Development of Constructivist-Based Mathematics Learning Media on Geometry Materials

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Abstract. The purpose of this study is to describe the process and results of the development of constructivist-based computer-aided mathematics learning media on geometry material with the sub-topic of distance on spatial shapes that is valid, practical, and effective. This type of research is development research, using modified Borg and Gall research procedures consisting of several main steps, namely analysis of developed products, developing initial products, and product trials. This media was tested at Tamansiswa University by taking one class in the second semester Mathematics Education study program. The results of this study indicate that the media developed is valid with an average validity score of 3.36, practical with an average practicality score of 3.58, effective with complete mastery of the material as much as 88.89%, and student assessments of 0.67 with positive criteria.

Keywords: Learning Media Development, Geometry, Borg and Gall.

1 Introduction

Seeing the role of mathematics is so important, then every student should be interested and interested in learning mathematics. However, in reality, students' interest in learning mathematics still needs to improve, and the learning process needs to be more effective. This is caused by several factors, one of which is the learning media used by the teacher. According to Amiyati (2010), the entire history of media and technology has influenced education [1].

Based on the results of observations at Tamansiswa University in March 2022, it can be seen that students' interest in learning mathematics in geometry material with the sub-subject of distance in geometric shapes is still low. One of the causes of the low interest in students' learning is that in teaching this material, they still use the media of books and eraser boards, which are, for example, building spaces, causing learning to be less effective and when drawing takes a long time. This is due to the unavailability of computer-assisted learning media.

The use of computer technology in mathematics learning is under the National Council of Teachers Mathematics NCTM (2000), which states that technology is essential in teaching and learning mathematics; it influences the mathematics taught and enhances students' learning [2]. The statement more or fewer means, "Technology is essential in

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teaching and learning mathematics; technology affects how mathematics is and enriches student learning."` Using computers has a positive effect in learning mathematics, as stated by Nieven (2010), that using computers has a positive effect in visualization [3]." The statement, more or fewer, means "using a computer has a positive effect on visualization."

Several studies on media development using Macromedia Flash include Afidah (2013) stating that students can use the developed interactive learning media for independent study [4], and Nurcholis (2013) stating that the developed interactive learning media allows students to find concepts independently so that students actively involved in learning and students feel challenged in finding [5].

Realizing the many benefits of using computer technology and Macromedia flash programs to develop mathematics learning media as a tool in the learning process as well as the lack of learning media on distance material in space, the author tried to conduct a research entitled "Development of Constructivist-Based Mathematics Learning Media on Materials. Geometry"

2 Methods

According to the Puslitjaknov Team (2008), the development model is the basis for developing the product to be produced. The models are procedural, conceptual models, and theoretical models [6]. The model in this study refers to the procedural development model, which is a descriptive model.

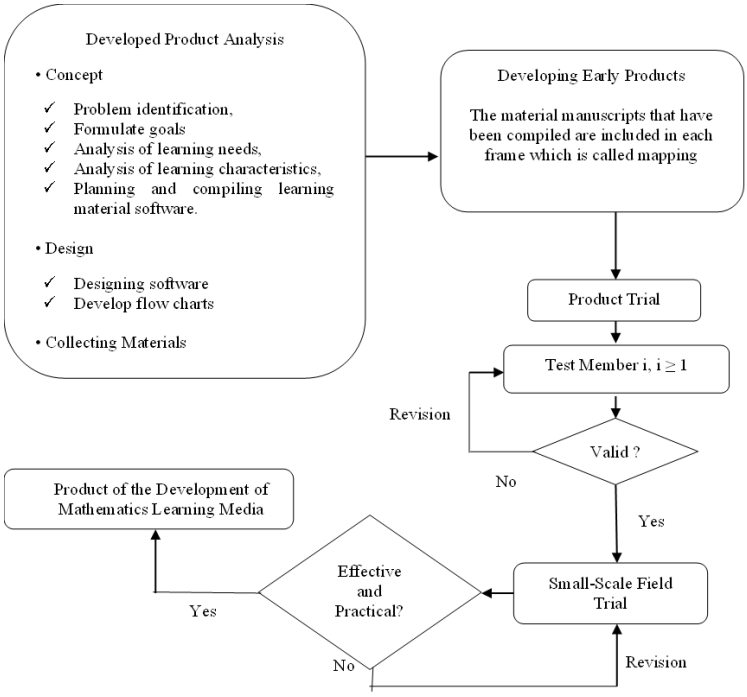

Fig 1. Research implementation procedure.

The development model refer to Borg and Gall (1989) and modified by Soenarto (2003), which involves several main steps, including product analysis developed, developing initial products, product trials consisting of expert validation and revision, scale field trials small scale and product revisions, large scale field trials and final products [7][8].

3 Results and Discussion

3.1 Expert Test

Validation scores for learning media and research instruments from experts in the field. Based on the scores provided, it has indicated that the media and instruments are considered valid according to established validity criteria. Here is a breakdown of the scores mentioned and their implications:
Validity Scores: Learning Media (according to media experts): 3.36, Learning Media (according to learning experts): 3.36, Worksheets: 3.27, Observation Sheets on the Implementation of Learning Media: 3.33, Student Assessment Sheets of Learning Media in Math: 3.33
Interpretation: The scores provided are in the range of 3.27 to 3.36, above the midpoint of a hypothetical scale (e.g., a scale of 1 to 4). This suggests that the validators have collectively rated the learning media and research instruments as valid.

Validity Criteria: We have mentioned that these scores align with established validity criteria. This indicates that the materials and instruments meet the predetermined standards for validity. These standards have been set to determine when the materials are valid for further testing.

Implication: Based on these validation scores and the fulfillment of validity criteria, it has concluded that the learning media and research instruments are considered valid and feasible to be tested in the next phase of development, which involves small-scale field trials.

Overall, it is a positive outcome that learning media and research instruments have been rated as valid by expert validators. This suggests that the materials are likely to be effective and suitable for the intended educational purposes and can proceed to the next stage of testing and development. However, it is important to remember that further testing and revisions will still be necessary as the development process continues.

3.2 Field Trial

This trial was conducted to assess the practicality and effectiveness of learning media. This trial was conducted on students of the Mathematics Education study program and was carried out for 3 (three) meetings with a time allocation of 2 × 50 minutes in each meeting.

This field trial is a small-scale field trial where two meetings are held for learning and one meeting for a material mastery test (evaluation), and students fill out student assessment sheets for mathematics learning media. The trial runs from 19 April 2022 to 10 April 2022.

Two observers observed this field trial. Acting as an observer is a lecturer in mathematics education at Tamansiswa University. When carrying out field trials, it was seen that students were very enthusiastic about participating in the learning process using

mathematics learning media. During this small-scale field trial, the researchers faced several obstacles, including the researcher needing help to be able to use the computer labor room because the labor was under repair and the activities were moved in the classroom.

Learning Media Practicality Data. Based on the results of observing the implementation of learning media, the practicality score (P) is 3.58. According to the established practicality criteria, the learning media is practical and does not need to be revised.

Learning Media Effectiveness Data. One of the criteria for the effectiveness of learning media is the completeness of learning outcomes. The material mastery test (evaluation) was followed by the second-semester students of the Mathematics Education Study Program at Tamansiswa University. This material mastery test (evaluation) was carried out at the third meeting on 24 April 2015. The average value of the results of the material mastery test (evaluation) is 83.70. Classically, the results of this test are said to be complete, which is 88.89%.

Student assessment of this media was given at the third meeting after the material mastery test (evaluation). This student assessment sheet on the media is one of the criteria for the effectiveness of learning media. This student assessment consists of five aspects. The average student gives a positive assessment ($\bar{S}$) of 0.67. According to the criteria set, the student's assessment of the mathematics learning media is positive. Based on the results of field trials, there were several findings of errors made by students in completing evaluation questions including:

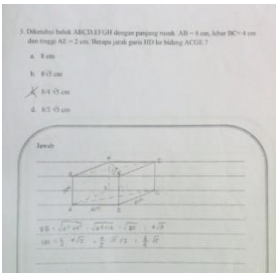

Fig 2. The results of the first student work.

In Figure 2, students draw a block with the appropriate side ratio, but the solution still needs to be entirely right. Students can project from the drawn point to the projection plane and find the length of the line segment EG. To find the distance of the HD line to the ACGE plane, namely the length of the HO, the students look for it with half the length of the HF line segment.

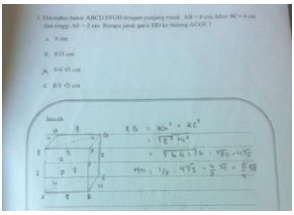

Fig 3. The results of the second student's work

In Figure 3, there is an error in the visualization stage, so the solution is also wrong. The visualization stage is when students draw blocks like cubes, even in different sizes. The researcher concludes that one of the factors why students visualize wrongly is because the learning media only provides examples of cube shapes, so students focus on these shapes.

Revised Product Development Results. Based on the results of quantitative data analysis, it is known that the developed learning media has met the valid, practical, and effective criteria, so it does not need to be revised. However, in qualitative data, there are several inputs, suggestions, and observations from developers during the trial, so the learning media developed needs to be improved.

In this study, constructivist-based learning media was developed. The development of this learning media aims to help build an understanding of the concept of distance in spatial shapes. After using this media, students are expected to be able to use the unique properties that apply to specific flat shapes, the positional relationship between points, lines, and planes, and to use the concept of the Pythagorean theorem in solving problems related to distances in shapes.

The development of learning media has undergone stages of development from Gall (1989) and modified by Soenarto (2003), namely analysis of developed products, development of initial products, product trials consisting of expert validation and revision, and small-scale field trials [7][8].

Based on the results of validation and testing, constructivist-based mathematics learning media on distance material in spatial shapes are valid, practical, and effective. The validity of the learning media was obtained from the validation results of media experts and learning experts. The validation results show that the average score of all aspects is 3.26. Because the average score of all aspects is 3, the learning media meets the established validity criteria, namely, valid.

According to Nieven (2011), media includes content validity (relevance) and consistency validity (consistency) [3]. A product is valid if the formulation and preparation of the developed media product is based on scientific knowledge and is designed logically. There is a link between the components in the developed media product. From the explanation above, the constructivist-based mathematics learning media on geometry material is valid.

The practicality of learning media is obtained from the implementation of learning media, carried out by two observers, obtaining a practicality score of 3.58. Because the score is 3, the learning media meets the specified practicality criteria, namely practical. According to Nieven (2011), a product is practical if the developed media can be used in real situations where the media is created and developed [3]. Internally, the developed media can be applied in the classroom, and operationally, the developed media can be appropriately applied by the teacher. From the explanation above, the developed media is practical.

The effectiveness of learning media is obtained from the results of the material mastery test (evaluation) and student assessment sheets of learning media. The results of the material mastery test (evaluation) showed that 88.88% of students completed it. In comparison, the results of the student assessment sheet on the learning media were obtained with an average score of 0.67. Based on the established effectiveness criteria, the learning media is declared effective.

A product resulting from development is effective if it can achieve the expected learning objectives. Media as a development product is said to be effective if student activities participating in the learning process use development products with high categories [3]. From the explanation above, the research media developed is effective.

4 Conclusion

a. This learning media allows students to construct their understanding so that students are actively involved in learning.
b. This learning media has the potential to be used for self-study in order to achieve learning objectives with distance material in building spaces. This is because this learning media was developed with a narration (tutorial with voice), equipped with components of instructions, competencies, material descriptions, sample questions, exercises, and evaluations.
c. This learning media contains material on distance in spatial shapes and questions that direct students to find the concept of distance in spatial shapes.
d. This learning media is equipped with pictures and animations in everyday life related to distance.

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