathematics is complicated, only dealing with numbers and boring. There are several praiseworthy attitudes when we study mathematics. These attitudes include: (1) thorough, careful, and thrifty; (2) honest, firm and responsible; (3) never give up and be confident [7] [8]. When learning mathematics, students are taught and trained to think logically, critically, creatively, and are trained and required to have good conceptual understanding skills. The mathematics ability possessed by the students is still low. This low math ability causes the students' grades to be less good. The lack of the teacher's role in utilizing instructional media is one of the factors of low grades. The existence of learning media can increase student motivation and interest in learning [9].

Learning media is one of the teaching aids for teachers to deliver teaching materials, increase student creativity and increase student attention in the learning process [10]. With the media students will be more motivated to learn, encourage students to write, speak and imagine more aroused. Thus, through learning media can make the teaching and learning process more effective and efficient as well as a good relationship between teachers and students. In addition, the media can play a role in overcoming boredom in classroom learning [11]. Researchers made observations on learning mathematics with integer material with the sub-topic of addition and subtraction. From the results of these observations, it appears that when teaching and learning mathematics activities, students are lazy to listen so that only a small proportion of students are able to master the mathematics subject matter presented. busy playing alone or chatting with friends, there are even students who just pretend to understand because they are afraid to ask the teacher about the material explained. Students are less active in learning. This is because learning has not used media that attracts students so that students do not focus on learning. The teacher should use learning media because with the existence of learning media, the learning process will attract students' attention so that it fosters student interest in learning and helps the effectiveness of the learning process, and clarifies the learning objectives to be achieved.

Based on the description of these problems, researchers feel the need to develop mathematics learning media. The learning media chosen by the researcher is manipulative media, this is because it is to meet the student's need for visual media to understand the concept of addition and subtraction of integers. Then, manipulative media is a material that can be manipulated by hand, rotated, held, turned, moved, arranged or cut into pieces [12]. The use of manipulative media for learning media has also been used by several researchers. Manipulative media in the form of card media is used to improve mathematics learning outcomes. Based on the problems found, the researchers tried focuses on the development of manipulative media to understand the concept of addition and subtraction of integers for elementary school students [13].

2. Literature Review and Hypothesis

2.1 Literatur Review

According to [14], "learning is another term for teaching. In learning activities students must be the center of the activity. "Mathematics is important both as a tool, as a science (for scientists), as a guide for thinking patterns, and as an attitude maker. Therefore, we must encourage students to study mathematics well. Learning mathematics is made to improve
mathematics teaching which prioritizes understanding, so that mathematics is easier to learn and more interesting. Mathematics learning is the process of providing learning experiences to students through a series of planned activities so that students gain competence about the mathematics material being studied [15].

Based on the explanation above, it can be concluded that learning mathematics is a teaching and learning activity that studies mathematics with the aim of building mathematical knowledge so that it is useful and able to practice the results of learning mathematics in everyday life. According to the Big Indonesian Dictionary (2002: 480) states that "addition is the process, method, act of adding". Learning media is a messenger technology that can be used for learning purposes [16]. Then, [17] adds that "addition is a way of finding the total sum of two or more numbers. The ‘+’ sign in addition indicates that the numbers are added ". The addition is a rule that associates each pair of numbers with other numbers. This addition has several characteristics, namely: the nature of exchange (commutative), the nature of identity, and the nature of associative grouping. According to the Big Indonesian Dictionary states that "addition is a process, method, act of reducing or subtracting". Subtracting integers is the calculation of integers using a subtraction operation that produces an integer.

Learning media are anything that can be used to transmit messages from sender to message recipient. Meanwhile, according to [6] says that, "the media is a means or tool for the teaching and learning process. Instructional media is anything that can be used to provide stimulation so that teaching and learning interactions occur in order to achieve certain instructional goals. Media is a transfer of information that can be used to present and convey information to other parties (participants or recipients of information). Based on some of these opinions, in this study what is meant by learning media is a learning aid that is deliberately and planned to be prepared or provided by the teacher to present and / or explain learning materials, and to be used by students to be directly involved with learning.

Manipulative media in elementary school mathematics learning is a learning aid used primarily to explain mathematical concepts and procedures. This media is a direct part of mathematics and manipulated by students (reversed, cut, shifted, moved, drawn, sorted, grouped or classified.

The use of manipulatives is intended to make it easier for students to understand mathematical concepts and procedures. This manipulative media serves to simplify difficult / difficult concepts, present relatively abstract materials to be more real, explain definitions or concepts more concretely, explain certain properties related to calculating (operations), the properties of geometric shapes and show facts. Manipulative media is a concrete model that can be touched, moved by children, which serves to help children understand various mathematical concepts. In learning mathematics, it is better if the learning materials provided are easier for students to understand, materials that need to be prepared by the teacher, from items that are relatively cheap and easy to obtain, for example manila paper, cardboard, wood, wire, cloth to embed. specific mathematical concepts according to necessity.

2.2 Previous Literature Preview

Based on several studies that researchers have read, there are several studies that examine manipulative media as a learning medium, including by [16] in the title of scientific learning assisted by manipulative media to understand the concept of addition and subtraction of integers. The results obtained were an increase in the understanding of students' mathematical concepts by 8.6% and the completeness of learning outcomes by 11.11% after two cycles.
Research by [15] on the use of manipulative media in mathematics learning to improve student learning outcomes in elementary schools the success rate reached 100%. This shows that learning mathematics using manipulative media in the form of number cards can improve student learning outcomes in class V SDN Tondo G.

2.3 Framework of Thinking

The success of the learning process can be seen from the student achievement. Many factors influence the success of the learning process, including the use of learning media. The use of appropriate media will help both teachers and students in the learning process. The product to be developed is a manipulative medium that will be used to understand the concept of addition and subtraction of integers. The use of manipulative media was chosen because it supports students’ enthusiasm for learning and becomes a measure of whether the learning carried out can be successful and in accordance with expectations. Even so, this medium has the benefit of attracting students' attention so that it can improve understanding of integers. These considerations are what make researchers want to apply manipulative media to the material of addition and subtraction of integers in mathematics learning activities which will later help understand the concept of addition and subtraction of integers.

2.4 Hypothesis

Based on the problems and theoretical discussion, the hypotheses in this study are: The development of manipulative media on the material of addition and subtraction of integers can meet the needs of students in learning mathematics in elementary school.

3. Research Methods

3.1 Research Design

The research design used in this research is Research and Development (R&D) research or development research. Development research is research-oriented to develop and validate products used in education. Furthermore, [17] state that for needs analysis research so as to be able to produce hypothetical products, basic research methods are often used. Furthermore, to test the hypothetical product, experiment or action research was used. After the product is tested, it can be applied. The product testing process with experiments is called applied research. Research and development aims to find, develop and validate a product. In this study, there are ten steps used from the steps developed by Borg and Gall. The research procedures in this study can be described as follows:

a. initial research and information gathering

At this stage the researcher conducts a needs assessment, namely by studying literature and classroom observations and identifying potential or problems in the classroom. In the initial data collection, the authors conducted a needs analysis by conducting a survey using a questionnaire related to the manipulative media needs of addition and subtraction of integers in the classroom.

b. Planning

At this planning stage the researcher defines manipulative media on integer material, formulates research objectives, determines the learning sequence, and tests feasibility on a small scale. The sequence is as follows:

1) The teacher explains the integer material
2) The teacher will use manipulative media to explain the integer material
3) Some students try to use manipulative media to solve questions related to integers.

c. Early product development
At this stage, the researcher develops learning media in the form of manipulative media to understand the concept of addition and subtraction of integers. The steps in developing manipulative media are:
   1) prepare a problem related to the matter of addition and subtraction of integers.
   2) create manipulative media
   3) prepare the board to be installed with nails measuring 60 cm x 70 cm
   4) prepare the wood to be cut into a square and colored, for the front it is marked with a positive sign (+) while the back is marked with a sign (-) to be installed on the nail board.
   5) the process of making manipulative media.
   6) prepare evaluation instruments for manipulative media products.

d. Initial product trials
After the manipulative media was formed, a feasibility test was carried out. In this case the expert will judge based on the assessment items, using the assessment score figures, the suggestion column, and suggestions for improvement materials.

e. Major product revisions
At this stage, a revision is made based on the advice of the supervisor and validator during the field test. Based on the revision results, it then corrects the deficiencies in the design. Product improvement is carried out by researchers.

f. Product trials in class
at this stage conducting initial product trials based on the judgment of the experts. Testing to determine the feasibility of manipulative media that has been developed and to see the effectiveness of using manipulative media in the material of addition and subtraction of integers. The subjects at this stage were 10 students of class VI SDN Sumbangrejo.

g. Revised field test results
After being tested, the manipulative media was then revised based on limited trials in class. Revisions were made to perfect the manipulative learning media product so that it really was suitable for use as mathematics learning media in elementary schools.

h. Product validation
After revising the field test results, the next step is validating the resulting products.

i. Final product revision
At this stage, criticism and suggestions from the validator are accommodated and as input for the shortage of the final product

j. Dissemination and implementation
Report research results in professional discussions and in journals.
3.2 Research Data Sources and Types

Research Data Sources

The source of the data is the subject of obtaining the data. Sources of data from this study are:

1) Students
   Students as a data source to obtain the feasibility of manipulative media on integer material. Sources of data are class VI SDN Sumbangrejo and SDN Segoromulyo, Pamotan District, Rembang Regency.

2) Teacher
   The teacher as a source of data to obtain information on the difficulties and weaknesses of learning integers in Class VI.

3) Media expert
   Expert as a source of data to obtain the feasibility of manipulative media.

Types of research data

The type of data collected from this study comes from needs analysis data, validity data, acceptance data and effectiveness data. First, data analysis of student and teacher needs. Second, the data on the feasibility of manipulative media from the results of expert validation by providing input for the improvement of manipulative media before being tested. Third, the acceptance data for manipulative media were obtained from the results of written assessments in the control class and the experimental class. From several types of data above, later it can prove that the results of the development of manipulative media with integer material for grade VI SD students are feasible to use.

3.3 Research Instruments

The research instruments used by researchers were:

a. Guidelines for learning observations
   Learning observations are carried out to find out how the students' initial conditions in learning.

b. Interview guidelines
   1) Students
      This response guideline is provided by conducting interviews. This observation sheet is used to determine students' needs for manipulative media in learning mathematics on the material of addition and subtraction of integers.

   2) Teacher
      This interview is used to determine the teacher's need for manipulative media in mathematics learning.

3.4 Data Validity Test

a. Needs analysis, the data analysis test was carried out by determining the characteristics of the needs according to the perceptions of teachers and students by analyzing the results of interviews with manipulative media needs to understand the concept of addition and subtraction of integers in grade VI. From the results of interviews with grade VI SD teachers and 10 students, final conclusions will be drawn. This final conclusion will be used in the development of the manipulative media prototype.
b. Analysis of media validity test data, the next data is the results of the assessment of the validity of manipulative media (integers). This assessment is obtained by presenting the media prototype to the expert with the provided assessment sheet. The results of the assessment obtained will then be analyzed the percentage based on the score obtained on each assessment item. This is done by knowing the value of each statement item, the value is accumulated and the average score is sought.

The steps in determining media eligibility are as follows:
1) Recapitulate the media feasibility assessment data into a table covering aspects, indicators, and values for each validator.
2) Determine the average value of the validation results from all validators for each indicator with the following formula:

\[ P = \frac{\sum X}{\sum X_{I}} \times 100\% \]

information;
P: Final grade
\( \sum X \): total score of the validator's answers
\( \sum X_{I} \): Highest answer score (expected value)
(Arikunto, 2010: 313)

| Persentase (%) | Level of Validity          |
|---------------|----------------------------|
| 80 – 100      | Valid / No Revision        |
| 60 – 79       | Enough Valid / No Revision |
| 40 – 59       | Less Valid / Partially Revised |
| 0 – 39        | Invalid / Revised          |

Media effectiveness test analysis
The written test assessment was carried out in the control class and the experimental class. The formula used to calculate the average ability of addition and subtraction is

\[ \text{Mean} = \frac{\text{total student scores}}{\text{total students}} \]

3.5 Data Analysis
a. Analysis of the Effectiveness of Using Manipulative Media
The next data analysis is the effectiveness of manipulative media for grade VI elementary school students which can be seen from:
Data analysis on the effectiveness of manipulative media for grade VI SD students was carried out using the processing of the multiplication skills written test results obtained in research in the experimental class. To determine the level of effectiveness of manipulative media on student abilities, it can be seen using the Score Test (N-gain) with the following formula:

\[ g = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \]
Skor Kategori
≥0,70 Tinggi
0,30 ≤(g) ≥0,70 Sedang
(g) > 0,30 Rendah

b. Comparative analysis of the average written test results was carried out in the control class and the experimental class.

\[ t = \frac{X_1 - X_2}{\sqrt{\frac{S^2}{n_1} + \frac{S^2}{n_2}}}, \]

Information:
- \( t = t \) count which is then consulted with \( t \) table
- \( X_1 \) = average of the experimental class
- \( X_2 \) = average control class
- \( S \) = standard deviation
- \( N_1 \) = number of experimental classes
- \( N_2 \) = number of control classes
- By finding the standard deviation first according to the formula

4. Results and Discussion

Manipulative media is a medium developed for learning integer mathematics that is tailored to the core competencies and basic competencies in mathematics in grade VI. Based on the validation of the media expert, it was noted that the manipulative media product was included in the good category with an average score of 87% while the material expert was also in the good category with an average score of 85%. From the results of student responses obtained data with an average percentage of responses to manipulative media reaching 90% with the very good category. From the results of these studies it can be concluded that the manipulative media products developed are feasible and good in terms of media and material. So that the development of manipulative media in teaching mathematics can understand the concept of addition and subtraction of integers in grade VI elementary school.

5. Conclusion

The conclusion that can be drawn from this development research is that the development of manipulative media in mathematics learning can have a positive impact on students, namely understanding the concept of addition and subtraction of integers in grade VI elementary school.

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