Development of STACKOPER Learning Media on Direct and Inverse Proportion Subject

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**Abstract.** Learning media is a tool to deliver material to students during the learning process. This research aims to develop Stackoper's manipulative learning media on direct and inverse proportion subject in Class VII. Development method is carried out using the [1] development model. The process of developing instructional media has three stages, namely, planning, design, and development. The research trial was conducted at Hidayatul Mubtadiin Singosari Middle School in class VII with 35 students as research subjects. Based on data analysis, the results obtained are (1) the results of the validity test of learning media included in the valid criteria by obtaining an average score of 3.55 and the category is quite valid and (2) the results of the effectiveness test are obtained through the observation sheet of the students' effectiveness with the average score averaging 3.5 including the category is quite valid. Based on the two results of the trial, research on the development of Stackoper's manipulaktive learning media on comparative material worth and reversing grade VII grades of SMP produces a valid and effective media.

1. Introduction

 Mathematics is integral to what everyone does in daily life. All human activities involve mathematics. Unintentionally, mathematics becomes part of human life [2]. Moreover, mathematics also becomes a compulsory lesson in elementary school level and even until senior high school level [3]. However, many students have trouble to learn this number-related subject area [4]. The common problem is that mathematics has characteristic of an abstract object, so it caused many students to find it difficult in learning mathematics [5].

 One of the mathematical concepts that often used for daily life is proportion [6]. In mathematics, proportion means as a statement of similarity between two ratios and usually written as a/b=c/d. Children and even adults show the lack of understanding of proportion concept even though they have been using this in their daily basis, for example in transaction. Some adults did not show mastery of this proportion concept [7].

 Before learning concept of direct proportion, students initially need to understand the concept of proportion itself. Proportion is represented as relation between two specific quantities, while direct proportion is represented as statement of two equal ratios [8]. One concept implementation of direct proportion is in food processing or food recipes, such as the proportion of the amount of flour and sugar. Unintentionally, this concept of direct proportion is awfully close to human’s daily life. However, to the students, this concept understanding is still difficult to be understood. According to Suryani (2010), students still found it difficult to solve questions related to proportion. Furthermore, students still found it difficult to solve questions related to direct and inverse proportion.

 Learning mathematics is important. It is important because of its role in daily life [5]. There are various available sources in learning mathematics. Teacher as a mathematics learning source is the most common used method in formal education [6]. Other than that, as an alternative, learning media can also be used as a mathematics learning source [10]. Learning media in mathematics learning is a tool to assist students to receive and understand mathematics so they will have a good learning result [9]. One method to present mathematics lesson to assist students’ understanding is by using media [11].

 In the reality, mathematics learning is generally considered as one of difficult learnings [12]. For example, the material of direct and inverse proportion. In order to understand the problem, concrete things are needed even though the mathematics is an abstract learning [13]. One of the efforts to improve students’ understanding is by providing media to motivate students to learn and make the learning process more attractive [14]. The use of interesting learning media includes legibility, ease of use, quality of display, quality of students’ response handling, quality of the program management, and quality of the documentation [15]. This research used media to facilitate teachers in learning process, and to make students quickly understand the concept of direct and inverse proportion.

 Some researchers had studied the learning media related to direct and inverse proportion subject such as [16], [17]. The research by [16], [17] were both using direct and inverse proportion learning material. The learning media they developed was computer-assisted interactive learning media. Both research that they had developed were lack of adequate tools because of the use of computers as the media, so that not all students got involved directly during the research implementation. Therefore, this research will develop another interactive media by using Uno Stacko games to attract the students’ interest during the learning process. This to-be-developed media was called as STACKOPER and it used direct and inverse proportion learning material. Based on the description above, a manipulative media is needed to be developed to facilitate students in understanding the concept of direct and inverse proportion through a guided discovery learning.

1. Experimental Method

 Development of the interactive media was conducted by using multimedia development model developed by[1]. This model consisted of three stages: planning, designing, and development. According to the model, steps of the research are as follows: (1) identifying needs, objectives, and constraints; (2) collecting ideas and sources; (3) developing media prototype; (4) designing the learning; (5) developing learning media and tools; and (6) evaluation and revision.

 In evaluation and revision step, some validation and limited testing were conducted. The validation was conducted by lecturer of postgraduate mathematics education at Universitas Negeri Malang and master student of mathematical education at Universitas Negeri Malang who were taking the learning media material. The media was tested through peer teaching to seventh grade of Hidayatul Mubtadiin Singosari Junior High School. The media was subjected to 35 students who were taking direct and inverse proportion learning material. Students were divided into six groups. Five groups consisted of six students and one group consisted of five students. Each group used one media. After conducting the validation and testing, then a recommendation to revise the media was obtained.

 Data obtained from the validation and testing activity was then analyzed quantitatively and qualitatively. Quantitative data was used to decide the validity and practicality of the media. To decide the media validity, questionnaires were handed out to the students. The questionnaires result was compared to validation criteria as shown in Table 1 below. The practicality was determined by the result of testing on students through peer teaching. The media was called as practical when the testing result showed that the media could be implemented with less or without revision. Meanwhile, the media prototype, observation result of the testing, and recommendation of validators and users became the data to be qualitatively analyzed. The media was qualitatively analyzed based on theory of learning media.

**Table 1.** Media Validity Criteria

|  |  |
| --- | --- |
| Score | Validity Criterion |
| 4 | Very Valid |
| 3 | Quite Valid |
| 2 | Less Valid |
| 1 | Invalid |

1. Result and Discussion

 The first step of this research was to analyze the learning tools planning. In this step, it had been decided that the subject used in the research was direct and inverse proportion. Afterwards, display design of the developed manipulative media was created. In this step, the backgrounds and bases in manipulative media were designed. Initially, the design was in form of picture and then the size was adjusted to Styrofoam.

 The next step was to collect materials needed to make the media. Materials used to make this media were as follows: (1) Uno Stacko, (2) brown and blue Styrofoam, (3) plotting paper, (4) push pin, (5) buffalo-type paper, (6) origami paper, and (7) wool yarn. Meanwhile, the tools used were as follows: (1) cutter, (2) scissor, (3) double tip, (4) ruler, (5) black-colored marker, and (6) glue.

 The developed media in this study was called as STACKOPER. This media was used to give students understanding about direct and inverse proportion subject. Uno Stacko was likened as the material to build a building. Brown-colored Styrofoam was the base to place the plotting paper, and blue-colored Styrofoam was used as the background. Afterwards, two pieces of origami paper were prepared. The first piece contained direct proportion table, and the second piece contained inverse proportion table, as shown in Figure 1 below.

 There was a slight difference between the concept understanding of direct proportion and inverse proportion. In direct proportion, the higher the building was built, the longer the time required to build the building, with the condition that the number of workers had not changed. Meanwhile for inverse proportion, the more the number of workers who built the building, the shorter the time required to build the building, with the condition that the amount of materials used had not changed. The observation of direct proportion and inverse proportion was conducted three time to see the difference in the required time.

 Initially, before implementing the media in the research, teacher needed to explain the introductory lesson of direct and inverse proportion. The introduction was related to general subject and the application in daily basis. Therefore, students could obtain conception of the proportions intuitively. Giving examples in form of daily basis made the learning process became more meaningful for students and made the students appreciated knowledges they would learn.

 Then the students were instructed to observe proportion in mathematics through the STACKOPER media. In this step, students started to find the concept of direct and inverse proportion. Started with observation, students then arranged hypotheses and proved their guest. They conducted this step by using guideline in LKPD. At the end, students could find the concept of direct and inverse proportion. The activity sequence to find the concept of proportion by students using media is in line with the guided discovery learning. The use of the guided discovery learning made the students actively involved in learning process [3].

 After obtaining the introductory lesson from their teacher, the students worked on LKPD as their practice. LKPD consisted of questions representing each sub-material. LKPD was a description complemented with processing steps by using the provided media. And then, students could try the competency test to test their understanding about all learning materials in the chapter of proportion. The STACKOPER manipulative media is shown in Figure 1.



**Figure 1**. STACKOPER Manipulative Media

 Each group was provided with a table of direct and inverse proportion, as shown in Figure 1. Then, each group recorded the data obtained from the table. After obtaining the data, students needed to analyze the direct and inverse proportion.

 After developing the product, testing consisted of two stages was conducted. The stages were expert testing and small-scale testing. Expert testing or validation stage consisted of media validation and subject validation. The result of validator assessment on the media was presented in Table 2.

**Table 2.** Result of Media Validation

|  |  |
| --- | --- |
| Assessed Criteria | Average Score for Each Aspect |
| Contents of Learning Media1. Learning media can assist students on learning mathematics for direct and inverse proportion learning material
2. Learning media can assist students to develop understanding about direct and inverse proportion
3. The activities enable positive interaction between students and learning media
4. The activity of using learning media are in accordance with the learning goals
5. Learning media does not cause ambiguity
 | 3.543.53.53.5 |
| Benefits of Learning Media1. Can be used to assist students in achieving learning goals
2. Can be used as mathematics learning support in school
3. Can encourage students to be more active
 | 43.53.5 |
| Form and Display (Physical/Manipulative Media)1. Attractive learning media display
2. Proportional-shaped media

Validity Score | 3.533.55 |

 In expert testing stage, revision of the media was carried out two times: revision from media expert and revision from subject expert. Media revision process consisted of making the writing of media usage guideline and scale image clearer. The image was placed so that the media was easy to be seen. Furthermore, the division of groups also needed to regard heterogeneity.

 Based on Table 2, the validity score was 3.55. This means that the media was valid. According to the validity test, it can be concluded that the media was valid and ready for testing. This testing was conducted to assess students’ responses of the developed media. In this testing, students were given questionnaires and requested to rate the learning media. Result of the students’ response questionnaire are shown in Table 3.

**Table 3.** Media Testing Result

|  |  |
| --- | --- |
| Aspect | Average Score for each Aspect |
| Subject Presentation1. Mathematics learning media is easy for me to use
2. Problem presentation in mathematics learning media assists me to understand the mathematical concept
3. I love to learn mathematics through this learning media because of its attractiveness
4. This learning media makes me love mathematics
5. This learning media makes me want to understand mathematics even further
 | 3.73.33.73.63.4 |
| Language and Display1. Provided guidelines and information is easy for me to understand
2. The display of learning media is interesting

Validity Score | 3.53.63.5 |

 Based on the result of validation and testing, it can be concluded that the manipulative learning media on proportion subject was valid. The manipulative media validity was based on the result of media expert and subject expert validation. The validation showed that the average score was ≥3 for each assessed aspect.

 Result of the manipulative media testing indicated that students gave positive responses for each assessed aspect. The result also indicated that the media could motivate students in learning mathematics. The result reinforced the conclusion stated by[18] that manipulative learning media can increase students’ motivation in learning mathematics. With motivation, students will tend to learn which results in increased learning outcomes[19].

 The developed manipulative learning media does not only give the students understanding of the concept about direct and inverse proportion, but also allows students to be actively involved during learning using the media [20]. The students were directly involved in using the media and it made them to be easier to understand the lesson being taught. This condition is in line with report by [21] which stated that the students that directly involved would understand the concept easier. Concrete activities with media are valuable learning for students[22]. The usage of LKPD also guided students in writing the subject being learned.

 The STACKOPER manipulative media was established by using students’ favourite games, so that the students became more interested to use this STACKOPER media. Students were also able to extend their understanding and ability in solving problems. This because the designed LKPD was adjusted to the related subject and addressed to make students obtained a better learning experience than before. This is in line with report by [23]. They stated that LKPD that had been adjusted to the related subject can improve the students’ ability and learning experience to solve certain problems. Educational media can also have a positive impact on children[24], [25].

 Each established media always has its advantages and disadvantages [26]. Generally, the advantages of this developed manipulative learning media are as follows: (1) simple but elegant display, (2) focus to the subject being taught, (3) easy to use, and (4) can be used in groups.

 However, this media also has some disadvantages as follows: (1) less practical media packaging due to its quite large size, (2) less durable and fragile background and base materials, and (3) the media cannot be used for individual, but have to be in group with more than three students.

1. Conclusion

 The STACKOPER manipulative learning media on direct and inverse proportion subject of seventh grader was classified as valid with average score of 3.55. The result of effectiveness testing with observation form was classified as quite valid with average score of 3.5. The result of students’ work indicated that the use of STACKOPER manipulative learning media has a good effect on students’ understanding in solving questions about direct and inverse proportion. The disadvantages of the media in this research are as follows: less practical packaging due to its quite large size; and fragile and less durable background and base material.

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