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Muhamad Taufiq, Arief Agoestanto, Ni Luh Tirtasari, et al.

Development of Virtual Science Laboratory (VSL) on Linear Motion Concept

Muhamad Taufiq[1, a)], Arief Agoestanto[2, b)], Ni Luh Tirtasari[1, c)], and Muhammad Iqbal[2, d)]

[1] *Department of Integrated Science, Faculty of Mathematics and Science, Universitas Negeri Semarang, Semarang, Indonesia*
[2] *Department of Mathematics, Faculty of Mathematics and Science, Universitas Negeri Semarang, Semarang, Indonesia*

[a)] *Corresponding author: muhamadtaufiq@mail.unnes.ac.id*
[b)] *arief.mat@mail.unnes.ac.id*
[c)] *niluhtirtasari@mail.unnes.ac.id*
[d)] *muhammadiqbal@mail.unnes.ac.id*

Abstract. Laboratory activities play a very important role in supporting science learning activity which allows students to gain practical skills through experimentation and provides opportunities to have a deeper understanding of the content or concepts being studied. Especially during the current covid-19 pandemic, laboratory activities are directly limited or even eliminated, therefore there needs to be a solution for implementing substitute laboratory activities so that student competencies, especially practical skills through experimental activities, are still mastered. The most likely opportunity is through virtual laboratory activities. This study aims to develop a Virtual Science Laboratory (VSL) in the form of a computer application designed to improve the learning approach by introducing a safe and interactive lab environment for students. The design of this research is Research and Development (R & D) with the ADDIE (Analysis, Design, Develop, Implementation and Evaluation) method. The Virtual Science Laboratory (VSL) learning media product has produced the concept of linear motion using a Virtual Ticker Timer. The feasibility of the VSL for linear motion concept was analyzed based on the average percentage score of material expert validation 83.0%, media/ technology expert validation 84.0%, teacher validation 87.5% and it can be concluded that the validation reached the very feasible criteria.

INTRODUCTION

Our lives today have entered the era of technology that is growing rapidly due to the widespread use of computers as the carrying capacity of Information and Communication Technology (ICT), which has entered almost all areas of life. In the field of education, emerging technologies provide opportunities to improve the learning process using effective technology in the teaching process which has changed learning and communication methods [1][2]. For example, an artificial or virtual educational environment uses computers to simulate a real environment or is often called a virtual lab. During the last two decades, the application of artificial education situations or virtual labs has resulted in changes in the educational process for students or students and teachers and lecturers which have been confirmed to be effective for teaching math and science topics, especially complex content and concepts that involve and require laboratory activities [3][4][5].

Laboratory activities play a very important role in supporting the fields of learning mathematics and science [6][7]. Laboratory activities allow students to gain practical skills through experimentation and provide opportunities to have a deeper understanding of the content or concept being studied. However, if the existence of a laboratory is not supported due to the limitations of expensive or dangerous tools and materials) and especially

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during the current covid-19 pandemic, laboratory activities are directly limited or even eliminated, therefore there needs to be a solution for implementing substitute laboratory activities so that student competence, especially skills, is needed. practical activities through experimental activities are still mastered. The most likely opportunity is through virtual laboratory activities [8]. This study aims to develop a Virtual Science Laboratory (VSL) in the form of a computer application designed to improve the learning approach by introducing a safe and interactive lab environment for students.

A virtual laboratory is a form of laboratory with observation or experimental activities using software that is run by a computer, all the equipment needed by a laboratory is contained in the software [9][10]. Virtual Laboratory has an important role in implementing practicum activities. The virtual laboratory is used for demonstrations before the actual practicum takes place in the laboratory. Virtual laboratories provide flexibility for students to do or carry out practicums anywhere and anytime without having to depend on guidance from the teacher [11][13].

Computer simulations provide opportunities for students to learn science dynamically and interactively. Simulation can be in the form of interactive multimedia-based computer software that can be accessed online or offline, which is operated by a computer and can simulate activities in the laboratory as if the user is in a real laboratory or virtual laboratory [14][15]. Virtual laboratories are designed to provide simulations or visualizations in the form of tools, materials, and laboratory equipment in computers to subjectively display experiments anywhere and anytime [16][17][18].

Virtual/virtual laboratories are needed to strengthen understanding of concepts in the learning process. The virtual laboratory is not a substitute but part of the real laboratory that is used to complement and improve existing weaknesses. Especially during the Covid-19 pandemic, virtual laboratories are an effective choice for teachers and lecturers, especially teachers or lecturers in the fields of mathematics and science or science in carrying out learning activities that require support for practical activities.

METHOD

The Research and Development (R & D) method with the ADDIE model (Analysis, Design, Develop, Implementation and Evaluation) ass seen in Fig. 1 will be carried out for the Virtual Science Laboratory (VSL) in the form of a computer application platform designed to improve learning approaches by introducing a safe and interactive lab environment for students [19][20]. The subjects of this study were prospective science teacher students at FMIPA Semarang State University with the determination of the sample using purposive sampling technique.

FIGURE 1. ADDIE Model

The development stage of the Virtual Science Laboratory (VSL) learning media includes analysis, which is a needs assessment process, identifying problems (needs) and performing task analysis. Design is to make a VSL learning media conceptually and underlie in the next development process. Development process contains activities for realizing the design of VSL learning media. In the development stage, the conceptual framework is realized into a product that is ready to be implemented. Implementation is applying VSL learning media that has been developed in the classroom for testing the results of the development. After the application of the VSL learning media, an

initial evaluation was carried out to provide feedback on the application of the VSL learning media. Evaluation or evaluation of VSL learning media products after small-scale trials. This evaluation is used to measure the effectiveness of VSL learning media. Revisions are made according to the results of the evaluation or needs that have not been met in the development of VSL learning media that has been carried out.

RESULTS AND DISCUSSION

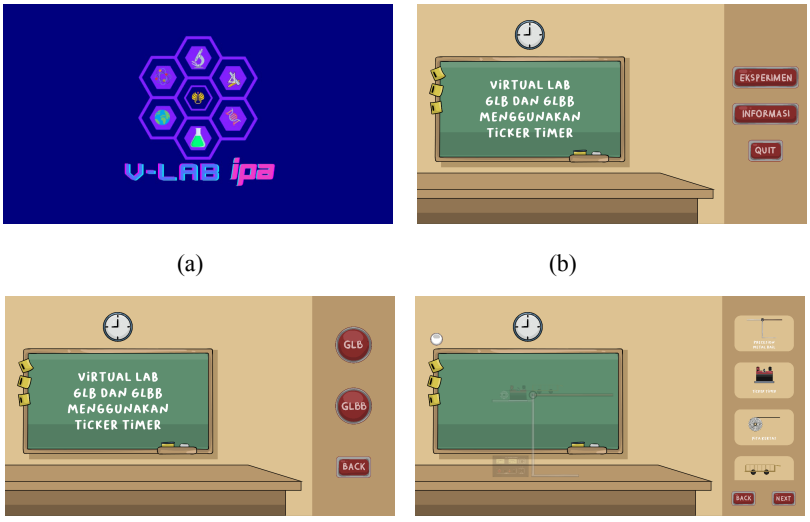
This research has produced VSL learning media on linear motion material using a Ticker Timer. The development process until the VSL media is obtained in detail can be presented as follows.

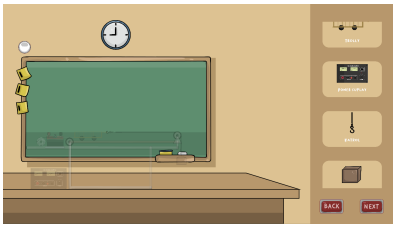
Analysis

Analysis activities have been carried out in the form of a needs assessment process, identifying problems (needs) and conducting task analysis. The needs analysis in this study includes the type of VSL that was developed, namely Virtual Lab IPA the concept of linear motion, especially the material for uniform straight motion and uniformly changing straight motion using a ticker timer. The VSL specifications are in the form of a virtual laboratory computer application that facilitates linear motion practicum activities using a ticker timer and other supporting equipment, including vibrators that can be varied in frequency, trolley models, loads and display results that can be printed as material for practicum report analysis. Analysis of the problem in this research, namely how is the development of VMSL on valid or appropriate natural science material to use? Meanwhile, we analyzed the VSML development task by dividing the research team according to their duties and competencies.

Design

At this stage, the VSL design has been obtained in the form of a product design that is still conceptual and underlies the development process. The design of the VSL on linear motion concept learning media in detail presented in Figure 2.





(e)

FIGURE 2. VSL Development Design, (a) loading page and VSL logo, (b) menu page, (c) practicum menu page, (d) Regular Straight Motion Practicum (e) Uniformed Straight Motion Practicum page

Development

The realization of the VSL learning media design activity has been carried out. The design that has been compiled in the form of a conceptual framework for learning media VSL on linear motion concept using a Ticker Timer has been realized into a product that is ready to be implemented. The results of the VSL development were validated and the results are presented in Table 1 through Table 3.

TABLE 1. VSL Validation Results by Content Experts

No	Aspect	Validation (%)	Criteria
1	Learning Content	86	Very Feasible
2	Learning enhancement	82	Feasible
3	Language	88	Very Feasible

TABLE 2. VSL Validation Results by Media and Technology Experts

No	Aspect	Validation (%)	Criteria
1	Usability	85	Very feasible
2	Technology Aspect	82	Feasible
3	Visual Communication	86	Very feasible

TABLE 3. VSL Validation Results by Teacher or Prospective User

No	Aspect	Validation (%)	Criteria
1	Usability	90	Very Feasible
2	Learning Content	87	Very Feasible
3	Learning enhancement	87	Very Feasible
4	Visual Communication	84	Very Feasible

The results of the average percentage score of material expert validation are 83%, media/technology expert validation 84%, teacher validation 87.5% and it can be concluded that the validation reaches the very feasible criteria.

Implementation

At the implementation stage this has not been carried out and is expected to be carried out in the next stage of research. The plan for implementing VSL learning media on the concept of linear motion using a ticker timer that has been developed in real situations in the classroom or in a location that allows for testing the results of the development. After the application of VSL learning media, an initial evaluation is carried out to provide feedback on the application of VSL learning media.

Evaluation

Evaluation activities are carried out at each stage of developing VSL learning media products on the concept of linear motion using a ticker timer. This evaluation is used to measure the effectiveness of VSL learning media. Revisions are made according to the results of the evaluation or needs that have not been met during the process of developing VSL learning media stages.

Laboratory activities are closely related but very important in the science teaching and learning process. Especially with the online school situation, it is quite challenging to carry out direct laboratory activities. The combination of inquiry-based learning with virtual lab activities can be an alternative to develop a more engaging but meaningful learning process in online learning. This study aims to develop a Virtual Science Laboratory (VSL) in the form of a computer application-based platform designed to improve the learning approach by introducing a safe and interactive laboratory environment for students. Science learning activities with VSL can be considered as an alternative to conducting meaningful online learning activities [21, 22], especially in science practicum.

At the end of this research, VSL learning media products have been produced on the concept of linear motion using a ticker timer. The feasibility of VSL was analyzed based on the average percentage score of content expert validation 83%, media and technology expert validation 84%, teacher or prospective user validation 87.5% and it can be concluded that the validation reached the very feasible criteria.

VSL in the form of a computer or web application-based platform has the advantage of being easy to develop and easy to access [23, 24]. VSL applications can be accessed using a variety of devices and operating systems. The programming language used to develop is HTML (Hypertext Markup Language), and JavaScript which is generally already mastered by most programmers. Therefore, VSL is easy to develop further on other science practicum materials.

Based on the results of the feasibility analysis of the development of VSL development on very feasible criteria. All of the feasibility indicators on the very feasible criteria, only the learning enhancement and technology applicability indicators are still on the feasible criteria. Based on input from media and technology expert validators and science teachers for the developed VSL, it is necessary to improve the program's usability, namely related to system capacity and ease of operation, especially in the drag and drop user experience. The previous VSL drag and drop function did not work properly and could not be reset. At the end of the development, revisions and improvements were made to the drag and drop function which can be reset in the preparation of virtual practicum tools and materials.

CONCLUSION

This research has produced a product in the form of a Virtual Science Laboratory (VSL) learning media on the concept of linear motion using a valid ticker timer and obtained very feasible criteria. Science learning activities using VSL can be considered as an alternative to conducting meaningful online learning activities, especially in science practicum

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