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Implementation and Evaluation of Using Virtual Laboratory Media to Learning Geometry in Universitas Terbuka and Universitas PGRI Semarang

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Abstract:
The current condition of the virtual laboratory is developing so 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, research methods using 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 university&private university in the region of Central Java and its surroundings, this is because the science faculty virtual lab product has not been developed much in Indonesia, another thing that makes the appeal of this virtual lab product is that it is able to display virtual and augmented reality which can increase motivation and learning outcomes. Student, based on the validation of media experts and material experts on the virtual geometry lab product, it scores 89,57 and 70,84 meaning that the virtual geometry lab product is very suitable for use, then more than 90% of lecturers and students at the Open University are very happy to use it
Kata kunci: virtual lab, virtual reality, geometry, motivationand learning outcome

Introduction

In the world of education today there are many learning media circulating in the market, but not in accordance with the demands of the times, 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 From this reality, 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, state and private universities in Semarang and its surroundings, both public and private, 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.

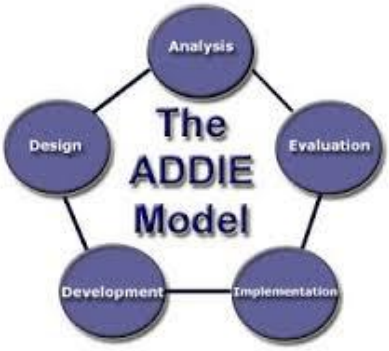
Based on interviews with several mathematics lecturers, both state university&private universityin the city of Semarang, it shows that almost 80% of the state university&private universitystill use mathematics and science learning media that have not had the touch of renewable technology such as augmented 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) weak student skills in make 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, D., Wiyono, K., & Muslim, M. (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, WC, Suratno, S., & Iqbal, M. (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. 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 (Arsyad, A. 2014). 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. So that educational application media can continue to be developed, one of which is Virtual Reality (VR) technology (Azuma, Ronald T.;1997). This is in accordance with Tüysüz, C. (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 "Evaluation of Virtual Laboratory Media to Learning Geometry in Open University"

Methods

This research method is a research and development (Research and Development). Research and development (Research and Development) 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 3 below:



Picture3. ADDIE Model

Preliminary studies 1. Analysis (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 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 (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 (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 (Sugiyono; 2010). 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 (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 (Sukmadinata, N. S. 2013). In the implementation stage, researchers applied Android-based learning media using a Virtual Laboratory to build flat-sided space materials.

5. Evaluation (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).
In this research and development, the researcher will evaluate the learning program. The evaluation includes:
a. 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.
b. Evaluate 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 Discussions
In this study using the ADDIE development model with five stages, in order to obtain the following research results:

1. Analysis (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 open university 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 (Pribadi, 2010: 128). 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 (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 (Tegeh, I. M & Kirna, I. M. ; 2013).
In making virtual laboratory products, geometry courses have been created in a team by the UT research team and assisted by IT experts outside open university 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.

Picture 4. Design virtual laboratory geometry

3. Development (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 (2010: 132). 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 Open University and the PGRI University of 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 2. 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 above, 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.

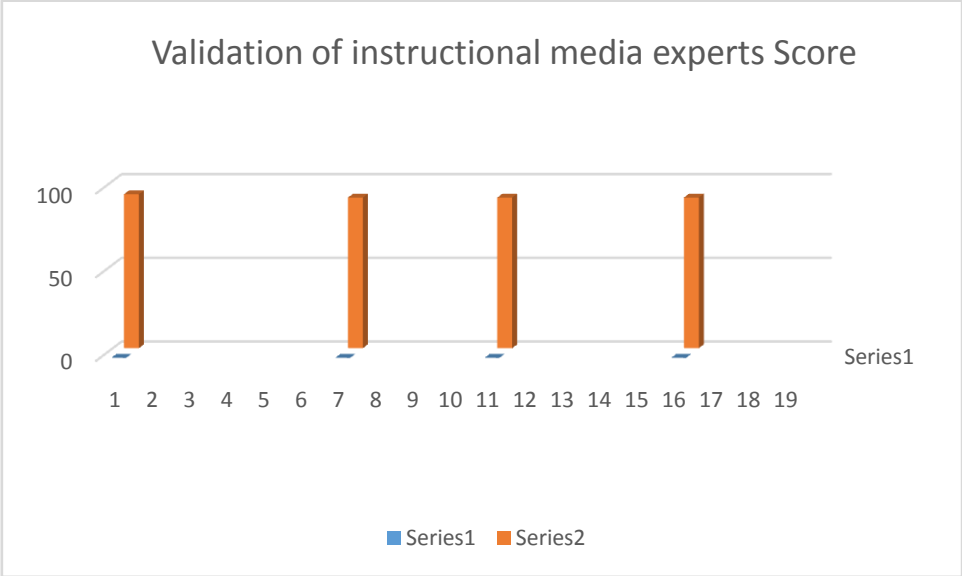


Table 3. Validation of instructional media experts

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.

Table 4. 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.

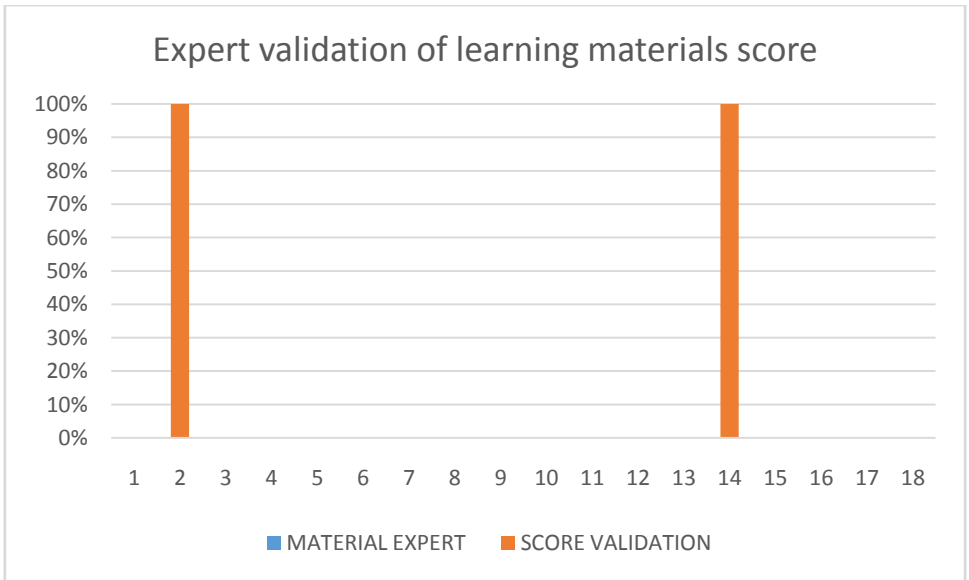


Table 5. Expert validation of learning materials

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 (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 (Sukmadinata, N. S. 2013). In the implementation stage, researchers applied Android-based learning media using a Virtual Laboratory to build flat-sided space materials.

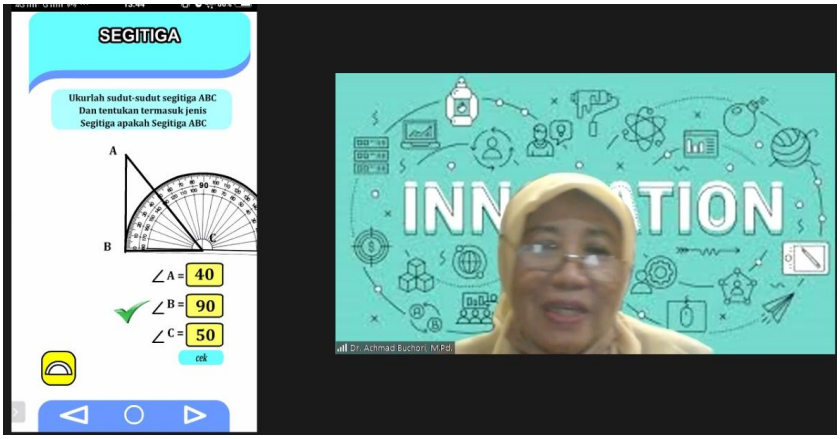


Figure 5. Limited test via zoom cloud meeting

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. 5. Evaluation (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

Students' Responses Result

College Students from Open University and Universitas PGRI Semarang respond to the media of virtual laboratory geometry by filling out a questionnaire given by the researcher via the google form link for students to fill out. The questionnaire link is given to students after students have finished using virtual laboratory geometry media. This is done so that researchers know how well virtual laboratory geometry media is used for students. The results of the analysis of student responses for each question are presented in the following table.

Tabel 2. Students' Responses Result

Number	Criteria	Score	Percentage
1.	Learning by using virtual laboratory geometry media is able to improve students' spatial skills more fun than just using the lecture method	113	90,4
2.	I can understand math learning better	106	84,8
3.	The use of virtual laboratory geometry media based on virtual augmented reality is able to increase student enthusiasm for learning	109	87,2
4.	With the virtual laboratory geometry media based on virtual reality, it makes me more active in learning	104	83,2
5.	Good color composition and media display for interesting learning	109	87,2
6.	Images presented in the virtual laboratory geometry media based on virtual reality clarify mathematical material	106	84,8
7.	Learning by using virtual laboratory geometry media based on virtual reality is able to increase interaction between students	104	83,2
8.	virtual laboratory geometry media based on virtual reality can improve understanding of concepts and is well presented	111	88,8
9.	During the learning, exercises were presented in the magic book math media based on virtual reality which were able to improve students' understanding of mathematics material	106	84,8
10.	The exercises in virtual laboratory geometry media based on virtual reality are in accordance with the material being taught	106	84,8

From the above calculation, the average percentage of the feasibility of virtual laboratory geometry of 85.92% by students. After being converted to a scale conversion table, virtual laboratory geometry media is in the range of 81% - 100%. So placing the position on the criteria is very good. The documentation of data collection at Universitas PGRI Semarang and Open University can be seen in the following figure.

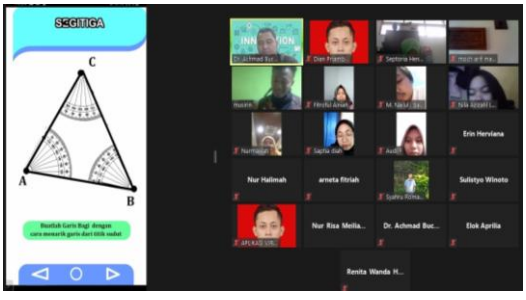


Figure 1. The process of learning mathematics with virtual laboratory geometry

The Effect Test of Students' Responses on Learning Achievement

To analyze the effect of students' responses on learning achievement used simple linear regression and the results obtained can be seen in Table 3.

Table 3. ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2501.886	1	2501.886	78.862	.000[b]
	Residual	697.947	22	31.725		
	Total	3199.833	23			

a. Dependent Variable: Learning Achievement
b. Predictors: (Constant), Students' responses

From the results of the data processing above, the value of F = 78,862 and sig = 0.000 = 0%, which means that H0 is rejected. This result in the linear regression equation having the meaning that students' responses affect learning achievement. To measure the magnitude of the influence of student responses on learning achievement can be seen in Table 4.

Table 4. Summary Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.884[a]	.882	.772	5.632

a. Predictors: (Constant), Students' responses

The magnitude of the influence can be seen from the value of R square = 0.882 which means that 88.2% of student achievement is influenced by students' responses factors in learning using virtual laboratory geometry. Meanwhile, the regression equation can be seen in Table 5.

Table 5. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-37.433	13.377		-2.798	.010
	Students' Responses	1.620	.182	.884	8.880	.000

a. Dependent Variable: Learning Achievement

From this table, the equation Y = -37.433 +1.620X means that each students' responses (x) increases one unit, then learning achievement (Y) increases by 1,620. This research was corroborated by Ferrer-Torregrosa, J., Torralba, J., Jimenez, M. A., García, S., & Barcia, J. M. (2015). ARBOOK: Development and assessment of a tool based on augmented reality for anatomy The ARBOOK group received the same standard sessions but additionally used the ARBOOK tool. At the end of the training, a written test on lower limb anatomy was done by students. Statistically significant better scorings for the ARBOOK group were found on attention–motivation, autonomous work and three-dimensional comprehension tasks. Additionally, significantly better scoring was obtained by the ARBOOK group in the written test. The results strongly suggest that the use of AR is suitable for anatomical purposes. Concretely, the results indicate how this technology is helpful for student motivation,

autonomous work or spatial interpretation (Buchori, Achmad, dkk. 2017). The use of this type of technologies must be taken into account even more at the present moment, when new technologies are naturally (Zheng, R., Zhang. D. and Yang, G. ; 2015)

Conclusion

Learning geometry based virtual laboratory geometry is effective. The effectiveness is because 3 effective indicators have been fulfilled, namely: 1) Students' learning achievement reaches completeness. The average value of the experimental class was 89.57, which was above 70.00. This value indicates the average test score is more than the completeness criteria so that it can be concluded that classical learning achievement is complete. 2) Students' responses during the learning process affect learning achievement. It can be seen from the magnitude of the influence or contribution of students' responses to learning achievement of 88.2%. c. There is a difference in learning achievement between the experimental class and the control class. It appears that the average test score of the experimental class learning outcomes is 89.57, much better than the control class learning outcome test score average of 70.84.

Suggestion: It is recommended that the product be produced in large quantities and can be used outside the UT and UPGRIS campuses, because this virtual geometry lab product is very much needed by mathematics education study program students

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