Design and Development Computer-Based E-Learning Teaching Material for Improving Mathematical Understanding Ability and Spatial Sense of Junior High School Students

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Abstract. This paper aims to make a design and development computer-based e-learning teaching material for improving mathematical understanding ability and spatial sense of junior high school students. Furthermore, the particular aims are (1) getting teaching material design, evaluation model, and instrument to measure mathematical understanding ability and spatial sense of junior high school students; (2) conducting trials computer-based e-learning teaching material model, assessment, and instrument to develop mathematical understanding ability and spatial sense of junior high school students; (3) completing teaching material models of computer-based e-learning, assessment, and develop mathematical understanding ability and spatial sense of junior high school students; (4) resulting research product is teaching materials of computer-based e-learning. Furthermore, the product is an interactive learning disc. The research method is used of this study is developmental research which is conducted by thought experiment and instruction experiment. The result showed that teaching materials could be used very well. This is based on the validation of computer-based e-learning teaching materials, which is validated by 5 multimedia experts. The judgement result of face and content validity of 5 validator shows that the same judgement result to the face and content validity of each item test of mathematical understanding ability and spatial sense. The reliability test of mathematical understanding ability and spatial sense are 0,929 and 0,939. This reliability test is very high. While the validity of both tests have a high and very high criteria.

1. Introduction
Among the various branches of mathematics, geometry of position of the most concern. There are still many students who had difficulty in understanding the geometry, particularly the geometry of space [1] [2] [3]. Similarly this condition found in Indonesia on the level of primary and secondary education [4] [5]. Factors that play a role in learning geometry that is the understanding of the concept and spatial sense [6] [7] [8]. Based on the above description, then the necessary efforts to develop and improve the ability of mathematical understanding and spatial sense. Therefore researchers propose a study with the title “Design and Development Computer-Based E-Learning Teaching Material for Improving Mathematical Understanding Ability and Spatial Sense of Junior High School Students”.

Design and development computer-based e-learning teaching material referred to in this study is a strategy of learning by the use of computer media for delivering learning materials all or part with the help of the media learning shaped interactive multimedia software. As for the problems in this
research is "How to design and development computer-based e-learning teaching material for improving mathematical understanding ability and spatial sense of junior high school students?"

2. Method
This research method used of this study is developmental research which is conducted by thought experiment and instruction experiment, and concludes with a study of experiments for the purposes of validation of the learning model developed.

Step of research are reflected in the diagram below:

| Stage       | Forms of Study | Types of Methods                          | Research Steps                                                                 |
|-------------|----------------|--------------------------------------------|-------------------------------------------------------------------------------|
|             | Theoretical    | Study of The Development                   | Design and development computer-based e-learning teaching material for improving mathematical understanding ability and spatial sense of junior high school students |
| I           | The Empirical  | The Study Implementation                   | Getting teaching material design, evaluation model, and instrument to measure mathematical understanding ability and spatial sense of junior high school students |
|             | Theoretical    | Study Documentation                        | Conducting trials computer-based e-learning teaching material, assessment, and instrument to develop mathematical understanding ability and spatial sense of junior high school students |
|             |                |                                            | Completing teaching material models of computer-based e-learning, assessment, and develop mathematical understanding ability and spatial sense of junior high school students |

Figure 1. Research Flowchart

3. Results And Discussion

3.1 The development of learning materials
Computer-based e-learning teaching material used in the study is organized in the form of computer-based multimedia learning using Macromedia Flash software program and 3D Max. The preparation of computer-based multimedia considering students ability in operating computer designed to increase learning ability in understanding mathematical and spatial sense on geometry with flat-sided

The procedure of making computer-based multimedia learning according to Rusman [9] is (1) manufacturing of implementation plan of learning; (2) the creation of computer-based learning programme planning, including the introduction (the title of the program, the purpose of presentation, instructions), goals, learning experiences, and treatment; (3) the creation of computer-based learning, flowchart in accordance with the model used; (4) the making of a multimedia learning computer-based storyboards. Further development of learning materials is done through the following steps.

- Analysis of computer programs according to the presentation of images and animation in the concepts of mathematics. At this stage the researcher using Macromedia Flash with 3D Max that has any purpose provider tool making animations or dynamic and interactive writing.
Furthermore the technology choice of the resulting animations can be run in multiple platforms and a wide range of computers.

- Analysis of the subject matter of mathematics junior high school class VIII. At this stage the subject was taught on a semester in progress to inventory and further prepared to become subject to published materials. The fundamental thing of taking the topic of learning materials is the essence and the suitability of the presentation with computer media. After selected topics that meet these criteria, then made public its computer program design. In this stage the author chose the material geometry with flat sides is presented in the form of interactive learning materials.

- Manufacture of model design learning materials in the form of interactive computer programs. First thing to do after choosing an appropriate discussion topic presented with computer media is designing a computer program Flowchart, and then continued with the storyboarded. Story board this is the reference framework, making the program more. In addition to visualize ideas story board also presents the contents of the display of interactive multimedia.

- The process of making an interactive multimedia program. After the making of the Story Board, then the next stage is the process of making an interactive multimedia program.

Development of computer-based e-learning teaching material prior to use validated by expert people multimedia 5. As for the given sheet of multimedia considerations include: (1) Learning materials which are made in accordance with the principles of interactive multimedia computer-based; (2) Learning materials through interactive multimedia can help students develop the ability of understanding the mathematical and spatial sense; (3) Guidance in the learning materials in accordance with the level of development of junior high school students; (4) Organizing systematic learning materials; (5) Materials through interactive multimedia can help students establish the concepts/principles of mathematics with their own abilities; (6) The language used is clear/precise; (7) Images or representations mathematically used clearly/precisely. Based on the results of consideration to 5 validator retrieved the conclusion that learning materials can be used very well. As for the instruments used in this research are mathematical comprehension tests and tests the ability of spatial sense. A test of the ability of mathematical understanding and spatial sense ability tests developed by researchers based on a scoring rubric refers to Facione [10].

Instruments validated the theoretical validity of face and contents. Validity was done by 5 judgements people who are considered experts in mathematics education. The purpose of doing validation is expected to generate a valid instrument and reliability. As for the validity of the contents weighed are associated with: (1) The given subject matter; (2) Indicators of achievement of the learning results; (3) The aspect of the ability of mathematical understanding and spatial sense measured; (4) The difficulty level for junior high school students of class VIII. While the validity of advance which weighed include: (1) The clarity of the language or editorial; (2) The clarity of the picture; (3) The language is standard.

After the validity of the face and contents by 5 judgements done, then done little revision and testing to students who have received material learning materials to be used in research activities. Tryout to know the reliability, validity of the distinguishing power grain of matter, and the difficulty level of each grain of matter. the whole things is measured on the test input problems on test instruments and statements on non test is used or not.

Below will be described from each of the research instrument:

3.2 Test the ability of Mathematical Understanding

The results of the consideration of the validity of the advance and the content of the five penimbang with the hypothesis tested is as follows.

\[ H_0 : \text{All judgements give the same considerations} \]

\[ H_1 : \text{All judgements gives the consideration is not the same (at least there are two different judgements give consideration)} \]
The criteria used is the test: If the value of the probability (sig) greater than $\alpha = 0.05$, then $H_0$ accepted and in other circumstances $H_0$ denied.

The results of the calculation of validity and contents of mathematical comprehension tests by using the Q-statistic Cochran presented in table 1.

Table 1. Test Results of Consideration of The Validity of Advance Mathematical Understanding Ability Test

| N   | Cochran's Q | Df    | Asymp. Sig. |
|-----|-------------|-------|-------------|
| 13  | 2.476\(^a\) | 4     | .649        |

Based on table 1 above seen that value the Q-statistic Cochran to face validity was 2.476 asimtotis 0.65 significance with numbers greater than 0.05, so $H_0$ accepted. So all judgements give the same reasoning against the validity of advance at any granule tests. As for the validity of the content of the assessment with a score of judgements give the same i.e. 1 so that it can be concluded all judgements give same consideration against the validity of the contents of each grain tests MU.

Next to test the reliability and validity of the grain problem by using reliability test values obtained ANATES 0.929 belongs to very high. Based on the calculation of the accrued ANATES 8 grains of matter, 2 grains of matter have validity with high criteria and 6 grains of matter has the validity criteria are very high. The results of the analysis showed that the mathematically understanding ability tests can be used for research.

3.3 Test the ability of Spatial Sense

The results of the consideration of the validity of the advance and the content of the five judgements with the hypothesis tested is as follows.

- $H_0$: All judgements give the same considerations
- $H_1$: All judgements gives the consideration is not the same (at least there are two different judgements give consideration)

The criteria used is the test: If the value of the probability (sig) greater than $\alpha = 0.05$, then $H_0$ accepted and in other circumstances $H_0$ denied.

The results of the calculation of validity of the advance and the contents of the test spatial sense by using Q-statistic Cochran presented in table 2 and table 3.

Table 2. Test Results of Consideration of The Validity of The Advance Tests The Ability of Spatial Sense

| N   | Cochran's Q | Df    | Asymp. Sig. |
|-----|-------------|-------|-------------|
| 16  | 6.435\(^a\) | 4     | .169        |

Table 3. Test Results of Consideration of The Validity of The Content of The Tests The Ability of Spatial Sense

| N   | Cochran's Q | Df    | Asymp. Sig. |
|-----|-------------|-------|-------------|
| 16  | 4.000\(^a\) | 4     | .406        |

Based on table 2 above seen that value the Q-statistic Cochran to face validity is 6.4 with number asimtotis 0.17 significance greater than 0.05, so $H_0$ accepted. From table 3 is also seen that the value the Q-statistic Cochran for the validity of the content is 4 by number asimtotis 0.41 significance greater than 0.05, so $H_0$ accepted so the judgements give the same reasoning against the validity of advance and the contents of each grain of ability test spatial sense.

Next to test the reliability and validity of the grain problem by using reliability test values obtained ANATES 0.939 belongs to very high. Based on the calculation of the accrued ANATES 12 grains of matter, 6 grain question has validity with high criteria and 6 grains of matter has the validity criteria are very high. The results of the analysis show that tests the ability of spatial sense can be used for research.
4. Discussion

Learning materials computer-based e-learning that is generated is interactive multimedia learning materials-based computer by using several models of learning (model tutorial, simulation, discovery, drill and practice) in the form of a media text, images, sound, animation, and interaction to convey the overall learning materials packed in computer software (CD study).

Based on the results of the validation of materials against computer-based e-learning that is validated by an expert multimedia, retrieved the conclusion that learning materials can be used very well. As for pieces of interactive multimedia computer-based considerations are given include: (1) Learning materials which are made in accordance with the principles of interactive multimedia computer-based; (2) Learning materials through interactive multimedia can help students develop the ability of understanding the concept and spatial sense; (3) Guidance in the learning materials in accordance with the level of development of junior high school students; (4) Organizing systematic learning materials; (5) Materials through interactive multimedia can help students establish the concepts/principles of Mathematics with their own abilities; (6) The language used is clear/precise; (7) Images or representations mathematically used clearly/precisely.

The following is a printscreen from one of the videos on an interactive multimedia program about the shape of a flat wake looks up, looks ahead and looks right in the wake of its spatial model.

![Video Footage on Learning](image)

5. Conclusion

The results showed that the learning materials computer-based e-learning that is validated by expert people multimedia 5 can be used very well. The results of the consideration of the validity of the advance and the contents of the 5 judgements shows that the judgements gives the same reasoning against the validity of advance and the contents of each grain of mathematical understanding ability test and spatial sense. Reliability ability test mathematical understanding and spatial sense of 0.929 and 0.939 belongs to very high. While the validity of both the test has high and very high criteria. The results of the analysis showed that the mathematically understanding ability test instruments and spatial sense can be used.
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