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A Learning Multimedia of Geometry Using Mayer Principles and J. Bruner Learning Approach

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Abstract

The aim of this study is to produce learning multimedia products of geometry material for the fifth grade students of elementary school students using Mayer principles and J. Bruner learning approach. It also describes the effectiveness level of using multimedia learning as well as improving students' mastery in achieving cognitive goals of mathematics learning material especially the geometry after using the multimedia. This study applies the development research (R & D) method by adapting the Alessi & Trollip model. The stages in this study consist of planning, designing and developing stages. The results showed that the multimedia products produce were feasible as a mathematics learning media for geometry materials based on the validation by material and media experts on the alpha test with very good assessment, as well as the assessment conducted by 16 students in the beta test showed very good results. Multimedia products of mathematics learning on geometry material effectively improve the learning outcomes with a mean of 45,83 pretest, while the posttest score is 83,75. So it has a gain value of 0.7 with a value that has a "high" criterion.

Keywords: multimedia, mathematics learning, geometry, Mayer Principle, J. Bruner learning approach

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1. Introduction

In the development of science and technology, recently it cannot be denied that mathematics has an important role in education. Mathematics is the science of numbers and their operations, relationships, combinations, abstractions and configuration of space. The study of abstract structures is the center of mathematics [1]. Structure, measurement, estimation, generalization and opportunity are mathematics based on invention. Mathematics is a universal science that underlies the development of modern technology. The rapid development of information and communication technology recently is based on the development of mathematics in terms of numbers, algebra and geometry. Thus, to be able to master and create technology in the future, it is needed

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a strong mathematical mastery. Mathematics is given to all students in elementary school. It helps students to have the ability to think logically, analytically, systematically, critically, creatively and the ability to work together. Those competences are needed so that students have the ability to acquire, manage and utilize information in an ever-changing, uncertain and competitive situation in the future era of globalization. On the other hand, mathematics taught in the elementary, middle, and high school is always being the subject of study. Some studies show that mathematics is still a difficult subject for most students [2-3].

Geometry is a 3-dimension construction of which boundaries are in the form of a flat plane and curved plane [4]. Geometry is a combination of perception about space and the development of visual perception to conceptualize a more logical or sequential space. The object of spatial geometry is abstract objects such as cubes, cuboids, prisms, pyramid and so on. One of the sub topics of geometry and measurement taught in elementary school is simple geometry including cubes and cuboids. To learn about simple geometry, students are faced with abstract objects. Abstract objects can be illustrated in various ways. Theoretically according to cognitive development, students in the 5th of elementary school (aged 10-11 years) are generally in the concrete operational thinking stage [5]. However, since mathematics is related to abstract concepts, there are some students who still have difficulty in understanding the abstract concepts. The survey result of the Program for International Student Assessment (PISA) in the year of 2000/2001 shows that students are weak in learning geometry materials, especially in understanding space and form.

Therefore, to overcome those problems an interesting alternative learning is needed such as completing the learning facilities and infrastructures as well as enriching the learning resources which are supported by learning media innovations. The learning media innovation is used to improve the quality of learning. One of the technology products that can be used as an innovation in learning is computer. Computer as one of the technology products is considered as an appropriate means as teaching aids [6]. One of the computer-based learning media is multimedia learning. Based on research studies, multimedia have some advantages for instance, (1) teaching will attract students' attention so that it can arise the students' learning motivation; (2) teaching material will be more clearly defined so that it can be better understood by students; (3) teaching methods will be more varied, not merely verbal communication through the words of the teacher; (4) Students do more learning activities, because they do not only listen to the teacher's description but can also do other activities such as observing, experiencing, demonstrating and others [7]. Multimedia entirely combines computer technology, video

systems and audio systems to get better combinations and increase the interaction between user and computer. Audio and visual offerings in multimedia learning make the visualization more interesting. It is supported by animations to maximize the visual effect and provide continuous interaction. Multimedia display will make students more flexible to choose, synthesize and elaborate the knowledge they want to understand, so that the difficulties can be overcome. Multimedia used in the right way also can succeed the psychomotor development and strengthens the visual process of users [8]

The multimedia learning development of this study applies Bruner's learning approach as a strategy for delivering material in multimedia. Bruner's learning approach covers three stages of learning namely, Enactive - learning by doing, Iconic - learning by means of images and pictures and Symbolic - learning by means of words or numbers [9]. In the context of learning according to Bruner's theory, learning can be done anytime without having to wait for a student to reach a certain learning stage. If the lesson material is well designed, students can learn eventhough their efforts are not sufficient yet. In other words, students' cognitive development can improve through the designed material according to the students' cultural characteristics [10]. Then, the multimedia design was also developed applying the Mayer principles in order to produce a good quality multimedia so it can be effectively used in learning.

Based on the description above, the aim of this research is to produce multimedia learning products for geometry materials for the 5th grade students of elementary school who are eligible by applying Mayer principles and J. Bruner approach. It also aims to describe the effectiveness level of using multimedia learning as well as to increase students' mastery of the material in terms of achieving cognitive learning of mathematics related to geometry material after using multimedia.

2. Literature Review

Multimedia can be simply interpreted as more than one media. Multimedia is seen as a combination of several elements, including; text, images, sound, video, and animation. This merger is a unit that simultaneously displays information, messages, or content of subjects as learning resources. Multimedia can be categorized as technology to present material in verbal form and in the form of images (pictorial form) [11]. Multimedia make use of several media in presenting information applying combination of graphic text, animation, video and sound [12]. The success of developing a learning multimedia depends on the composition of multimedia components that are integrated in the product [13]. Multimedia components that needs to be considered in the development

of learning multimedia consist of five elements, namely (1) text, (2) audio, (3) video, (4) graphics, (5) animation [14]. Based on research studies, multimedia have many benefits such as (1) teaching will attract students' attention so that it can grow the learning motivation; (2) teaching material will be more clearly defined so that it can be better understood by students; (3) teaching methods will be more varied, not merely verbal communication through the words of the teacher; (4) Students do more learning activities, because they do not only listen to the teacher's description, but can also do other activities such as observing, doing, demonstrating and others [7].

The development of learning multimedia is inseparable from the principles of multimedia design. Thus, the resulting multimedia has a good display quality so that it can improve students' comprehension competencies when it is applied on the learning. The multimedia principle commonly used as references in multimedia development is Mayer principles (2009). Mayer principle consists some principles of multimedia, proximity to space, time proximity, coherence, modality, redundancy, individual differences, interactivity, markers, personel [11].

3. Material & Methodology

This study applies the Research and Development (R & D) research model by adapting the Alessi & Trollip (2011) model. The development procedures cover the stages of planning, designing, developing [15]. The planning stage includes needs analysis (literature study and field study), collecting and determining sources, brainstorming. In designing stage, it consists of drafting, creating flowchart and screen design, and determining the software used. In development stage, it consists of developing learning multimedia using the Adobe Flash CS 6 program, conducting evaluations by alpha testing (formative evaluation) to 2 material experts and 2 media experts, making revisions based on the validators' feedback, evaluating using Beta Test (formative evaluation) to 16 grade V elementary school students, final revision, producing products, and conducting summative evaluation (effectiveness test).

The research data was obtained from questionnaires and tests. Data from questionnaires were obtained from expert questionnaires, media expert questionnaires, and student responses to the product which is developed and analyzed. Data sourced from the tests were obtained through a test of students' ability in geometry to find out the effectiveness of multimedia products developed. The instrument used to collect data was in the form of assessment questionnaires for material experts consisting of learning aspects and material aspects. Meanwhile, media expert questionnaires consist

of aspects of multimedia display design, programming, material delivery strategies, principles of material presentation. Students' response questionnaire consists of material aspects and media aspects.

To test the effectiveness, the data obtained from the student's ability tests on geometry material were analyzed by comparing students' pre and post learning outcomes in using multimedia and using the Normalized-gain formula.

$$\frac{S\ post - S\ pre}{S\ max - S\ pre}$$

Information;

$S\ post$ = Post-test average score

$S\ pre$ = Pre-test average score

$S\ max$ = maximum score

The scoring result is interpreted into the table of gain value interpretation classification.

TABLE 1: Gain value representation.

No.	Gain value	Category
1	g ≥ 0,70	High
2	0,70 > 0,31	Average
3	0,00 < 0,30	Low

4. Results and Discussion

Multimedia learning is a learning media that contains geometry material for the fifth students of elementary school. This learning multimedia is developed based on the needs analysis obtained through interviews with subject teachers. Based on the needs analysis, there are several problems in learning mathematics, namely (1) Mathematics is considered difficult learning evidenced by the results of the students' average daily score which is under the completeness that is 63 of which the limit is 75, (2) The methods applied by teachers in learning mathematics are lecture method, discussion, question and answer, and group work. (2) Generally, Panjatan Elementary School V students can already use a computer or laptop. They can turn it on and off without the help of others, (3) Computer labs have not been used optimally to support mathematics learning, (4) Multimedia owned by schools is still very limited. Furthermore, after analyzing the needs, learning multimedia was developed as a solution to the above constraints. This study applies the Research and Development (R & D) research model by adapting the Alessi & Trollip (2011) model. The development procedures carried out consists of the stages of

planning, design, development [14]. This multimedia development process also applies Mayer's principles and Bruner's learning approach.

Technically, this learning multimedia is developed using Adobe Flash CS6 application using action script 2.0. The results of this multimedia development product are formatted in. exe and stored in CD. This multimedia learning generally consists of the opening page, introduction, main menu, material and training, evaluation, games, developer profile and usage instructions page. Meanwhile, the visual display of this multimedia applies several media elements of multimedia composition such as text, animation, images, video and audio. In the feasibility stage, this learning multimedia has passed the alpha test and beta test processes. In the alpha test with validation by 2 media experts and 2 material experts, it was found that this learning multimedia was included in the criteria of "Very Feasible" with the results of the validation in terms of media scored 3.86 and in terms of material scored 3.79. Furthermore, in the beta test with validation by 16 students, it was found that this learning multimedia was included in the criteria of "Very Feasible" with the validation results scored 3,85. In addition, there were several feedbacks and suggestions for both stages as improvements for the developed multimedia. By reviewing the data on the alpha and beta test, it can be concluded that this learning multimedia product has been worthy of being tested for effectiveness on the trial subject by priorly revising the product based on the suggestions and improvements.

5. Conclusion

The multimedia products are mathematics learning multimedia of geometry for grade 5 elementary school students. Generally, this learning multimedia consists of the opening page, introduction, main menu, material and training, evaluation, games, developer profile and manual user page. The applied learning approach is Bruner's learning theory.

The multimedia quality of mathematics learning material is declared feasible to be used in learning. Based on the results of expert evaluation of material I 3.75 (very good), expert material II 3.84 (very good), while media expert I 3.73 (very good) and media expert II 3.87 (very good). Assessment of 16 students in the beta test scored 3.85 (very good). Mathematics learning multimedia of flat slide geometry is declared effective in improving students' learning outcomes. This is proved by the difference between the average of pretest and posttest namely the gain score which valued of 0,7 defined as a high criterion. Besides, there is also a difference between the highest score and the

lowest score on the pretest and posttest. The highest scored in pretest is 7.3 and the lowest score is 2. Then, the highest score in posttest is 10 while the lowest is 6.6.

There are several things to be concerned in the future research related to the material developed that is not only limited to the material of cubes and cuboids but also can cover pyramid and prism. Some multimedia components need to be enhanced such as the use of 3D and 4D technology to support the material delivery.

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