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DEVELOPMENT OF LEARNING MEDIA BASED ON VIRTUAL LABORATORY IN PHYSICS PRACTICUM

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ABSTRACT

This research is motivated by the lack of use of learning media, especially physics subjects at SMA Makassar Raya. This study aims determine the development of learning media based on virtual laboratory in physics practicum. The type of research used is Research and Development (R&D) research. The research was conducted at SMA Makassar Raya for two weeks in November 2021 with a sample of 20 students. The research method used is a 4D model which includes Define, Design, Development, and Disseminate. The results showed that the virtual laboratory-based learning media was declared valid with a value of V> 0.4 based on the Aiken's V expert agreement index analysis test. The results of data analysis show that the development of virtual laboratory-based learning media is feasible to use to carry out practical practical activities that are effective and can improve students' psychomotor abilities. The effectiveness learning media based on virtual laboratory in learning is shown from practicum activities and physics learning test results with a percentage of 65%.

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1. INTRODUCTION

Learning is a process of interaction that occurs in a learning environment between students and learning resources and educators. The learning process in learning is not only knowing and memorizing but also having students learning motivation in order to understand the material and become a complete knowledge (Haryadi, 2021).

Other research suggests student-centered learning makes learning related to new concepts and information based on relevant and concrete experiences. This provides an opportunity to understand concepts and apply appropriate learning tools (Sari, 2022).

Learning media plays an important role in the learning process. The existence of learning media has an important meaning because it can help students clarify material that is not understood, generate desire and motivation in learning activities (Haqiqi, 2020).

Physics is one of the subjects that are part of the Natural Sciences. Physics studies the phenomena that occur in the natural environment. In studying physics, not just talk about theories or concepts. Instead, people who study physics, are expected to have a skill. This skill is intended as an application to understand the theory that has been learned. As a science, these skills are referred to as science process skills (Rosdiana, 2019).

One indicator of science process skills is planning experiments through practical activities. This practicum activity is intended to apply the theory that has been accepted by students in the classroom. Because the knowledge gained in class is not enough to improve students' science process skills. Practicum in a natural science, is very important, because it is considered as a way that can increase confidence about existing concepts or theories. The existence of a practicum will show how students can be skilled in everything to realize science process skills (Sugiyono, 2017).

The learning process so far, still impressed teacher-centered (teacher oriented). The physics learning process it goes on like that, where is the teacher considered as one of the sources main to be able to receive lessons, while students only receive information provided by the teacher. Thing this is what supposedly caused the result learning does not match expectations. Students only get theoretical knowledge and action passive, while the teacher acts actively in provide information. In addition to this, there are several factors that affect student learning outcomes do not change (increase) (Hajar, 2020).

The problem is caused by several factors, including 1) the inadequate quality and quantity of laboratory personnel causes the utilization of the physics laboratory to be not optimal; 2) the scoring guidelines in the instrument are not clear so that the components assessed are difficult to observe and difficult to use; 3) the appraiser is generally only one person, namely the lecturer in charge, while the components being assessed and the number of students assessed are quite large, so it is difficult to get comparisons to be taken into consideration in making decisions; 4) there may be a tendency to give a high score or vice versa, this is caused by the instrument used does not meet the validity and reliability requirements (Irwan, 2018).

The development of technology in the learning process, especially physics, encourages the creation of a variety of learning media that teachers can choose to use in the teaching and learning process. Such as pouring ideas in making animations or simulations used in the learning process (Gunn, 2017). In addition, there are technological advances that have given birth to new concepts in information technology-based practicum activities or known as virtual laboratories (Arista, 2018).

Virtual laboratory as one of the innovation products of computer-based learning media and technology can be applied in schools that have implemented information technology in their learning process (Duban, 2019). The use of virtual laboratories is very helpful for schools with inadequate laboratory facilities and can require students to have a scientific attitude in finding concepts without working in a real laboratory (Engelou, 2018).

According to Agustine (2014), virtual laboratory is a hard device technology of interactive multimedia that simulates laboratory experiments into a device. Sanggara and Doyan (2019), virtual laboratories are media used to experiments without using real experimental tools. Virtual experiments to help constructive feedback students in the application of their concepts, apply abstract concepts and encourage improvements.

Based on the results of observations made at SMA Makassar Raya, there were several problems found by the researchers. One of the problems found by researchers is that practicum activities cannot be carried out due to inadequate laboratories. As well as the use of learning media, especially multimedia-based learning media, which is still very lacking, causing a lack of interest and motivation of students, especially in SMA Makassar Raya. An alternative learning media that is suitable for practicum when the laboratory is inadequate on virtual laboratory.

The results of the interview with physics teachers at SMA Makassar Raya, namely the use of learning media that is less varied, makes researchers want to develop learning media based on virtual laboratories, especially practicums so that students can learn more effectively and efficiently. This media is used in schools with inadequate laboratories, so students will not worry about the lack of laboratory equipment. This media can also be accessed through the play store, so that it is not only virtual learning through a computer displayed on the LCD but can be used on each student's smartphone during independent learning at home. An analysis of the needs of students was carried out by using a learning style questionnaire test to determine the characteristics of students in learning. The analysis is done by analyzing the learning styles of students which include visual, auditory and kinesthetic. The results of the analysis of learning styles for class XI MIPA Makassar Raya shows that students tend to have a visual learning style.

2. METHOD

a. Types of Research

This type of research is research and development (R&D) with a 4D development model (Santyasa, 2007). This includes 4 stages, namely the stage of defining, designing, developing and disseminating.

The stages of the 4D model are explained as follows:

1. Definition, to determine the learning process and collect various information related to the product to be developed.
2. Design, to design a learning media based on virtual laboratory that can be used by students at practical activities.
3. Development, to produce learning media based on a virtual physics laboratory that has been revised based on expert input and trials to students.
4. Dissemination, disseminating learning media based on virtual laboratory. In this study, only limited dissemination was carried out, namely by disseminating the final product of virtual laboratory-based learning media in learning activities in schools.

b. Location of Research

This research was conducted in the Odd Semester Academic Year 2021/2022. The location of the trial was carried out in class XI SMA Makassar Raya.

c. Subject of Research

The test subjects that will be conducted in this research are 20 students of class XI MIPA SMA Makassar Raya Academic Year 2021/2022. The selection of research subjects was based

on schools with inadequate laboratories and several considerations related to the characteristics of students.

d. Instrument Data Collection

The instruments used to collect data in this development research are as follows:

1) Initial Observation and Interview

Observation is a process of direct observation to the object of research. This stage was carried out to find out the problems to be studied and then interviewed the physics teacher for class XI MIPA SMA Makassar Raya about the learning media used by students in schools.

2) Learning Style Questionnaire

Learning style questionnaires are used to analyze the needs of students and find out more about the characteristics of students in learning. The learning styles of students include visual, auditory and kinesthetic learning styles. The results obtained indicate that students tend to have a visual learning style.

3) Validation Sheet

The validation of virtual laboratory-based learning media is carried out by competent experts.

4) Educator Response Questionnaire

This questionnaire sheet is used to obtain information in the form of opinions and assessments of educators/teachers on the use of learning media based on virtual laboratory in the learning process.

5) Student Response Questionnaire Sheet

This questionnaire sheet is used to obtain information in the form of students' opinions on the learning process using virtual laboratory-based learning media.

6) Learning Outcome Test

This learning outcome test is used to obtain information in the form of the effectiveness of using virtual laboratory-based learning media. This test is done by students after using virtual laboratory-based learning media.

e. Data Analysis Technique

The data obtained from the research are then analyzed to perfect the expected final product. The analysis of the validity of the virtual laboratory-based learning media as a result of expert validation for the virtual laboratory-based learning media was analyzed by considering the input, comments, and suggestions from the validator.

Aiken (1985) formulated content-validity coefficient based on the results of an expert panel assessment of n people on an item in terms of the extent to which the item represents the construct being measured.

Assessment of questionnaire responses of educators and students is done by giving a score based on the provisions. Analysis of the effectiveness in virtual laboratory-based learning media by using student learning outcomes tests.

3. RESULTS AND DISCUSSION

Learning media based on virtual laboratory is considered feasible to be tested if it meets three conditions, namely didactic (content), construction (language), and technical (format)

requirements. To test the feasibility of virtual laboratory-based learning media, Aiken's V formulation is used with the condition that the value of V>0.4. The statement is given through a validation sheet with 36 statement items for the four aspects assessed, namely the material/content aspect, presentation, language and graphics. For the four aspects that become the criteria for learning media, the average validity value ($\bar{V}$) is 0.71 (>0.4). This shows that the learning media developed is suitable for use in research.

After measuring the response of educators to virtual laboratory-based learning media, the results of the analysis of the percentage of educator responses on aspects of material/content, presentation, language, and graphics are as follows.

Table 1. Results of Percentage Response Analysis Educators on Learning Media Virtual Laboratory Based

Aspect	Total Score	Percentage (%)
Material/Content	100	83.33
Presentation	90	83.33
Language	81	84.38
Graphics	85	86.11

Source: Processed Primary Data (2022)

The largest percentage is given to the graphic aspect, which is 86.11%, while the lowest percentage is in the aspect of content/material and presentation presented in virtual laboratory-based learning media, which is 83.33%. In general, the teacher's comments lie in the visualization of animations related to everyday life and practice questions so that students have more information about physics problems visually, auditory, and kinesthetically.

In general, the developed media is in the very good category. The following is a summary of the results of the three teachers' responses, which in the following figure.

Picture 1 Graph on the Percentage of Teacher Responses to Learning Media

After measuring student responses to virtual laboratory-based learning media, the results of the analysis of the percentage of participants responses on aspects of material/content, language, presentation, and graphics are as follows.

Table 2. Results of Percentage Response Analysis Learners Against Virtual Laboratory-Based Learning Media

Aspect	Total Score	Percentage (%)
Material/Content	663	82.88
Presentation	590	81.94
Language	524	81.88
Graphics	588	81.67

Source: Processed Primary Data (2022)

In accordance with the score interpretation criteria used as a reference, the percentage of student responses is in the very positive category.

The level of effectiveness of the learning media, obtained information about the effectiveness of the learning media when used in the learning process.

The following summary of the results of student responses in Picture 2.

Picture 2 Graph on Student Response Percentage of Learning Media

Table 3. The Percentage of Student Learning Outcomes

Category	Percentage (%)	Percentage Learning Outcomes (%)	Total of Students	Conversion Learning Outcomes (%)
Very Low	0-20	0	0	0
Low	21-40	0	0	0
Medium	41-60	58-60	2	10
High	61-80	76-80	5	25
Very High	81-100	82-90	13	65

Total	20	100

Source: Processed Primary Data (2022)

Table 3 shows the percentage of effective learning media from learning outcomes as many as 2 people or as much as 10% meeting the moderate criteria, as many as 5 people or 25% have met the high criteria and as many as 13 people or 65% have met the very high criteria. The learning process is said to be effective if it has high or very high criteria. In accordance with the criteria for categorizing the effectiveness of the learning media that is used as a reference, the percentage of learning outcomes is in the high category.

The following summary of the results of student responses in Picture 3.

Picture 3 Graph on the Percentage of Students Physics Learning Outcomes on Learning Media

This topic is research and development with the aim of producing a valid virtual laboratory-based learning media product so that it is suitable for use in schools, especially in SMA Makassar Raya. Learning media based on virtual laboratory cannot be used in learning, it is necessary to conduct a quality assessment to obtain maximum results.

This research is a type of research and development. The item developed in this research of virtual laboratory-based learning media using a 4D development model. The results of research conducted by researchers; data analysis was carried out the form in analysis of the results of the validity of the content of learning media based on virtual laboratory by experts (experts). The development of learning media based on virtual laboratory that was developed refers to the 4D development model which consists of the stages of defining, designing, developing (develop) and deployment (dessimenate).

The definition stage is the initial stage of designing the development of virtual laboratory-based learning media. At this stage, a needs analysis is carried out to determine the right problems and solutions in the research and development process that will be carried out. The needs analysis here is to determine the competence of students, then analyze the learning media that is used as the basis to see how the advantages of virtual laboratory-based learning media are developed.

Designing a virtual laboratory-based learning media, the researcher conducted a preliminary study, namely conducting initial interviews with physics subject teachers at SMA Makassar Raya. The purpose of this preliminary study is so that researchers can see the initial

problems that exist in schools and then carry out analysis at the next stage, namely student analysis, basic competency analysis, analyzing learning objectives, and conducting media analysis in accordance with the virtual laboratory aspects visual, auditory, and kinesthetic.

One of the principles that must be considered before designing a virtual laboratory-based learning media is student analysis, by looking at the individual differences of students such as basic abilities, psychomotor abilities, learning interests, intellectual level, cultural background and student environment. The conditions that occurred in SMA Makassar Raya showed that the learning activities of students were passive and not student centered (student centered) due to the teacher-centered learning system (lectures). The activities of students are very limited and less able to understand the concepts of Physics being taught. Teachers still use media that focus only on solving problems.

Observations that have been made by researchers, it is considered necessary to develop a virtual laboratory-based learning media that can help students learn independently in practical activities and be able to analyze every concept of Physics in their environment, so that Physics material is easier to understand.

The next stage is the design stage of designing a virtual laboratory-based learning media framework. The design stage in making virtual laboratory-based learning media is the stage of selecting the appropriate virtual laboratory-based learning media format.

The display of virtual laboratory-based learning media is made more proportional by using animations that occur in everyday life. The placement of every aspect of the virtual laboratory, namely visual, auditory and kinesthetic, is displayed with colors, images, and animations so that readers can get to know every aspect of the learning media. Then the preparation of the test instrument for learning physics learning outcomes is carried out based on indicators of competency achievement in each of the basic competencies developed. The preparation of test instruments has been adapted to the concept and integration of the appropriate virtual laboratory aspects (Gunawan, 2013).

After the learning media has been created, the researchers then prepare validation sheets for virtual laboratory-based learning media, teacher response questionnaire sheets, student response questionnaire sheets and Physics learning outcomes test instruments which will then be validated by validators (experts) in the field of Physics. Based on this, the stages in the development model are the basis for the preparation and manufacture of virtual laboratory-based learning media that were developed. The next stage was the development of virtual laboratory-based learning media before being tested in the field (Sukiman, 2012).

At development stage (development) this virtual laboratory-based learning media is ready to be validated by experts. To determine whether a virtual laboratory media can be applied or not in the school, that is by looking at the validation results that have been carried out by experts (validators). The assessment of the media components provided includes (1) assessment of the feasibility aspects of the content (material), (2) assessment of the feasibility aspects of presentation, (3) assessment of the feasibility of language aspects, and (4) assessment of the feasibility of graphic aspects.

The assessment of the feasibility aspects of the content/material includes fixative and manipulative, the assessment of the feasibility aspects of the presentation includes distributive, accessibility, and interactive, the assessment of the language feasibility aspects includes conformity to the level of development of students, communicative language, interactive

dialogue, straightforward and coherent and integrated line of thought , while the assessment of the feasibility of the graphic includes the size of the display, the design of the beginning and the design of the media content (Widoyoko, 2013).

After validating the virtual laboratory-based learning media, three validators assessed the validity of the teacher response questionnaire sheet. From the results of the assessment of the three validators, in general the content component has a percentage of 79.17%, the presentation component has a percentage of 78.70%, the language component has a percentage of 78.13%, and the graphic component has a percentage of 78.70%. By using the Aiken's V expert agreement index, in general the teacher questionnaire sheets have an average of greater than 0.4 so it can be said that the teacher response questionnaire sheets that have been validated are declared valid and can be used in the field with slight revisions.

Assessment of the validity of the student response questionnaire sheet by three validators. The results of the assessment of the three validators, in general the content component has a percentage of 79.17%, the presentation component has a percentage of 78.70%, the language component has a percentage of 79.17%, and the graphic component has a percentage of 80.56%. By using the Aiken's V expert agreement index, in general the teacher questionnaire sheets have an average of greater than 0.4 so it can be said that the teacher response questionnaire sheets that have been validated are declared valid and can be used in the field with slight revisions.

The physics learning outcome test instrument was then validated. The test instrument for learning physics in the form of multiple choice consists of 50 questions. From the results of the validity coefficient test of the Aiken's V expert agreement index, it was obtained an average of 0.72 which was in the Valid category. In general, from the assessment of the three validators, it can be concluded that the developed Physics learning outcome test instrument can be used in the field with a few revisions.

After the validation stage has been carried out by three experts (validators), the next stage is the dissemination stage. At the stage of distributing virtual laboratory-based learning media, it was tested on students of class XI MIPA SMA Makassar Raya. The trial process for using virtual laboratory-based learning media was carried out in class XI MIPA with 20 students.

The learning process in the classroom on static fluid material, using virtual laboratory-based learning media as learning media in the classroom. The researcher as a facilitator analyzes physical quantities in static fluids and their application in everyday life. Students will be grouped into several groups to conduct experiments on virtual laboratory-based learning media (Riduwan, 2010).

At the first meeting the researchers will show how to use and share learning media of applications that can be opened on students' smartphones. Furthermore, at the second meeting the researchers reviewed the material in the learning media, and at the third meeting an experiment was conducted on static fluids in the virtual physics laboratory application. Then the last stage is the evaluation stage to see the effectiveness implementation of virtual laboratory in learning, students are given multiple choice questions totaling 50 questions on static fluid material.

The teacher response questionnaire sheet that has been validated and declared valid, is then given to the teachers to see their response to the implementation of virtual laboratory-based learning media. There are three teachers who provide an assessment of the

implementation of learning media based on virtual laboratory. Aspects assessed in the teacher's response questionnaire include content/material components, presentation, language, graphics, measuring instruments (multiple choice questions), as well as integration of learning media based on virtual laboratory.

In general, the teacher gives an assessment of the media content which is assessed from the suitability of the Physics material with indicators of competency achievement, learning objectives in class XI MIPA. Then in the content/material component, the teacher gives an assessment of the systematic consistency of material presentation in virtual laboratory-based learning media, on the language component an assessment of how to use communicative and interactive language without causing double meaning. The teacher gives an assessment of the formative test instruments contained in the learning media, whether the available practice questions can measure the achievement of student competencies.

Table 2 shows that all aspects of the virtual laboratory-based learning media assessment component that were assessed by the teacher obtained a percentage above 80% for each component. In general, the teacher's response scores for the implementation of virtual laboratory-based learning media are in a very practical category, so it can be concluded that the virtual laboratory-based learning media that have been developed can help teachers and students in the physics learning process to understand the concepts of Physics visually, auditory, and kinesthetically. and it is easier to carry out an experiment in the virtual physics laboratory application to improve the psychomotor of students in learning.

The use of virtual laboratory-based learning media in learning physics in class XI MIPA SMA Makassar Raya was carried out for 4 (four) meetings. The virtual laboratory-based learning media that has been developed is then tested for its effectiveness on static fluid materials. The virtual laboratory-based learning media that was developed consists of integrating visual aspects by presenting information in the form of images, animations, and activities such as conducting simple experiments, then seeing how they are used in everyday life in relation to learning Physics. Furthermore, by looking at the more dominant learning style, namely visual, students can train and use learning styles by looking at pictures or animations as done by students when conducting experiments on applications provided on virtual laboratory-based learning media.

Learning using virtual laboratory-based learning media can make it easier for students to achieve the expected learning goals. In order for an active and effective learning process to occur, the learning media used by students should be virtual laboratories, especially for learning that does a lot of experiments (Valdehita, 2019).

The effectiveness of using virtual laboratory-based learning media can be seen in the achievement of student's physics learning outcomes. Then a limited trial was carried out at SMA Makassar Raya in class XI MIPA, totaling 20 people. After participating in learning as much as 4 (four) meetings, then a test is given at the end of the meeting. The test given is in the form of multiple-choice questions on static fluid material as many as 50 question numbers with a processing time of 90 minutes (2 JP).

The student's physics learning result test in Table 3, it was obtained as many as 2 students in the medium category with a percentage of 10%, as many as 5 students in the high category with a percentage of 25% and as many as 13 students were in the very high category with a percentage of 65%. Based on the results of the research conducted, it can be concluded that

the virtual laboratory-based learning media has a positive impact on learning Physics for class XI MIPA SMA Makassar Raya.

4. CONCLUSION

The results of the content validity coefficient test, the virtual laboratory-based learning media that has been developed has met the Valid criteria based on the results of expert agreement index analysis using Aiken's V content validity coefficient analysis and can be used as learning media in learning Physics. The assessment of the teacher's response to the developed virtual laboratory-based learning media gave a positive response with a very practical category. Assessment of student responses to the developed virtual laboratory-based learning media gave a positive response in the very good category. The effectiveness of virtual laboratory-based learning media is seen from the learning outcomes test. The results obtained by students with a percentage of 65% in the high category, so it can be said that the virtual laboratory-based learning media is effective in learning in class XI MIPA SMA Makassar Raya.

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