Development of Learning Media Based on Virtual Laboratory on Straight Motion Kinematics Materials

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Abstract *- This study aims to determine the feasibility of virtual laboratory media on straight motion kinematics using model problem-based learning and to know how students perceive when using the product that has been developed are reviewed based on the feasibility of the content, graphics, appearance and language. The method used in this study is a quantitative research method obtained from the results of assessments by media expert validators, material expert validators, and student perception questionnaires regarding the product being developed with a sample of 28 students. The sampling technique used was purposive sampling. The instruments used were media validation questionnaires, materials, and perception questionnaires. The data analysis used is descriptive statistics, in which the average result obtained from the five assessment indicators is 79.76%, indicating that the media is suitable for use and is greeted very positively by students who use it.*

Keywords*: Learning Media; Virtual Laboratory; Kinematics of Straight Motion*

INTRODUCTION

The development of science and technology can give birth to innovations. The development and progress of science and technology today are not spared in achieving national education goals (Muslim et al., 2021; Chen et al., 2022). The main factors for educational success come from the curriculum, teachers, and the teaching and learning process. Every learning requires strategies, methods, and learning media that can give a positive impression to students in learning activities. It is so that student achievement progresses and the expected national education goals are achieved (Astalini et al., 2021). Like learning science, almost all material requires experimental activities to support the achievement of learning objectives. However, in practice, the teacher often does not do this because it is time-consuming and complicated. Therefore, a virtual laboratory-based media is needed to facilitate the practicum implementation.

The limitations of direct practicum can be overcome by other types of practicums that can be operated by each student in the form of a virtual practicum or virtual laboratory. Virtual practicum presents a virtual practicum operated by a computer (Hikmah et al., 2017). The current development of educational technology can be used to improve the quality of learning in schools. The virtual laboratory is an interactive science situation with the help of an application on a computer in the form of a science experiment simulation. This virtual laboratory is sufficient to assist the learning process in increasing students' understanding of the material and is also suitable for anticipating direct laboratory unpreparedness. This virtual laboratory is expected to provide opportunities for students, especially to carry out practicums through and without internet access, so that these students do not need to be present to participate in a practicum in the laboratory room (Jaya, 2012). It becomes effective learning because students can actively learn on their own without the help of an instructor or assistant, such as a running system. During its development, this virtual laboratory was created with the help of Adobe Flash Cs5.5.

Adobe Flash Professional CS5.5 includes the latest version of other Adobe Flash (Afrijhon, 2021). This version is much better than the previous version because Adobe Flash Professional CS5 has several advantages with its newest features, where the software has added and changed commands to make it easier for users to manage animations. Although there are now newer versions of Adobe Flash Professional, their use remains the same. Because the action script in the latest version of Adobe Flash now does not support notebooks/laptops to be used and there is no flexibility. Then the material used as a virtual laboratory is free-fall motion material.

Free fall is the motion of an object that falls in a vertical direction from a certain height without initial velocity. Free fall motion states that all objects will fall with the same acceleration without air and other obstacles (Dasriyani et al., 2016). The acceleration constant for free fall is the acceleration due to gravity (g). Based on the theory, free fall motion events are influenced by the earth's gravitational force, so the value of the acceleration of an object when it experiences free fall approaches the value of the acceleration due to gravity. So, doing a practicum or free fall motion experiments is necessary. Based on this, this research was conducted to see how the feasibility and perception of students towards virtual laboratory media that had been developed previously.

RESEARCH METHODS

The place of research is the area or place where the research will be carried out. After the virtual laboratory is designed, a trial phase will be carried out on research subjects, namely physics education students class of 2021 at Jambi University who have studied straight motion kinematics material. The research product trial phase was carried out on June 20, 2022.

This research is development research where the development model used is the 4D model proposed by S. Thiagarajani, consisting of 4 stages, namely the defining stage (*define*), planning stage (*design*), development stage (*develop*) and the level of diffusion (*disseminate*). The defining stage (*define*) is done by initial analysis, student analysis, task analysis, concept analysis and formulating learning objectives. At the design stage (*design*), preparation of instruments, selection of teaching materials, selection of formats and initial product design. The development stage (*develop*) includes expert assessment and development trials. The last stage is the deployment stage (*dissemination*). The deployment stage uses tools that have been developed on a broader scale, for example, in other classes, other schools, and other teachers (Rochmad, 2011).

The research sample consisted of two assessor lecturers from the virtual laboratory that had been created and 28 primary physics contract students. The sampling technique used purposive sampling with data collection in media validation questionnaires, material validation, and student perceptions. The media expert validation questionnaire has four indicators, while the material expert has five. Data analysis used descriptive statistics in the form of a total score divided by the maximum score and multiplied by 100% from two expert judgments. The range of assessment categories can be seen in Table 1 for media experts and Table 2 for material experts.

Table 1. Range of laboratory virtual media validation categories

Interval Score	Presentase (%)	Category Score
42 – 51	87,5 – 100	Very good
32 – 41	66,67 – 85,42	Good
22 – 31	45,83 – 64,58	Not good
12 – 21	25 - 43,75	Not so good

(Modified from Sugiyono, 2019)

Table 2. Range of laboratory virtual material validation categories

Interval Score	Presentase (%)	Category Score
35,78 – 44,03	81,32 – 100	Very good
27,52 – 35,77	62,54 – 85,42	Good
19,26 – 27,51	43,77 – 64,58	Not good
11 – 19,25	25- 43,75	Not so good

(Modified from Sugiyono, 2019)

Then the perception questionnaire is used to test the results of the development, the indicators are appearance, content, quality of language, media efficiency, and benefits. The range of categories is as follows.

Table 3. Range of Student Perception Scores

Interval Score	Presentase (%)	Category Score
1368 – 1683	81,43 – 100	Very good
1052 – 1367	62,62 – 81,36	Good
736 – 1051	43,81– 62,56	Not good
420 – 735	25- 43,75	Not so good

(Modified from Sugiyono, 2019)

RESULTS AND DISCUSSION

Results

The research and development results are *a virtual laboratory* on straight-motion kinematics using problem-based learning models. Development *Virtual Laboratory* This study uses a 4-D development model which consists of 4 stages, including (1) Defining stage (*Define*); (2) the Planning Stage (*Design*); (3) the Development Stage (*Development*); (4) the Level of Spread (*Dissemination*).

The first stage is defined, where the purpose of the defined stage is to determine instructional requirements by conducting analysis. This stage includes distributing an initial observation questionnaire to physics education students class of 2021 who have contracted physics courses and conducting interviews with laboratory technicians and laboratory assistants.

The second stage is the design stage, which aims to design *a virtual laboratory* that can be used in learning physics on straight-motion kinematics material. This design stage includes analysis of learning objectives, selection of media and formats, and designing products to be developed.

The third stage is the development stage, where this stage aligns the product design that was previously designed at the design stage, and product validation is carried out, which is tested by a team of material experts and media experts. After the following validation is the product trial stage for students. Validation was carried out twice for media and material, while the validation results from the media and material expert questionnaire can be seen as follows.

Table 4. Media validation results

Indicator	**Material validation I**	**Material validation II**
Legibility	15	16
Display Quality	24	24
Ease of use	4	4
Program management	4	4
Total	47 (97.9 %)	48 (100%)

After the media has been declared feasible, the next step is to validate the material, the results of which are validated by the material experts, which can be seen in the following table.

Table 5. Material validation results

Indicator	Material validation I	Material validation II
The suitability of the material with the learning objectives	6	8
Accuracy of material with content	7	8
Convenience	3	4
linguistic component	12	12
Attractiveness	9	12
Total	37 (84.09 %)	44 (100%)

After this validation, the developed media is feasible to be used and tested, as for the results as follows.

Table 6. Results of student perceptions of virtual laboratory-based media

Indicator	Statement	Score	Presentase (%)
Appearance	The combination of background color, type and size of writing in the virtual laboratory is appropriate The clarity of the images and simulations in the virtual laboratory is appropriate	177	79%
Contents	The overall design of the virtual laboratory is attractive Compatibility of virtual laboratories with learning outcomes in basic physics courses 1 The material presented is easy to understand Practice Questions in the virtual laboratory for straight motion kinematics material is interesting and can improve students' thinking skills The problems given to each experiment in the virtual laboratory are in accordance with the stages of *problem based learning*	439	78,39%
Language Quality	The language use is standart Indonesian and easy to understand	90	80,35%
Media Efficiency	Clear instruction for using the virtual laboratatory	89	79,46%
Benefit	This virtual laboratory allows students to learn actively and independently Virtual laboratories can attract students' attention and interest in learning and practicum This virtual laboratory can help lecturers and students more effectively and efficiently in the implementation of practicum, because it can be done anytime and anywhere	268	79,76%
Average		1.063	79,39%
Category			Very good

In Table 6 above, it can be seen that the student perception questionnaire that the researcher used has five assessment indicators, namely: (1) appearance; (2) content; (3) language quality; (4) media efficiency; and (5) benefits. Rating indicator 1 represents statements 1-2, assessment indicators 2 represent statements 3-7, assessment indicators 3 represent statements 8, assessment indicators 4 represent statements 9, and assessment indicators 4 represent statements 10-12. Based on Table 6, the display rating indicator obtained a score of 177, the content assessment indicator obtained a score of 439, the language quality assessment indicator obtained a score of 90, the media efficiency assessment indicator obtained a score of 89, and the benefits assessment indicator obtained a score of 268. It can be concluded that *virtual laboratory*-based *Adobe Flash Cs5.5* on straight motion kinematics, which has been developed, is included in the very good category based on the perceptions of 28 students. The average score for all aspects obtained is 1,063, which is very good.

Discussion

This research was conducted to develop a virtual laboratory on straight-motion kinematics material. The developed virtual laboratory aims to determine the feasibility of the developed media and students' perceptions of virtual laboratories on straight-motion kinematics. According to experts, the results of the validation show that the media is suitable for use. Virtual laboratories that have been categorized as "Very Eligible" for use by material and media expert validators will then go to the trial phase to obtain perception data from students about the virtual laboratory being developed.

Based on the percentage of students' perceptions in Table 6, the average in field trials is in the "Appropriate" category, which means that virtual laboratories are suitable for use in essential physics learning to help improve the quality of student learning so that the kinematics material of straight motion can be well understood. Media efficiency and benefits. In line with research conducted by Jagodzinski and Wolski (2014) that learning using a virtual laboratory positively impacts teaching efficiency, students also experience an increase in remembering information and show greater endurance in remembering material information (concepts).

This virtual laboratory also supports learning fundamental physics in straight-motion kinematics material so that students better understand the concept of straight-motion kinematics material. The product resulting from this research is a virtual laboratory in the form of an application stored in exe format. The obstacles found during product development were straight motion kinematics experiments which were tested manually first and then implemented in a virtual laboratory, lack of experience in solving problems and lack of experience in assembling tools, and software limitations. In line with what Puspita (2020) conveyed, there needs to be a more authentic experience in natural laboratories, confusing researchers in assembling and operating tools.

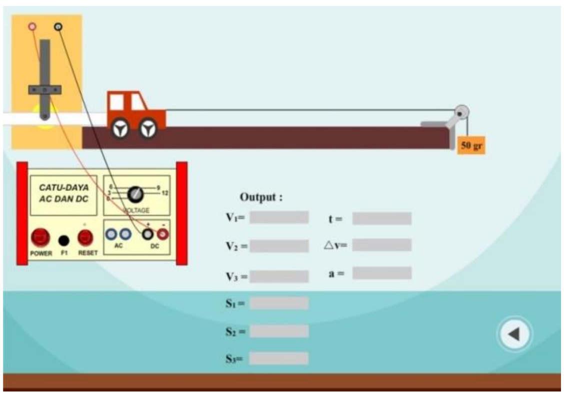

Figure 1. An example of the First Experiment on a Virtual Laboratory Learning Media

Based on the results obtained in this study, lecturers need a virtual laboratory to be used as a substitute for practicum and practical use in learning physics. The need for a virtual laboratory in previous learning has been proven by Hidayat & Fathurrahman (2018), who, in their research, provided knowledge and skills in developing a virtual laboratory and obtained results similar to the research that had been conducted, namely that virtual laboratories were needed by teachers in the learning process. In addition to the need for virtual laboratories, the practicality of virtual laboratories in learning has also been proven by Epinur & Yusnidar (2021), who, in their research, found the fact that virtual laboratories have proven practical to use in learning through a virtual laboratory feasibility test.

CONCLUSIONS

Based on the results obtained, it is known that virtual laboratory media is feasible to use both in terms of material and media. The perception results show very good results, which can help students in the practicum learning process. In addition, future researchers can develop a virtual laboratory with a more attractive appearance on other basic physics materials, and it is necessary to carry out field evaluations to determine the effectiveness of the products that have been developed so that the resulting products have a higher level of feasibility.

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