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Implementation of Virtual Laboratory Media to Learning Geometry in Mathematics Education Program of Universitas PGRI Semarang

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ABSTRACT

The current condition of the virtual laboratory is developing rapidly. One indicator is the number of Mathematics students both state and private Universities in Central Java who are looking for references related to practical geometry courses via online between lectures. This raises concern as a lecturer in adding value to lectures, which are adapted to the 21st century learning era today by creating virtual laboratories based on Virtual Reality. This research employed the ADDIE R & D model (Analysis, Design, Develop, Implementation and Evaluation) after the product is finished, the next step is implementing and marketing the product in state and private university in the region of Central Java and its surroundings. The consideration of creating the virtual lab is that the science virtual lab product has not been developed much in Indonesia, in fact this lab is able to display virtual and augmented reality which can increase motivation and learning outcomes. Based on the validation of media and material experts on the virtual geometry lab product, the scores show that the virtual geometry lab product is very suitable for implementing and more than 90% of lecturers and students at the PGRI Semarang University are very happy to implement it.

Introduction

Recently, in the education sector there are many learning media circulating in the market, but not in accordance with the demands of the era, for example, learning media in learning mathematics in universities, so far the learning media for Mathematics and Natural Sciences have not been associated with renewable technology applications such as Augmented Reality and Virtual Reality (Buchori et 2017). Based on this fact, teachers must be able to package and make learning media that is attractive to students and able to improve cognitive and spatial abilities of students for state and private universities in Semarang and its surroundings. Both state and private university, they have not been able to provide a virtual reality-based Mathematics laboratory capable of displaying 3D objects in each application or material. Therefore, it is necessary to create virtual reality-based virtual lab

learning media that can improve students' ability to understand mathematical material in a measurable manner (Arsyad, 2014).

Based on interviews with several mathematics lecturers, both state and private University in Semarang, it shows that almost 80% of the state and private university campuses still use mathematics and science learning media that have not had the touch of renewable technology such as augmented reality, virtual reality, mathematics and other science software applications. This makes a significant finding for the development of learning media in the form of virtual labs that are able to accommodate these problems. Based on Buchori's research (2017) there are several factors that cause low geometry values such as 1) textbooks owned by teachers are less attractive, 2) the weakness of students' skills in creating sketches both flat and space, 3) teachers who teach geometry only use media to make sketches or pictures and there are still a few teachers who use software-based media that makes subject abstraction easier for students, 4) students are still weak in solving problems related to geometry that is dat ang from everyday life. Then reinforced by Agustine, Wiyono, & Muslim (2014), those who have developed virtual laboratory-assisted e-learning for Basic Physics II practicum courses in the Physics Education Study Program, FKIP UNSRI, which greatly help the enthusiasm and learning outcomes of students, were further strengthened by Adi, Suratno, & Iqbal (2016) which shows that the development of a virtual laboratory excretion system is able to increase the learning motivation of high school students by 90 percent increasing their learning motivation.

According to the results of observations made by researchers at Universitas PGRI Semarang, it shows that the learning process of mathematics is less active and less interesting, this is due to the absence of learning media used by lecturers based on renewable media and the laboratory has not been connected to a renewable computer program, thus making students fast bored. Teaching and learning interactions in the laboratory cannot be separated from the influence of the media used by the lecturers in delivering course material. Today's fast growing media for computers and mobile are smartphones (Guimarães, Maffeis, Pereira, Russo, Cardozo, Bergerman, & Magalhães, 2003. The existence of technology, especially smartphones, which are now increasingly developing, must be addressed wisely. The phenomenon of the high number of smartphone users is certainly a challenge and opportunity in the world of education. The challenge is abuse for negative things. Besides being a challenge, the existence of smartphones also brings great opportunities to develop technology that is useful in the field of education. One of the benefits that can be taken from the existence of this technology is to use it as an effective, creative and educational laboratory-based learning medium (Azuma, Ronald T. 1997). So that educational application media can continue to be developed, one of which is Virtual Reality (VR) technology. This is in accordance with Tüysüz (2010) who showed that Virtual Laboratory greatly affects student motivation and behavior in learning chemistry. Based on this background, researchers will develop a virtual laboratory-based learning media using Virtual Reality (VR). This development has been carried out by a research entitled "Implementation of Virtual Laboratory Media to Learning Geometry in Mathematics Education Program of Universitas PGRI Semarang".

Research Methods (Cambria Bold, 12pt)

This research employed the research and development (R & D). R & D is a research method used to produce certain products and to test the effectiveness of these products (Sugiyono, 2010: 407). The research model uses the ADDIE learning design model. This model, as the name implies, consists of five main phases, namely (A) analysis, (D) esign, (D) development, (I) implementation, and (E) valuation. The five phases or stages in the ADDIE model, need to be done systemically and systematically (Personal, 2010: 125). The research procedure that adopts the 5 stages of ADDIE Model development can be seen in figure 1 below:

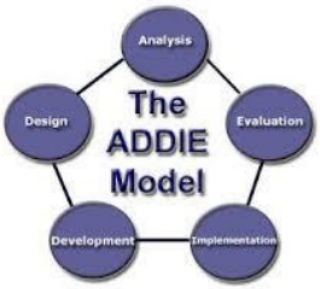

Figure 1. ADDIE Model

The research procedures consist of five stages as follows:

1. *Analysis*

The analysis step consists of two stages, namely performance analysis and needs analysis. The first stage is conducted to find out and clarify whether the performance problems faced require a solution in the form of program implementation or management improvement. In the second stage, the needs analysis is a step needed to determine the abilities or competencies that students need to learn to improve learning achievement (Pribadi, 2010: 128).

2. *Design*

This step requires a clarification of the learning program that is designed so that the program can achieve the expected learning objectives (Pribadi, 2010: 130). In product design, what is done is the next stage of the ADDIE model, namely design. In this step, it is necessary to clarify the learning program that is designed so that the program can achieve the learning objectives as expected (Pribadi, 2010: 130).

3. Development

This development step includes creating, buying, and modifying learning media to achieve predetermined learning objectives. Development steps, in other words, include the activity of selecting and determining appropriate methods, media and learning strategies used in delivering personal material (Sukmadinata, N. S. 2013.). In this development stage, the framework that has been designed will be realized so as to produce a product that can be implemented. In the development stage, Android-based learning media will be made according to the material, after the Android-based media is complete, it will be validated by media experts and material experts by the validator to get input and evaluate according to the input provided by the validator. Furthermore, the Android-based media is revised according to the input provided by the validator to improve the product.

4. Implementation

Implement learning programs by implementing learning program designs or specifications. The main objective of the implementation stage, which is the step of realizing design and development, is to guide students to achieve learning objectives, ensure solutions to address learning outcomes gaps faced by students, and ensure that at the end of the learning program students need to have competency knowledge, skills, and attitudes needed (Personal, 2010: 134). In the implementation stage, researchers applied Android-based learning media using a Virtual Laboratory to build flat-sided space materials.

5. Evaluation

The final step of the ADDIE model is evaluating learning programs and evaluating learning outcomes. As in the analysis step, the evaluation process is carried out by clarifying the competence of knowledge, skills and attitudes. This evaluation is known as formative evaluation. In addition, it can also be done by comparing the learning outcomes that have been achieved by students with the learning objectives that have been formulated previously (Sukmadinata, 2013).

In this research and development, the researcher will evaluate the learning program. The evaluation includes 1) evaluation of the quality of learning media based on the results of the learning media evaluation questionnaire given to media experts, material experts, field experts and students who participated in the trial. This evaluation can be used as input for the revision of the learning media; and 2) evaluation the impact of the use of teaching materials on the problem solving abilities of students who work on posttest questions. This evaluation is used as a material consideration in the use of Android-based learning media using Virtual Laboratory in online classroom teaching and learning activities. After conducting this evaluation, it will be known how the level of effectiveness of the learning program with Android-based virtual lab media in learning geometry.

Results and Discussion

In this study using the ADDIE development model with five stages, in order to obtain the following research results:

1. Analysis

The analysis step consists of two stages, namely performance analysis or performance analysis and needs analysis. The first stage, namely the performance analysis is carried out to find out and clarify whether the performance problems faced require a solution in the form of program implementation or management improvement. In the performance analysis, there has been an in-depth study of the performance of Universitas Terbuka (UT) lecturers who teach geometry courses which show that so far there have been no lecturers who have used a virtual laboratory during the Covid-19 pandemic, so it is very necessary to have this virtual laboratory media in helping students practice in create flat and runag shapes virtually.

In the second stage, the needs analysis is a step needed to determine the abilities or competencies that students need to learn to improve learning achievement (Haryati, 2012). What is clear is that learning media that are able to produce geometry material are packaged virtually and enable students to practice measuring angles in triangles and other geometric materials in an interesting and systematic manner.

2. Design

This step requires a clarification of the learning program that is designed so that the program can achieve the expected learning objectives (Pribadi, 2010: 130). In product design, what is done is the next stage of the ADDIE model, namely design. In this step, it is necessary to clarify the learning program that is designed so that the program can achieve the learning objectives as expected (Pribadi, 2010: 130).

In making virtual laboratory products, geometry courses have been created in a team by the UT research team and assisted by IT experts outside UT so that there is good collaboration with the UT research team to create a material and design framework that is expected in making a virtual laboratory, then executed by IT experts who competent in their field, after the virtual laboratory design is finished for about 2 months, the product is continued in the third stage, namely development.

Figure 2. Design virtual laboratory geometry

3. Development

This development step includes creating, buying, and modifying learning media to achieve predetermined learning objectives. Development steps, in other words, include the activity of selecting and determining appropriate methods, media and learning strategies used in delivering personal material (Sukmadinata, 2013). In this development stage, the framework that has been designed will be realized so as to produce a product that can be implemented. In this development stage, the virtual geometry lab product is validated first to the experts, namely material experts and media experts, so that this virtual laboratory geometry product is really suitable for use before being limited to the mathematics education study program of the UT and the Universitas PGRI Semarang. At the development stage, virtual laboratory-based learning media will be made according to the material, after the Android-based media is complete, it will be validated by media experts and material experts by the validator to get input and evaluate according to the input given by the validator. Furthermore, the Android-based media is revised according to the input provided by the validator to improve the product. Based on 2 validators who are experts in the field of mathematics education and educational technology, the following data are obtained:

Table 1. Validation of instructional media experts

Media expert	Aspect of aplication	Aspect of creativity	Aspect Inovative	aspect visual communication
Nilai Validasi	92%	90%	90%	90%

From the table 1, it is obtained an average score of 91%, which means that the virtual media for the geometry lab is very suitable for use in learning geometry in college.

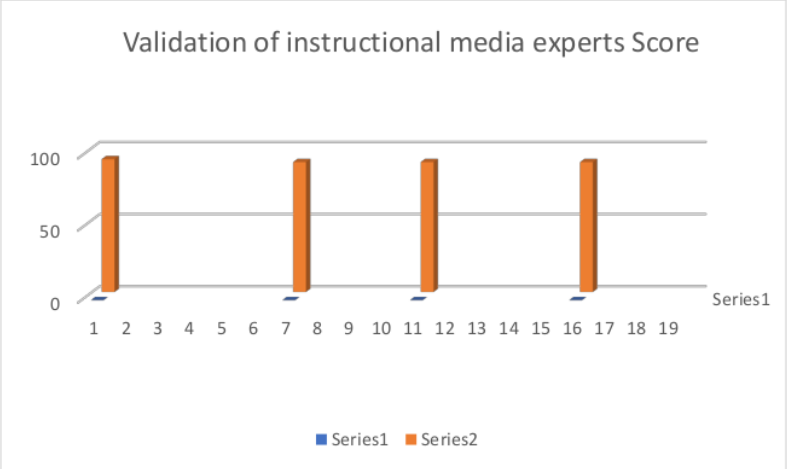

Figure 3. Validation of instructional media experts

Then continued with the validation of learning media experts, it was obtained data that the media virtual laboratory was suitable for use, so that the virtual laboratory media product could be used optimally. Proved by Permadi, Dendi dan Ahmad Rafi. (2015) showed if student using virtual laboratory with augmented reality can be get good score in science learning.

Table 2. Validation of instructional media experts

Material expert	Material Substance Aspects	Language aspects
Score validation	92%	96%

From the table above, it is obtained an average score of 94%, which means that the material in the virtual media of the geometry lab is very suitable for use in learning geometry in college according Zheng, Zhang, and Yang (2015) with *Seam the Real with the Virtual: a Review of Augmented Reality make college student more growed spatial ability.*

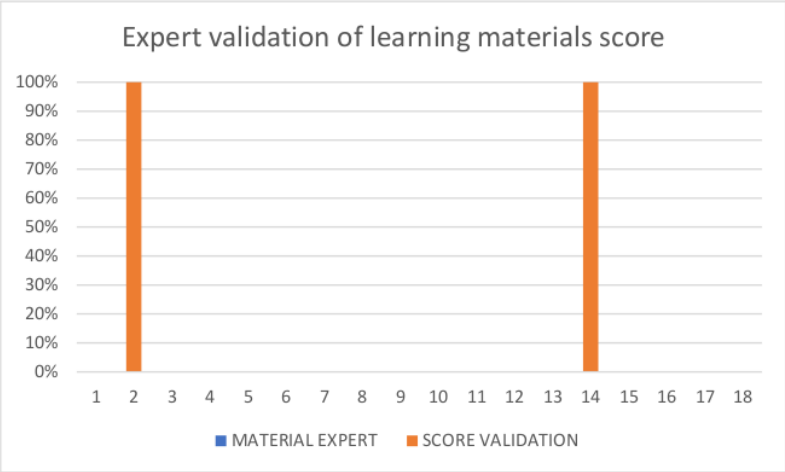

Figure 4. Expert validation of learning materials

Then proceed with the validation of material experts so that the suitability of the content of the material can be accounted for, so that the virtual laboratory geometry media products can be used materially.

4. Implementation

Implement learning programs by implementing learning program designs or specifications. The main objective of the implementation stage, which is the step of realizing design and development, is to guide students to achieve learning objectives, ensure solutions to address learning outcomes gaps faced by students, and ensure that at the end of the learning program students need to have competency knowledge, skills, and attitudes needed (Personal, 2010: 134). In the implementation stage, researchers applied Android-based learning media using a Virtual Laboratory to build flat-sided space materials.

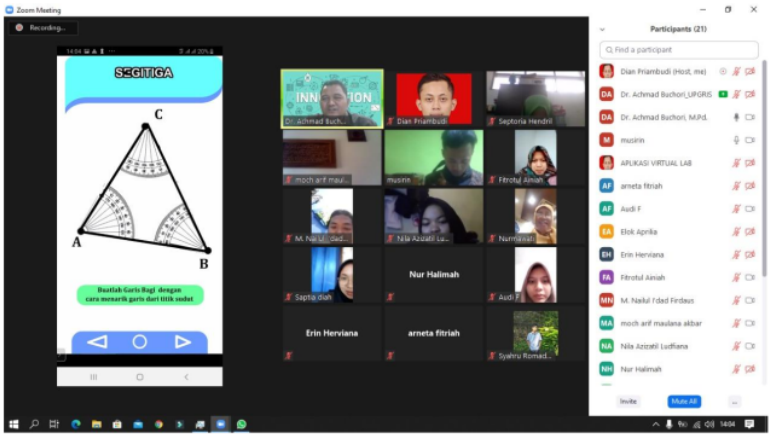

Figure 5. Limited test via zoom cloud meeting

by the research team In geometry learning, it has been done virtually with a zoom cloud meeting which is running smoothly, attended by more than 20 students from the PGRI University of Semarang. According to Mustaqim, Ilmawan dan Nanang (2017) student using virtual laboratory make student happy to learning material. Moreover, Wolf (2009) showed that assessing student learning in a virtual laboratory environment added motivation student and added learning outcome learning mathematics.

5. Evaluation

The final step of the ADDIE model is evaluating learning programs and evaluating learning outcomes. As in the analysis step, the evaluation process is carried out by clarifying the competence of knowledge, skills and attitudes. This evaluation is known as formative evaluation. In addition, it can also be done by comparing the learning outcomes that have been achieved by students with the learning objectives that have been formulated previously (Pribadi, 2010: 135). After practicing the use of a virtual geometry lab, lecturers and students were asked to fill out an online questionnaire with a google form with the results showing that more than 90 percent of lecturers, material experts and learning media and students are very happy to use geometry virtual laboratory products, so Koretsky, Amatore, Barnes, & Kimura (2008) showed enhancement of student learning in experimental design using a virtual laboratory, the student get score maximum after using virtual laboratory.

Conclusion

A virtual geometry lab product has been produced that can be used at the Universitas PGRI Semarang, especially in mathematics education study programs. The product has been expert validated and has received very good responses from users including lecturers, media experts and material experts and then Universitas PGRI Semarang's students. Based on this research, it is recommended that the product be produced in large quantities and can be used outside the Universitas PGRI Semarang because the virtual geometry lab product is very much needed by mathematics education study program students.

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