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THE DEVELOPMENT OF INTERACTIVE MATHEMATICS MULTIMEDIA FOR LEARNING TRIGONOMETRY WITH REALISTIC MATHEMATICS EDUCATION (RME) APPROACH

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Abstract

The use of technology in mathematics instruction is intended to help develop a constructivist-based learning environment, a learning environment that allows students to construct their own knowledge. This research aims to describe the process and the result of the development of the interactive mathematics multimedia for learning trigonometry with Realistic Mathematics Education (RME) approach measured by aspects of validity, practicality, and effectiveness. The subjects were students of grade X. This research was developmental research that used ADDIE model development through five stages such as analysis, design, development, implementation, and evaluation. Data collecting method used in this research were in form of validation by the expert, and the field tests to obtain data practicality and effectiveness of the media. The results showed that the interactive multimedia that has been assessed by the validator get the valid criteria with a percentage of 78.5%. Student questionnaire results in the field test showed a percentage of 90%. Moreover, after using the interactive multimedia mostly students achieve excellent learning achievement, it is shown through the classical completeness of students test result that is 80.6%. Based on the results of expert evaluation and field test showed that the developed interactive multimedia has been valid, practical, and effective.

Keywords: interactive multimedia, realistic mathematics education, trigonometry, ADDIE

INTRODUCTION

The purpose of learning mathematics is not just mastery of certain materials by students to answer math problems mechanically, but also enhance students' performance to solve problems in their life. Mathematics is often regarded as abstract subjects, difficult, and tedious. In general, students often have difficulty in learning mathematics, this is partly due to the low interest and motivation of students in learning mathematics.

One of the difficult subject in mathematics is trigonometry. A research by Usman (2017) showed that the most frequent errors made by students in solving problems in trigonometry is comprehension error. Most comprehension errors occur when students do not understand how to approach a given trigonometrical problem from the concept. That's because students just accept the concept that given from the teacher and do not know the history of the concept. Since every concept of mathematics is based on real life problems, then students have to know the origin of the concept so that students can apply the concept to solve the problem. The objects in mathematics are abstract. Because of its abstract nature, teachers and students experience some obstacles in the learning process. To reduce the level of student's abstraction to mathematics, this time has been introduced Realistic Mathematics Education (RME) Approach.

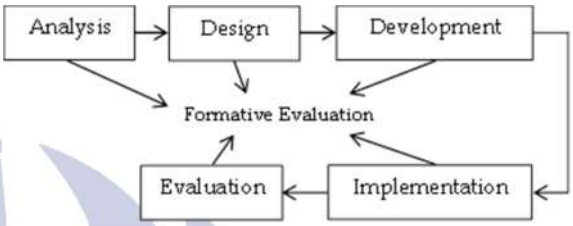
Realistic Mathematics Education (RME) approach is a learning theory in mathematics

education based on the idea that mathematics as human activity and mathematics must be connected significantly to the context of everyday life of students as a source of development and as an area of application through mathematical processes. The main idea of RME is that students should be given the opportunity to reinvent the concepts and principles of mathematics under the guidance of adults. Gravemeijer (1994: 91) stated three key principles of RME, ie guided reinvention progressive mathematization, didactical phenomenology and self developed models. Difficulties experienced by students in learning mathematics also can not be separated from the application of learning methods that are less precise. The mathematics learning done by the teacher during this time is learning in the following order: (1) explaining the mathematical objects, (2) giving examples of newly described mathematical objects, (3) asking students to solve similar problems with the example, and (4) giving exercises. This type of math learning tends to make students feel bored, uninterested, less creative, less developed. Edgar Dale theorized that learners retain more information by what they "do" as opposed to what is "heard", "read" or "observed". Various innovations in learning mathematics need to be done as an effort to improve the quality of learning mathematics.

One of those innovations is using learning media in teaching and learning mathematics. According to Guerrero (In Fadaee, Eslami, and Farhadian, 2008), the use of technology in mathematics instruction is intended to help develop a constructivist-based learning environment, a learning environment that allows students to construct their own knowledge. Therefore, the development of the media such as interactive multimedia with RME approach for learning trigonometry needs to be improved to assist in the learning of mathematics.

METHODOLOGY

This research includes the type of research development. In this developmental studies, the researcher used ADDIE development model includes five phases, namely: Analysis, Design, Development, Implementation and Evaluation. The evaluation was conducted based on the evaluation of Tessmer, the evaluator would conduct expert review first, revise the instruction, and then conduct one-to-one and small group evaluation and polish the instruction once again. Revisions may be made between the one-to-one and small group. The final step is then to field test the instruction in the learning environments for which it was intended. The experimental design is shown below.



The subjects in this study were X-grade high school students from SMAN 2 Sidoarjo. Based on the theory of Nieeven (1999), the result of an educational product must be of good quality. The criteria of the product that said to be good quality are valid, practical, and effective. The data collection instruments used in this study are media validation instruments that was given to the expert, media practicality instruments in the form of questionnaire that was given to students, and media effectiveness instruments in the form of test of learning achievement that was given to students. The expert review of media validation conducted by a mathematics lecturer that is an expert in the media, expert in the content, and expert in RME approach. The validator is Evangelista Lus W. Palupi, S.Pd., M.Sc., mathematics lecturer from Universitas Negeri Surabaya. The interactive multimedia is said to be valid if the score validation reaches the percentage score of ≥ 70%.

$$value = \frac{(total\ score\ obtained)}{maximum\ score} \times 100\%$$

Table 3. 1 Category of expert validation results

Percentage (%)	Category
$86 \leq HVA \leq 100$	Very Valid
$70 \leq HVA \leq 86$	Valid
$56 \leq HVA \leq 70$	Less Valid
$0 \leq HVA \leq 56$	Invalid

Questionnaires given to the students to determine the practicality of interactive multimedia that

contains 10 statements. Calculate the response value of learners who respond according to certain criteria by the formula (modified from Riduwan, 2009):

$K_i = n_i \times A_i$

$T = \Sigma K_{max}$

Percentage Score (%K) = $\left(\frac{\sum_{i=1}^{4} K}{T}\right) \times 100\%$

Explanation:

T = Maximum Total[∑(n × maximum answer score)]

K = Skor of each option

n = The amount of respondent who choose the answer

A = Answer scores

Then determine the percentage criteria of respondents' response value per item.

Table 3. 2 Criteria of respondents' response value per item statement

Score Each Item	Interpretation
80% ≤ K < 100%	Excellent
60% ≤ K < 79%	Very Good
40% ≤ K < 60%	Good
20% ≤ K < 40%	Fair
0% ≤ K < 20%	Poor

Calculate the number of very good and excellent criteria from all points of the statement by the formula

$$Score = \frac{Total\ of\ very\ good\ and\ excellent\ item}{Total\ item} \times 100\%$$

Table 3. 2 Criteria of score questionnaire interpretation

Score Questionnaire	Interpretation
81% - 100%	Very Practical
61% - 79%	Practical
41% - 60%	Reasonably Practical
21% - 40%	Impractical
0% - 20%	Very Impractical

The learning achievement test is used to assess the effectiveness of interactive multimedia. Interactive multimedia is said to be effective if 75% of students in a class obtain the KKM that is 78.

$$Classical\ Completeness = \frac{\sum completed\ students}{\sum all\ students} \times 100\%$$

RESEARCH RESULT AND DISCUSSION

Analysis

In this phase, researchers conducted several activities, namely 1) analysis of needs and students' characteristics, 2) curriculum analysis, 3) technology analysis and 4) situation analysis. Data obtained based on the observation in the class are the need for learning innovation to increase students contribution in the learning process such as the use of technology and rediscover mathematical concept, the prior knowledge, academic ability, and potential of students to learn trigonometry using learning media with RME approach.

Design

In this phase, researchers prepare the media content from books and journals related to learning trigonometric concepts and then associated with RME principles. Create a storyboard of interactive mathematics multimedia for learning trigonometry with RME approach. Prepare the research instruments include: validation sheet, questionnaire, and learning achievement test.

Development

Interactive multimedia software developed using Adobe Flash CS5. Researchers create an interactive mathematics multimedia with RME approach then do the formative evaluation. The steps taken by the researchers are as follows: (a) Make the frames that corresponding to the storyboard, (b) Fill in the material and games text in the frame, (c) Fill in images and create animations related to trigonometric material, (d) Fill in the programming language for each frame, (e) Fill in the backsound and narration into frame, and (f) Convert the main format into *.swf and *.exe so it can be used in all type of laptop/computer, and (g) Do the formative evaluation to expert review, one-to-one, and small group.

Interactive multimedia development through an evaluation period as well as input and suggestions from expert then one-to-one and small group. In the expert review, the media was assessed by the expert. The result of validation is 78.5%, so it categorized as valid. In the test one to one evaluation, there are two students who become the object of this study, while small group evaluation tested on 8 students. The questionnaire result showed 100% and 90% of one-to-one and small group practicality. The students'

learning achievement of one-to-one is 100%, while in the small group is 75%.

Implementation

The trial of interactive mathematics multimedia based on RME approach aims to test the practicality and effectiveness of the media developed after it has been validated by a validator and has been tested into one-to-one and small group. The trial was conducted on 13 and 14 March 2018 at SMAN 2 Sidoarjo. From the questionnaire result, the percentage score is 90%, so the media categorized as practical. The learning achievement of 31 students showed that twenty-five students are declared complete and six others are not complete. The classical completeness is 80.6%, then the media categorized as effective.

Evaluation

Based on data analysis that has been implemented in the previous stage, the developed learning media meets the following criteria.

1) ***Valid*** with the percentage of 78.5%.
2) ***Practical*** with the percentage of 90%.
3) ***Effective*** with the classical completeness of 80.6%.

Discussion

In the research result that has been discussed in the previous section shows that the interactive mathematics multimedia for learning trigonometry with Realistic Mathematics Education (RME) approach developed has met the valid, practical, and effective criteria. But despite that, there are still some weaknesses in the development of this media. The first weakness is to raise the principle of RME is the principle of self-developed model. On that principle, students should be able to explore and freely determine strategies in solving trigonometric problems, but because this media is not able to provide facilities where students are free to use any strategy, then in this media was made plots that guide students using similarity in solving trigonometric problems. The second weakness is the subject matter developed in this media only for one basic competence (cognitive and skills). The third weakness is the lack of teacher contribution in this media. Considering this media is used in learning, there must be a teacher's contribution.

CONCLUSIONS AND SUGGESTIONS

This study was a research development. The development process was done through five stages: analysis, design, development, implemention, and evaluation. There are three stages of evaluation: one to one evaluation, small group evaluation and field test evaluation. The results showed that the development of interactive multimedia for learning trigonometry with RME approach is declared valid, practical and effective.

The researchers provide suggestions for the development of interactive multimedia for learning trigonometry with RME approach can further the better. In the development of interactive multimedia, researchers should note the existing learning schedule in schools that will be addressed.

In raising the principle of self-developed model, researchers should provide space with actionscript so that students have the opportunity to develop their strategy on this media. In involving teachers on the use and development of the media can be in the form of questionnaires and interviews of teachers for media practicality.

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