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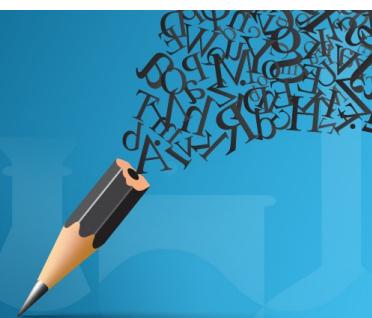


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# Design of Virtual Reality-Based Mathematics Learning Media on Trigonometry Material in Senior High School

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**Abstract.** Students' understanding of the concept of trigonometry is still low. This is because students have difficulty imagining the concept of angles in trigonometry which is only limited to memorizing formulas. Thus, it is hoped that through virtual reality-based mathematics learning media, students will be very helpful to learn about trigonometry concepts. This study aims to produce a virtual reality-based mathematics learning media on trigonometry material in high school that meets the valid criteria. This type of research is development research that is applied with the ADDIE model which includes the Analysis, Design, Development, Implementation, and Evaluation stages. The research subjects involved were students of class X SMA N 1 Tahunan Jepara. The sampling technique used was purposive sampling. The results of this study are virtual reality-based mathematics learning media on trigonometric material with material expert validation results with a feasibility percentage of 91,25% and media expert validation results of 92,00% with very good criteria. Thus, this product is suitable for senior high school students as an innovative learning medium.

## INTRODUCTION

Mathematics is the science of deductive theory starting with primary ideas and axioms. Through the main idea of all other ideas is defined. A theorem can be proven true based on axioms by using certain inference rules. Therefore, mathematics teachers can form in their class a series of definitions, theorems and proofs as a framework for understanding the material in mathematics learning [1]. According to [2] Mathematics learning requires special attention from teachers to students in conveying a concept. Teachers need a tool in the form of media in conveying material that is considered difficult by students. Teacher and students need to use mathematical activity instruments in solving a problem related to the material difficult to use technology.

One of the mathematics material that is considered difficult for students is trigonometry material. Trigonometry is a field of mathematics that students believe is very difficult and abstract compared to other mathematics subjects. The majority of errors made by students in solving trigonometric problems are incorrect equations, order of operations, and sin values, cosine, misused data, misinterpreted language, logistically invalid inference, distorted definition, and technical and mechanical fault [3]. Trigonometry is understood as the relationship between the angles and edges of a right triangle. In general, trigonometry is taught through the memorization method. This learning is generally active in the short term and difficult to transfer principles learned in new situations. The main reason for student errors is due to the teaching method. Thus, learning trigonometry needs to be given by the teacher with a new method [4].

The application of innovative learning media is one way for teachers to overcome the low understanding of students' concepts. Through the Trigonometry app in the form of an android-based pocket book declared valid and practical to use during the learning process [5]. According to research conducted by [6], concluded that the use of learning media that optimizes the use of the human senses to capturing a variety of learning materials can be a good alternative used by teachers.

With the rapid development of technology today, virtual reality is one of the alternative learning media that can be developed. Virtual reality is virtual reality experience like no matter where the user is effectively immersed in responsive cyberspace. It implies user dynamic control of viewing angles. The four technologies that are critical to VR are that visual (and aural and haptic) display immersing the user in the virtual world and block it give off a contradictory sensory impression of the real world; graphics rendering system that produces, at 20 up to 30 frames per second, ever-changing image; a tracking system that continuously reports the position and orientation of the user's head and limbs; and database construction and maintenance system to build and maintain detailed and realistic virtual world model [7]. Virtual Reality (VR) is an advanced technology, simulating human-computer interface realistic environment. Participants can move around in cyberspace. They can see it from a different point of view, grab it, grab it and reshape it. There is a small screen of symbols for manipulation or commands that must be entered to get computer to do something [8]. Based on the background description above, the purpose of this study is to produce virtual reality-based mathematics learning media on trigonometry material in high school that meets valid criteria.

## METHOD

This research includes educational research and development. This research method is the method used to produce virtual reality-based mathematics learning media products on trigonometry material. The subjects of this study were students of class X SMA N 1 Tahunan. The development procedures using the ADDIE model according to [9] are (1) analysis, (2) design, (3) development, (4) implementation, (5) evaluation. The analysis stage in this research is the analysis of performance and needs analysis related to the development of learning media. At the design stage, it is necessary to have a classification of learning programs designed to achieve learning objectives. In the development stage, the framework that has been designed will be realized into products that can be implemented. In the implementation phase, researchers apply the resulting product into learning. At the evaluation stage carried out are comparing the learning outcomes that have been achieved with the objectives previously formulated learning. The procedure can be seen in Fig 1.

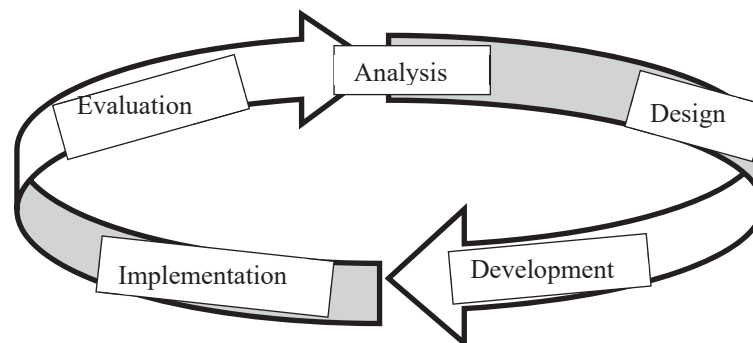


FIGURE 1. ADDIE model

## RESULTS AND DISCUSSION

Based on the ADDIE model procedure, the stages of implementing this development research are as follows:

### Analysis

At the analysis stage, the researcher conducted a needs analysis to develop a new product in the form of virtual reality-based mathematics learning media. The analysis was conducted through interviews with mathematics teachers at SMA N 1 Tahunan. Based on the results of the interview, it is known that there is still a lack of utilization of technology-based media. Therefore, it is necessary to develop learning media that can solve these problems. In addition, based on observations, it is shown that there are still many students who have difficulty understanding the concept of trigonometry. This is because there is no learning media that is used visually. After analyzing the needs of the newly developed media, the researcher also analyzed the feasibility of the new media

developed. Media analysis needs to be done to determine the feasibility of the media if applied. At this stage the researcher will conduct a preliminary analysis, namely analyzing the learning tools including the syllabus, lesson plans, and learning objectives on trigonometry material. Virtual reality is a technological development that currently promises to present a more interesting learning.

## Design

At this stage, the researcher designs a product that will be developed based on the results of the analysis that has been done in the previous stage. This research resulted in a virtual reality-based learning media design on trigonometry material. The software used in making the design is the Blender and Unity software. The display of the learning media can be seen in Figure 2.

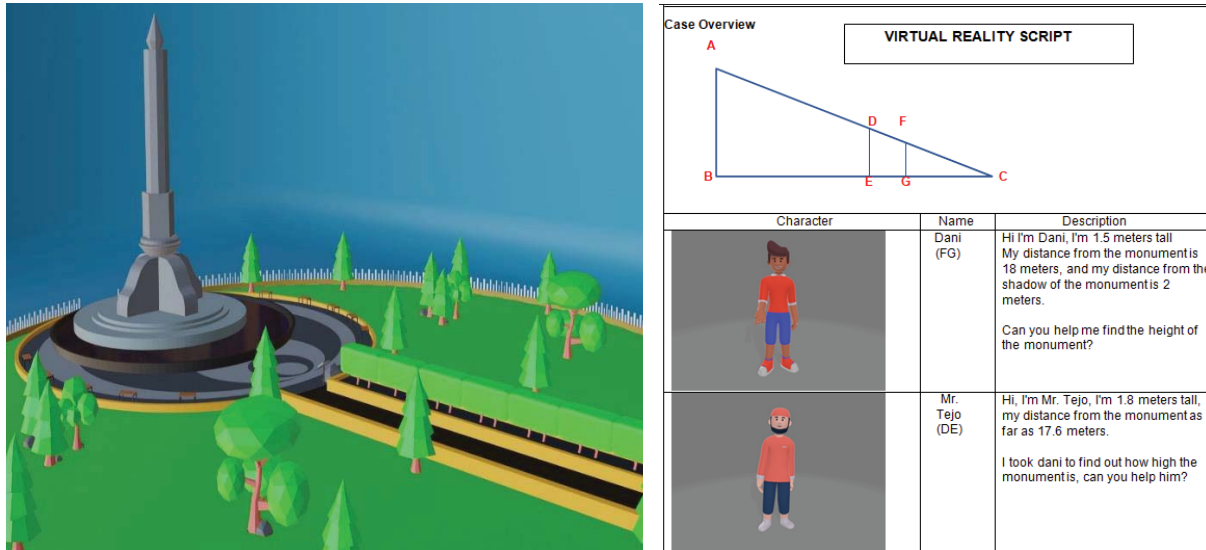


FIGURE 2. Design of virtual reality-based learning media on trigonometry material

## Development

At the development stage, researchers packaged trigonometry material into a virtual reality-based learning media. Then to see the feasibility of the product, validation of media experts and material experts was carried out. The results of expert validation calculations are as follows:

### 1. Material Validation

Material experts assess virtual reality-based learning media on trigonometry material through filling out questionnaires. The questionnaire filled out by material experts has 4 aspects, namely Aspects of Material Substance, Use of Language, Utilization and Evaluation of Questions. The validation results from material experts can be shown in table 1.

TABLE 1. Material expert validation results

No.	Aspects of material expert assessment	Desired score	Rating score	Eligibility percentage
1.	Material Substance	40	37	92,50%
2.	Use of Language	15	13	86,67%
3.	Utilization	15	14	93,33%
4.	Evaluation of Questions	10	9	90,00%

For the next stage, the researcher conducted an overall analysis of the results of the material expert validation. Based on the calculation of the validation of the material experts above, the percentage of feasibility of

virtual reality-based mathematics learning media on trigonometry material is 91.25%. Then after being converted into a scale conversion, it is in the range of 81% - 100%. So it shows that the media meets the criteria very well.

Comments from learning material experts (validation of material expert assessments) in general are that the media is very good because it contains material systematically in accordance with the learning objectives. In addition, trigonometry material is packaged very interestingly for students to learn trigonometry because it is equipped with practice questions and discussions.

## 2. Media validation

Media experts assess virtual reality-based learning media products on trigonometry material by filling out a questionnaire. The questionnaire has 4 aspects, namely General Appearance, Media Presentation, Language Feasibility and Visual Communication. The results of media expert validation are shown in table 2.

TABLE 2. Media expert validation results

No.	Aspects of media expert assessment	Desired score	Rating score	Eligibility percentage
1.	General Appearance	20	19	95,00%
2.	Media Presentation	20	18	90,00%
3.	Language Feasibility	15	14	93,00%
4.	Visual Communication	20	18	90,00%

The next stage, the researcher conducts an overall analysis based on the results of media expert validation. Based on the calculation of media expert validation, the percentage of eligibility for virtual reality-based mathematics learning media in trigonometry material is 92.00%. After being converted into a scale conversion is in the range of 81% - 100%. Thus, the media meets the criteria very well.

Media expert comments in general, namely virtual reality-based mathematics learning media on trigonometry material is an interesting medium for class X learning in high school. This is because the media is able to help students understand the concept of trigonometry visually through virtual reality. Thus, students do not only memorize formulas but learn concepts using interesting and fun learning media.

The results of this study are also supported by research that has been carried out by [10] which states that a learning using virtual augmented reality-based learning media is able to overcome students' difficulties in learning geometry. With technology-based games, students tend to have a more enjoyable learning experience so as to increase student activity. While [11] states that Virtual Reality is very useful for providing some opportunities: increasing student engagement; provide constructivist, authentic experiences to influence student identity; enabling the taking of new perspectives and empathy; and supports creativity and the ability to visualize difficult models. Virtual reality (VR) technology is a very attractive platform for inserting learning materials, assignments in a certain time in a learning environment as if it were real. So that there is a certain satisfaction that a student is able to use this Virtual Reality-based learning media [12].

## CONCLUSION

Virtual reality-based mathematics learning media on trigonometry material has been produced with product validation results of 91.25% and media experts 92.00%. That means that the virtual reality-based mathematics learning media on trigonometry material has been valid/feasible to use in senior high school. Thus this learning media can be used as an alternative media that is innovative and fun to use in learning mathematics in high school. Based on the results of this study, it is hoped that researchers can develop virtual reality-based mathematics learning media on other materials.

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