Development and Evaluation of Virtual Physics Laboratory As Multimedia Learning Physics On Senior High Schools (SMA) Pekanbaru

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Abstract: This research aims to design and evaluate the Virtual Laboratory for physics learning topic of dynamic electric for Senior High School (SMA) in Pekanbaru. Virtual Laboratory media have been designed by implementing research and development research method (Research and Development, R & D) with design using ADDIE ID Model techniques, development using PhET on materials physics dynamic electric includes the designing aspect, pedagogical aspects, aspects of content and programming aspects. Validation includes expert judgment and empirical validity and reliability by expert users, namely teachers of physics in senior high school and limited test against senior high school students. Descriptive analysis results show that Virtual Laboratory media is valid with \( r = 0.780 \). While the results of the empirical analysis shows Virtual Laboratory media is reliable media with Cronbach Alpha \( (\alpha = 0.845) \). From the analysis of the study obtained by the Virtual Laboratory, learning physics is valid and reliable.

Keywords: Virtual laboratory; dynamic electric; ADDIE ID Model; PhET; physic learning media

1. Introduction

One of the goals of main physics learning in high senior school is developing the ability to think analytically inductive and deductive using the concepts and principles of physics to explain natural events and resolve problems both qualitatively and quantitatively, master knowledge, concepts and principles of physics, as well as having the knowledge, skills and scientific attitude (Depdiknas,2007).

Issues that are important in learning physics is the poor quality of education of students. The quality of the process and outcomes of learning physics is determined by many factors, one of which is the availability of laboratory facilities. Laboratory activities are important in learning Physics, because aspects of the products, processes, and attitudes of learners can be developed.

Sutrisno (2012) stated that through laboratory activities can train scientific attitude and increase the activity of students in understanding the concepts of the lessons. One of the factors that influence the success of the laboratory is a resource that covers, materials and equipment, space and furniture, laboratory assistant, as well as technicians. Moreover, not all the experiments can be done not only because there are no tools, but the characteristics of the trial itself, which involves processes and abstract concepts (Muhammad Nasir, 2014) In addition, the safety factor to be considered further due to the dangers that would threaten when conducted the experiment eg AC current, transformer
or expansion, etc, so we need an alternative that activity of the trials included in the abstract concepts can still be done.

Many of senior high school in Pekanbaru did not have laboratory facilities are adequate, this is caused by many factors, among of them others: (1) material that does not exist because it is expensive, every time the experiment had to be purchased for consumables, (2) the damaged equipment, (3) laboratory technician or laboratory that does not exist, (4) inadequate safety factor and others. Therefore, the authors are interested in doing research to develop a virtual laboratory as an alternative to the limitations of the actual laboratory.

One of solution if inadequate laboratory equipment is utilizing instructional media in the form of a virtual laboratory (Lab-Vir). Lab-Vir utilization is expected to increase the activity of learners. Sutrisno (2012) states that learning activities can be done individually and flexibly group through Information and Communication Technology (ICT). In principle, the form of ICT-based learning activities structured to help in establishing the concepts, procedures, knowledge and express expression learners in learning. "Learning as an activity-oriented approach that emphasizes optimal activity learners to acquire the learning outcomes in a balanced manner" (Sanjaya, 2009). Learning activities should put learners at the center of learning. Learners are actively involved in the process, interact, and communicate with others and reflect on what they have learned.

2. Related Works

Virtual Laboratory (Lab-Vir) use the computer to simulate something complicated, costly trial device or replace experiments in hazardous environments (Mahanta and Sarma, 2012). Lab-Vir enable learners to visualize and interact with the symptoms they experience when doing experiments in a real lab (Martínez, et al., 2011). Furthermore, Dobrzanski and Honysz (2011), and Tatli and Ayas (2012) stated that the Lab-Vir as a contributing factor to enrich the experience and motivate learners to experiment interactively experiment and develop the skills activity.

Thus Lab-Vir can be defined as a set of computer programs that can visualize the abstract or experimental symptom complex if done in a real laboratory, so as to enhance the learning activities in an effort to develop the necessary skills in problem solving.

Putri Sarini (2012), found in her research that there are differences in learning outcomes and students' motivation to learn with virtual experiments with actual experiments. Further results of this study found that students who learn with virtual experiments to get better learning outcomes with students learning by conventional experiments while the students' motivation to learn with virtual experiments is better than the students who learn from the students who learn by actual experiment.

Choiron (2013) argues that the implementation of learning to use a computer effectively because it can expand and facilitate access to the inclusion of information in learning rapidly, can help to visualize materials that are abstract, can display instructional materials becomes more attractive, and allows the interaction with the material being studied. Based on this, the use of computers to improve the ability of students to understand the lesson.

Farreira research results (2012), found that some of the benefits that can be gained by using virtual labs media is economical, improve the quality of activities because it allows for repeated experiments to clarify the doubts in the measurement in the laboratory, improving learning effectiveness, security, and safety of students. Learning with multimedia in the form of a virtual laboratory can make teaching more attractive, more interactive, the amount of teaching time can be reduced, the quality of learning can be improved, and the learning process can be done anywhere and anytime.

One application is a virtual laboratory simulation of Physics Education Technology (PhET). The PhET Team (2015) explains that the PhET is a site that provides a simulation of learning physics and chemistry are given free of charge by the University of
Colorado for the sake of teaching in the classroom or can be used for the benefit of individual learning. Designed interactive simulation, enabling users to perform direct learning. Based on this, PhET simulations can be used as an approach to learning that requires.

Adams, et al. (2008) found that while students interact with simulations PhET when the learning process, students can portray the material that was initially difficult to understand the picture. Design on simulation that has the layout, the use of simulation tools, assistance, and representation of the actual experiment well, so effective in the process of learning activities. Learning activities using PhET simulations require work sheet student as a tool for learning activity.

3. Material & Methodology

This research is a development (R & D) Borg and Gall (1983) for the study will yield product in the form of Virtual Laboratory, Since this is mengahsilkan product in the form of media belaja or pembelajaran it must use Instuctional Desig Model in that it will use the ID ADDIE Models (Briggs, 1979), Sumadinata (2010). As well as other research to be conducted mengaplikasianya quasi experimental.

This study will be conducted at the Laboratory of Learning Media Development, Education Physics Laboratory for Virtual and development stages for the evaluation and implementation of virtual lab will dilaksanakan School (SMA) Negeri 4 Pekanbaru. Execution time this study was 8 months ie April to the month of December 2016, with the stages as in Figure 1.

The research methods must be appropriate to the objectives of the study. The methodology should also discuss the problems that were anticipated and explain the steps taken to prevent them from occurring, and the problems that did occur and the ways their impact was minimized.

The type of data in this research is the primary data that will be obtained directly by researchers in the field in the form of data validity of the expert, the Virtual Laboratory Test result data, the data Koqnitif Ability Learning Outcomes Learning Outcomes data and psychomotor ability.

Collection techniques in this study there are two kinds of techniques questionnaire questionnaire questionnaire validation of experts and the use of the user in this case is a student. The data collection technique is a technique both tests are written tests and psychomotor tests that will be given to students who have dibelajarkan using virtual laboratory.

Data analysis in this research is descriptive analysis and inferential analysis techniques. Descriptive technique is used to describe the results of the validation and reliability of Virtual Laboratory, while inferential techniques will be used in the evaluation of the Virtual Laboratory as a learning tool that is implemented by way of physics experiments shall use appropriate statistical test.

Step of conducted this research implemented refer to Figure 1.
The steps of to be conducted in this reasearch are:

1. Stages of Development of Virtual Laboratory. This stage consists of two stages, namely stages of planning and development phases Virtual Labaratorium. In planning tahpan will use Instructionala Design Model with reference to the ID ADDIE (Analyse Design, Depelovment, Implementation and Evaluatin Model), whereas in the Development stage will use the programming Phet. One application is a virtual laboratory simulation of Physics Education Technology (PhET). The PhET Team (2015) explains that the PhET is a site that provides a simulation of learning physics and chemistry are given free of charge by the University of Colorado for the sake of teaching in the classroom or can be used for the benefit of individual learning. Designed interactive simulation, enabling users to perform direct learning.

2. Evaluation Stage: In this evaluation phase will be evaluated products (Wrawan, 2011) which measures the output and the result or the effect of a program that is rated (a) The results or program outputs are as expected (b) whether the Service in accordance with the planned (c) the effect or result of the program to the people who get the service if there is a change to before or after receiving the service (d) Evaluation of the output also identify what must be done so that programs can influence occurred continuously. In this evaluation will be guided by the national education ministerial decree no. 27 of 2007 on Standards for Facilities and good infrastructure Madrassa / General Education standard learning tool especially high school (SMA).

Evaluation or assessment that will be conducted by experts include: expert design (design), expert content (content), Expert Engineering (technical) and Expert Pedagogy (Pedagogy). Assessment or evaluation is given by filling in questionnaires (Muhammad Nasir, 2014) which provides answers to Likert scale.

To convert assessment given by the expert then guided in Table 1. This conversion is necessary because to find the relationship between validity with expert judgment. Validity or denoted by r-value of 0-1 while expert ratings ranged from 1 to 5 with Likert scale.
Table 1. Conversion rate expert on the validity of the laboratory Virtual physics

<table>
<thead>
<tr>
<th>No</th>
<th>Rate assessment</th>
<th>Validit (r)</th>
<th>category of Validi</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4 &lt; N &lt;= 5</td>
<td>0,8 &lt; N &lt;= 1</td>
<td>high Valid</td>
</tr>
<tr>
<td>2</td>
<td>3 &lt; N &lt;= 4</td>
<td>0,6 &lt; N &lt;= 0,8</td>
<td>Valid</td>
</tr>
<tr>
<td>3</td>
<td>2 &lt; N &lt;= 3</td>
<td>0,4 &lt; N &lt;= 0,6</td>
<td>lease Valid</td>
</tr>
<tr>
<td>4</td>
<td>1 &lt; N &lt;= 2</td>
<td>0,2 &lt; N &lt;= 0,4</td>
<td>Not Valid</td>
</tr>
<tr>
<td>5</td>
<td>0 &lt; N &lt;= 1</td>
<td>0,0 &lt; N &lt;= 0,2</td>
<td>Very not Valid</td>
</tr>
</tbody>
</table>

(Muhammad Nasir, 2014), (Jaali, 2004)

In addition to evaluation will be carried out tests on senior high school students (SMA) Negeri Pekanbaru to use in the classroom learning. The students also do an evaluation and then the evaluation results will be analyzed to calculate the reliability of the laboratory Virtual Media physics.

4. Results and Discussion

In accordance with the method of research that has been presented so the results of this study will be presented two aspects: development or the development and evaluation aspects.

Aspect Development has successfully constructed a virtual physics laboratory as in Figure 2.

![Figure 2. Display Virtual Laboratory to take the Measure Tool](image)

In Figure 3 and Figure 4. It is the image of electrical circuits to be built with this virtual lab. As well as in figure 4 seen pictures implementation of the image on the electrical circuit built.

At the stage of development do virtual laboratory development as in the Figure (2) and (5). In the figure (2) shows how a virtual lab and display an figure (5) contain all the components in the virtual lab. While the figure (3) and (4) is a concept figure that will be implemented using the virtual laboratory media.
At the stage of the evaluation carried out an assessment of the results of the depiction of the concept of electricity and ease of use of virtual laboratory has been built. At the stage of evaluation by experts in the form of desk Evaluation and assessment stages to students using virtual laboratorium media performed directly in classroom learning.

At the stage of evaluation, the evaluation of aspects Laboratories media Analysis, Design, Development and Implementation. The assessment by experts is performed using questionnaire and using a Likert scale according to the above aspects. The results of the expert assessment can be seen as in Table 2.

Table 2 shows that the results of the expert assessment. Based on the table it can be seen that the highest value is in the content aspect with 4.21 and the lowest on aspects of pedagogy that is 4.01 while Table 3 shows the results of the expert assessment, with the highest assessment aspect is the designing aspect of 4.03 and the lowest in the aspect of Contents 3.76. Both ratings were based on five categories of good and excellent.
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Table 2. Evaluation result virtual laboratium by expert

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Questionair</th>
<th>Mean</th>
<th>Deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>1 - 10</td>
<td>4.11</td>
<td>0.54</td>
<td>0.30</td>
</tr>
<tr>
<td>Pedagogy</td>
<td>11 – 20</td>
<td>4.01</td>
<td>0.46</td>
<td>0.24</td>
</tr>
<tr>
<td>Content</td>
<td>21 – 30</td>
<td>4.21</td>
<td>0.40</td>
<td>0.22</td>
</tr>
<tr>
<td>Technical</td>
<td>31 – 38</td>
<td>4.18</td>
<td>0.40</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Totaly</strong></td>
<td><strong>1 – 38</strong></td>
<td><strong>4.12</strong></td>
<td><strong>0.43</strong></td>
<td><strong>0.21</strong></td>
</tr>
</tbody>
</table>

To be able to explain the results of the expert assessment according to the aspect can be converted using table 1. The results of expert assessment in the form of form of validity can be seen as in Table 3.

Table 3. Assessmen of Conversion The results of expert assessment in the form of validity

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Mean</th>
<th>Validity (r)</th>
<th>Validity of category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>4.03</td>
<td>0.806</td>
<td>very Valid</td>
</tr>
<tr>
<td>Pedagogy</td>
<td>3.97</td>
<td>0.784</td>
<td>Valid</td>
</tr>
<tr>
<td>Content</td>
<td>3.76</td>
<td>0.782</td>
<td>Valid</td>
</tr>
<tr>
<td>Technical</td>
<td>4.02</td>
<td>0.804</td>
<td>very Valid</td>
</tr>
<tr>
<td><strong>Totaly</strong></td>
<td><strong>3.95</strong></td>
<td><strong>0.780</strong></td>
<td><strong>Valid</strong></td>
</tr>
</tbody>
</table>

Based on the limited test results conducted at SMA Negeri Pekanbaru, to gain validity and reliability of Virtual Laboratory media such as describe in Table 4.

Tabel 4. Result of Reliability test Virtual Laboratory Media

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>Cronbach's Alpha Based on Standardized Items</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.843</td>
<td>.845</td>
<td>44</td>
</tr>
</tbody>
</table>

Based on the result of test reliability as shown in Table 4. The value α = 0.845 This means that the Virtual Media laboratory are releable with Alpha Cronbach α = 0.845

5. Conclusion

Based on data and analysis of data and discussion it can be concluded that the Virtual Laboratory Media as physic learning media as virtual laboratory at senior high school in Pekanbaru is Valid and Reliable. Thus can be used as a learning media physics learning in senior high school.

References


