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Development of a Virtual Lab in Science-Physics Learning Based on the STEM Approach

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Abstract: Learning innovation in the laboratory has experienced very rapid development in the current era of technological development. One of these innovations is through the use of virtual laboratory classes in science learning, as is the case with temperature and heat materials. The aims of this research are to develop a virtual lab based on the STEM approach on the concepts of temperature and heat, to test the validity and practicality of virtual lab products based on the STEM approach. The development method used is 4-D (four-D). The data obtained in the form of quantitative and qualitative data. Qualitative data in the form of suggestions, input, feedback and criticism from the validator and quantitative data in the form of a validation questionnaire. The validation results show that the validation is 87.89% (very feasible). In addition, the practical test of student responses was obtained at 96.15 (very practical) and the teacher at 3.31 (very practical). Practically speaking, the virtual lab based on the STEM approach that was developed is very useful to support practical activities.

Keywords: Virtual Lab; STEM; Science-Physics Learning; Temperature

Introduction

Physics is one of the branches of natural sciences specifically studying the phenomena of the universe. In studying the concepts of physics there are abstract and concrete. Concepts that are abstract, microscopic in size and difficult to convey in words will be easier to convey and interesting for students with the existence of learning media. The use of media will get direct experience and can be done using actual objects, or using practical tools in laboratory activities. Learning experiences can also be obtained by utilizing media in the form of artificial objects that resemble real objects, for example using props, pictures, videos, and computer simulations through virtual labs (Hadija et al., 2020).

Virtual labis a series of laboratory equipment in the form of interactive multimedia-based software, which is operated by a computer and can simulate activities in the laboratory as if the user was in a real laboratory (Maniruddin, 2017). Virtual lab is a tool that can be used to visualize abstract concepts, so that students can more easily understand the concepts being taught. This is in accordance with the results of research by Wibowo (2016) which states that "Characteristic of physics consists of microscopic and macroscopic properties. In physics is defined as a concept that can be observed with eye and measured". A virtual lab uses a computer program to simulate a series of experiments without performing the activity directly.

Virtual labs can also strengthen practicum activities that cannot be practiced in real terms, meaning that virtual labs can become alternative practicum media to replace real practicums, if it is not possible to do them. The virtual lab is one of the innovative learning media products produced by researchers. The virtual lab was used in this research, because it is one of several ways to facilitate learning, especially during a pandemic that requires the learning process to be carried out using distance or online strategies.

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The goal of the virtual lab is to develop synchronous and interactive experiments (Salganik et al., 2020). The virtual lab is one of the innovative learning media products produced by researchers. The virtual lab was used in this research, because it is one of several ways to facilitate learning, especially during a pandemic that requires the learning process to be carried out using distance or online strategies. The goal of the virtual lab is to develop synchronous and interactive experiments (Salganik et al., 2020). The virtual lab is one of the innovative learning media products produced by researchers. The virtual lab was used in this research, because it is one of several ways to facilitate learning, especially during a pandemic that requires the learning process to be carried out using distance or online strategies. The goal of the virtual lab is to develop synchronous and interactive experiments (Salganik et al., 2020).

Based on the results of observations in junior high school Junior High School Tunas Nusa Aceh Barat Daya conducted by researchers that various efforts have been made by teachers in the teaching and learning process both offline and virtually. The difficulties encountered during the pratikum are internal and external. Internal difficulties include an uncomfortable practicum room, and a lack of practical equipment. In addition, skills, readiness, habits, attitudes, interest in practicum as well as knowledge of practical material and student motivation are internal factors that will affect practical activities. External difficulties can come from the laboratory staff/teaching load of teachers, time allocation, manuals, and the school environment (Putri, & Kurniawati, 2019). Practical activities in the laboratory are not always carried out properly due to various kinds of obstacles such as limited facilities or difficulty in getting access to observe objects directly in the open. This is certainly an obstacle in carrying out practical activities, so to help practical activities to be effective and efficient, innovation in practical activities is needed..

The development of a virtual lab in science-physics learning based on the STEM approach is very suitable to be applied in the learning process. Several studies have revealed that virtual labs with a STEM approach can improve the skills possessed by students, as well as their experiences and abilities in integrating STEM into the learning process. The STEM approach has a positive effect on the development of scientific process skills and improves their attitudes and motivation. With the existence of a virtual lab based on the STEM approach, it is very impactful for students and has a very significant effectiveness and is an alternative for students in developing the learning process in schools and the real world (Zwart et al., 2021; Gunawan., 2017; Ying-Shao. 2017; Uğur., 2020).

Method

The research was conducted using Research and Development (R&D) research and development methods. R&D is research that is used to produce certain products and test the effectiveness of these products (Sugiyono, 2017). The research and development model used in this study refers to the 4-D development model which consists of the definition stage, the design stage, the develop stage and the dissemination stage.

The Development Procedure that adopts the 4-D model is described as follows:

Defining Stage

At the stage of defining step pThe first is an analysis of student needs which aims toto find out the availability of media and the types of media used by teachers when teaching, especially on temperature and its changes.The second step is curriculum analysis by identifying the basic competencies of the 2013 curriculum and understanding the depth and breadth of competencies that must be developed, then describing the basic competencies into several indicators. The third step is to analyze students' character to see students' attitudes towards learning physics. This is done so that the development carried out is in accordance with the character of the students.

Stage of Design

At this stage, the design of the product that will be developed is carried out to facilitate the process of developing a STEM-based virtual lab at the develop stage, so at this design stage a flowchart, story board, and user interface design are made.

Development Stage

At this stage it is made according to the storyboard design. Each experiment is equipped with a posed problem and practice questions on the experiment. At the development stage, expert validation was also carried out which carried out an assessment of 3 aspects, namely (1) the feasibility of presentation, (2) the feasibility of the content, (3) the feasibility of language and writing. In the development stage, an assessment (filling out a questionnaire) was also carried out by students and teachers regarding the practicality of a virtual lab based on the STEM approach.

Stage of Dissemination

The dissemination stage is the final stage of development. Dissemination is carried out in class with the aim of knowing the practicality and effectiveness of using a virtual lab based on the STEM approach. At this stage, the deployment of a virtual lab based on the STEM approach was carried out by implementing limited to one class, namely class VII Tusa at SMPN Unggul Tunas

Nusa in the 2021/2022 academic year, totaling 29 students.

The data obtained in the development of a virtual lab based on the STEM approach are in the form of qualitative and quantitative data. Qualitative explanation items in the form of comments, suggestions, and criticisms from the validator. While the quantitative explanation items are in the form of numbers obtained from filling out the product development validation instrument sheet using a Likert scale (5,4,3,2,1) (Riduwan, 2021).

Results and Discussion

Result of Design/Development Model

In the process of developing a virtual lab based on the STEM approach, the focus is on temperature and heat. The results of the development are presented as follows:

Initial view of a virtual lab based on a STEM approach

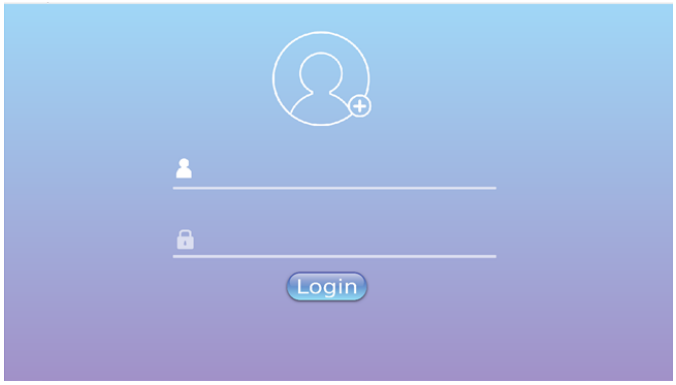


Figure 1. Initial view of the virtual lab based on the STEM approach

Main Menu Display

The main menu consists of several features on the media such as basic skills and indicators, learning objectives, materials, simulations, developer profiles, quizzes and instructions.

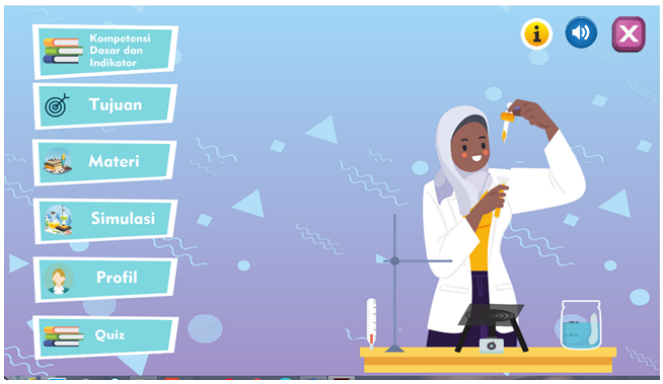


Figure 2. Main Menu Display

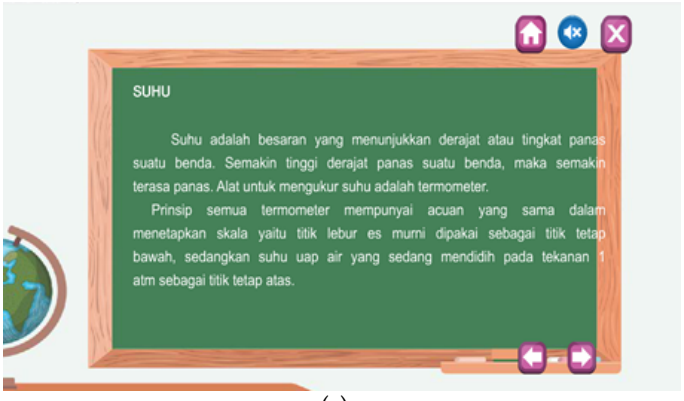
Development Results

A virtual lab based on the STEM approach as an application that can be used via a computer/laptop and does not require internet which was developed using the Adobe Animate version 2021 application. A virtual lab based on the STEM approach can be used before, during, and after learning. Students can make the desired practical choices, then students can read the initial procedure by applying the STEM concept which consists of science, engineering which consists of 5 steps, namely ask, imagine, plan, create and import, then technology and math. The virtual lab display based on the STEM approach is shown in the Figure 3, 4 and 5.

(a)

(b)

Figure 3. Display of (a) KD, Indicators and (b) Objectives



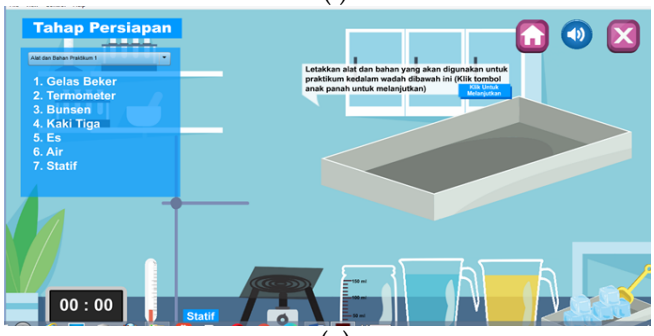
(c)

(d)

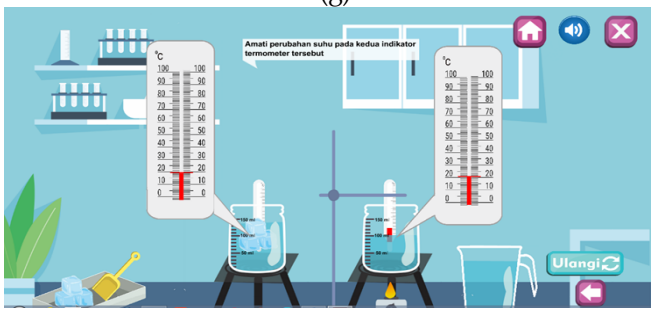
Figure 4. Display (c) Science and (d) Imagine

(e)

(f)

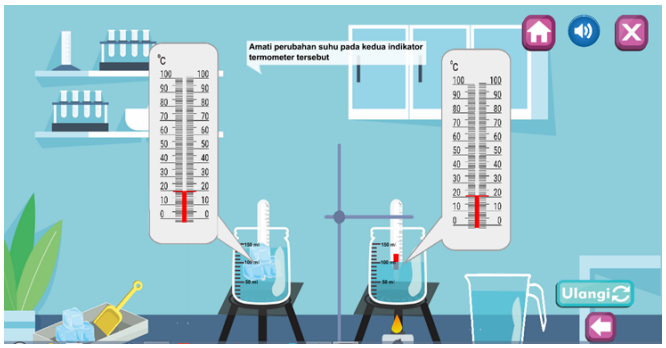


(g)



(h)

Figure 5. (e) Ask view, (f) Plan view, (g) Technology view, (h) Create view



(i)

Figure 6. Math Display

Validation and Trial Results

The virtual lab validation based on the STEM approach consists of the validation of media experts and material experts. Validation is carried out by lecturers who already have the ability in their field. The validator provides input for the product on the validation sheet that has been prepared.

Based on the validation that has been carried out by the experts, the results of the percentage score of 87.89% and interpreted in the interpretation table are categorized as very feasible. The assessment is obtained from the average of the three aspects of the assessment. If you look at each aspect, both in terms of the feasibility of presentation, the aspect of the feasibility of the content and the aspect of the feasibility of language and writing, all three are included in the very feasible category.

The next step is testing a virtual lab product based on the STEM approach to students and teachers, totaling 29 students and 1 teacher of physics. From the results of the development trials carried out, it was found that a percentage of 96.15 was in the very practical category and the teacher got 3.31 then it was matched with the interpretation of the teacher's response so that it was included in the very practical category.

The use of virtual labs based on the STEM approach is valid and practical to use and is appropriate to be applied in schools in accordance with the applicable curriculum and is one of the characteristics of the 21st century regarding the use and utilization of technology. In accordance with the research, Dewi (2021) states that the virtual lab based on the STEM approach is very feasible to use and can be applied in learning. With various activities carried out based on a virtual lab based on the given STEM approach, it can make it easier for students to understand temperature and heat material so that when a test is given, students will be easier to complete and the results obtained will be higher than the previous results.

So with the existence of a virtual lab based on the STEM approach, it can help students more easily understand and discover new concepts by being directly involved in the discovery of new concepts. Virtual labs based on the STEM approach also encourage students to

be more proficient in the use of technology and are a form of technology-centered change in society 5.0 (Ismail, 2016). As with the virtual lab based on the STEM approach, students are more required to play an active role in generalizing and constructing their knowledge so that students better understand the experiment. Thus, a virtual lab based on the STEM approach can help students improve learning outcomes (Permanasari, 2016).

Conclusion

The validation results show that the score on the presentation feasibility indicator is 86.67%, the content feasibility is 85.33% and the language and writing eligibility is 91.67%. Overall, a score of 87.89% Pwas obtained in the proper category. Practically, the media that has been developed is very useful to support practical learning. The advantages of virtual lab products based on the STEM approach are that teachers and students can connect interactively, learn faster, improve and reduce misconceptions and integrate STEM.

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