Development of a Virtual Physics Laboratory Based on Local Wisdom (BOI-LVF) Computer Assisted for High School Students

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Abstract

The problem of education is one of the important issues that concern individuals and society apart from health in Indonesia. Especially with the outbreak of the corona pandemic (COVID-19) so learning must be done online. This also has an impact on student practicum activities at various levels of education. Virtual or physical laboratories cannot be used during the coronavirus pandemic. This prompted us to develop a virtual physics laboratory with a focus on local wisdom in Indonesia. This virtual laboratory was developed on a computer or laptop device so that it is more optimal in carrying out practical activities. This study aims to develop a computer-assisted virtual physics laboratory based on local wisdom for high school students that is valid and practical. The development of this virtual laboratory is carried out by adapting the 4-D development model. The validity of the virtual laboratory was obtained from the results of validation by two expert validators, six physics teachers, and responses from 30 class XI students in a school in Central Maluku, Indonesia. Purposive sampling was used as a sampling technique in this study. Physics topics used in this study are momentum and impulse. Data were collected using validation sheets and response questionnaires. The data obtained were analyzed using descriptive analysis. Expert and practitioner validation is used as a reference for determining product feasibility. The results of the validation of experts and practitioners show that the product is categorized very high with value 3.58. Student responses are used to determine the practicality of the product being developed. The results of student responses to the product indicate that the product is categorized as very good with a value of 3.36. Therefore, a computer-assisted local wisdom-based virtual physics laboratory is appropriate to be used as a support for physics practicum activities and to improve students' various skills.

***Keywords**:* virtual physics laboratory, local wisdom, momentum and impulse

1. Introduction

Practical activities in learning physics are able to improve the ability of students to use tools, think logically, and solve problems by providing direct experience [1]. Although practicum activities are important activities in the scientific field, especially Physics, their current application is still not able to develop other abilities of students [2,3]. In an effort to maximize students' practicum activities, educators experience many obstacles including practicum preparation takes a long time and practical tools in the laboratory are limited. In addition, in

2019 an outbreak of a disease, namely the corona virus (COVID-19), resulted in a major health crisis in the world [4]. This causes practical activities to be carried out virtually. These practical activities can be carried out with the help of a virtual laboratory.

A virtual laboratory is a kind of software that is able to make students interact with real equipment, real instruments, and visualization mechanisms through an appropriate simulation platform to simulate students' practical activities in the laboratory as if the user was in a real laboratory [5–7]. Various virtual laboratory platforms are widely available and easily accessible on the internet. One of the platforms that is often used in practical activities is PhET. However, the platform has not been able to develop the abilities of other students [8]. Therefore, it is necessary to develop a virtual physics laboratory that is able to develop these capabilities.

Development of a virtual physics laboratory to match the expected competencies that can be linked to local wisdom in Indonesia. Local wisdom in various regions in Indonesia can be used as a source of learning. The local wisdom can be in the form of customs, clothing, culinary, buildings, handicrafts, dances, and traditional games. Local wisdom can be introduced to students as a method in learning concepts in physics learning [9]. However, many teachers have not utilized local wisdom to be linked in learning [10]. Therefore, local wisdom in the form of boi games is used to improve the other skills of students in learning physics.

The virtual laboratory with local wisdom was developed using existing technology in the surrounding environment. This is intended so that students can actively learn wherever and whenever, so that learning outcomes are maximized. However, some areas in Indonesia still experience difficulties in accessing the internet. This results in practicum activities not operating optimally [11,12]. The use of technology in the form of an offline computer can be applied in learning. This technology can be a virtual laboratory container to the fullest. The development of a virtual laboratory is integrated with local wisdom, stages of the scientific process, and practical multi-representation. Thus, the science process skills and multi-representation of students in learning Physics can be increased.

Based on the results of observations in several high schools in Maluku, it is known that teachers and some students already have technological devices and are able to use them. However, in carrying out Physics learning, there are still problems with internet connections so that students' practicum activities become constrained. In the end, the teacher returned to using the lecture method and giving assignments in learning so that the skills of students could not be developed properly. Teachers are also still not able to use technology to develop learning by linking local wisdom. Therefore, we developed a virtual physics laboratory based on computer-assisted local wisdom to optimally improve students' scientific process skills and multi-representation abilities.

Virtual physics laboratory based on local wisdom with computer assistance is a practical tool for teachers and students in carrying out learning without being limited by time and place. The virtual physics laboratory is a solution in the era of the COVID-19 pandemic and the rapid development of technology. Various features were developed to be able to train and improve various skills needed in theoretical physics learning and practical activities.

2. Methods

2. 1 General Research Background

The type of research used in developing a virtual physics laboratory based on local wisdom is development research with a 4-D model [13–15]. This type of research was adapted from [16] with the stages of research being define, design, develop, and disseminate. The research flow of the four stages of the 4-D model is shown in Figure 1

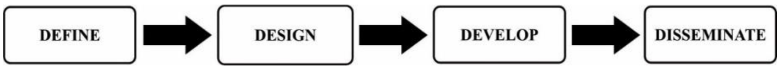

Figure 1. Research Flow With 4-D Model

The stages of research in this study are described in the research flow chart in Figure 2.

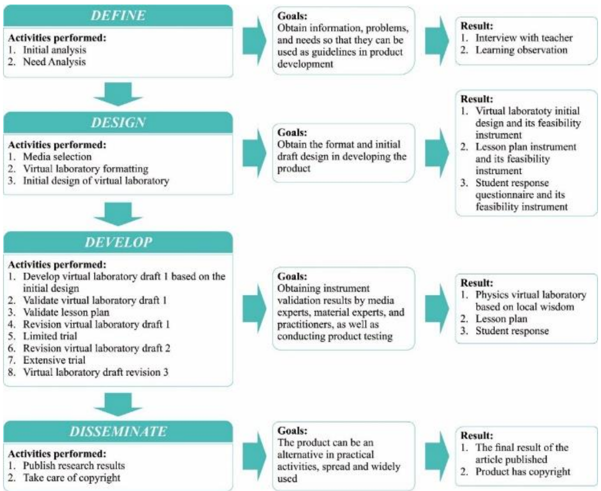

Figure 2. Explanation of Research Stages

2. 2 Participants

This development research involved two types of participants, namely validators and students. First, participants called validators are tasked with testing the feasibility of developing a virtual physics laboratory product. A total of eight validators participated in this study, namely two expert validators and six physics teachers. The validator was selected using purposive sampling technique [17,18]. The criteria for media and material validators have more than five years of experience in validating. In addition, there are physics teachers who have taught in high schools for more than three years and have attended local wisdom-based learning training.

Second, participants in the media testing phase involved students. The students involved in the trial were students of class XI MIA from one of the public high schools in Central Maluku. A total of 30 students were involved in the virtual physics laboratory media testing phase. Student involvement in the media testing phase was selected using a purposive sampling technique. The criteria for selecting participants in the pilot stage is that students have been taught about momentum and impulse materials.

2. 3 Research Instruments

The research instrument was used in this study to collect some data. The instrument used is a questionnaire which is divided into two types, namely the media feasibility test questionnaire and the response questionnaire. A feasibility test questionnaire was given to validators to assess the feasibility of a virtual physics laboratory based on local wisdom. Response questionnaires were given to students to find out the responses, impressions, and suggestions given by users (students). The preparation of the two questionnaires used several indicators, namely the content of the material, presentation of the material, media display, media use, benefits of use, language, and images.

Data collection with research instruments was carried out through four stages. First, developing a virtual physics laboratory based on computer-assisted local wisdom. Second, the validator tests the feasibility of the product with a validation instrument. Third, the product feasibility results are given to students as the main users. Fourth, the results of the feasibility test and student responses were analyzed in order to obtain a virtual physics laboratory based on computer-assisted local wisdom that is suitable for physics practicum activities in high school.

2. 4 Data Analysis

The feasibility test of computer-assisted local wisdom-based virtual physics laboratory media has been carried out by validators and applied to students. The level of feasibility of the developed local wisdom-based virtual physics laboratory media can be determined by analyzing the data that has been obtained. All data from the feasibility test are tabulated and analyzed by calculating the average score of each aspect, and interpreting it based on the reference criteria. The reference criteria in determining the percentage of eligibility using an assessment based on the ideal standard deviation with a scale of 4 are shown in Table 1.

Table 1. Criteria for assessment with a scale of 4

Quantitative score range	Category
$\overline{X} < X_i - 1.5SBi$	Not accepted
$X_i - 1.5SBi \leq \overline{X} < X_i$	Not good
$X_i \leq \overline{X} < X_i + 1.5SBi$	Good
$\overline{X} \geq X_i + 1.5SBi$	Very good

Table 1 contains information that X is the average score for each aspect. X_i is the ideal score or can be obtained from $1/2(\text{maximum ideal score} + \text{minimum ideal score})$. SBi is the standard deviation or can be obtained from $1/6\,(\text{maximum ideal score} - \text{minimum ideal score})$ [19,20]. The assessment criteria used in this study are shown in Table 2.

Table 2. Product validation criteria

Quantitative score range	Category
$\overline{X} < 1.75$	Not accepted
$1.75 \leq \overline{X} < 2.5$	Not good
$2.5 \leq \overline{X} < 3.25$	Good
$\overline{X} \geq 3.25$	Very good

3. Results

3.1 Define Stage

At this stage, observations were made on learning Physics during online learning due to the covid-19 pandemic. Observations were made on several teachers in various public high schools in Central Maluku District, Maluku, Indonesia. The findings from the observations carried out showed that in online learning, teachers delivered material using the lecture method and giving assignments. Whereas before online learning, physics teachers have applied various variations of models, methods, and learning media. This resulted in the concentration and motivation of students to learn is getting lower. Several teachers have attended workshops on physics learning that is integrated with local wisdom. However, teachers have not been able to apply it in learning. The teachers give reasons that if learning is integrated with local wisdom, the learning time will not be enough. In addition, teachers have not been able to use computers or smartphones in developing various digital learning media. This also has an impact on student practicum activities. During the COVID-19 pandemic, teachers cannot carry out practical activities in physical laboratories. Online learning causes teachers to rarely do practical activities, so that some skills cannot be grown and mastered by students. This is due to previous reasons and teachers also do not know the virtual laboratory platform. Whereas various virtual laboratory platforms have been widely available on the internet. However, some existing virtual laboratory platforms are still not contextual.

Observations were also made to several students to find out their opinions about physics learning given by their teachers during online learning. Some students feel bored and unmotivated in learning physics because of the teacher's delivery. In learning the teacher only conveys the material by reading it according to what is already on the PowerPoint slide or e-book. The material presented by the teacher is more often textual than contextual. The short time in online learning is also the reason students feel bored and unmotivated to learn. The teacher will give assignments to students in the form of questions that have been prepared by the teacher. Giving assignments by teachers is done after online learning. Boredom and lack of motivation of students in studying physics are also caused by teachers rarely doing practical activities. Practical activities are rarely carried out in online learning because tools and materials must be purchased individually.

Based on the results of these observations, it can be concluded that online physics learning carried out at senior high schools in Central Maluku still makes students feel bored, unmotivated, and give more assignments. In addition, teacher learning is less contextual, rarely combined with local wisdom, and practicum activities are rarely carried out. Therefore, it is necessary to develop a virtual physics laboratory that is integrated into local knowledge, able to improve student skills, can be accessed offline, and has a large display. In addition, the material for momentum and impulse is one of the materials that is integrated into local wisdom in the form of the traditional game of Bola Boi.

3.2 Design Stage

At this stage, several results were obtained related to material, practicum activities, and product design. The material chosen in this study includes momentum, impulse, momentum and impulse relationship, the law of conservation of momentum, and types of collisions. The student practicum activities were carried out in two meetings covering the law of conservation of momentum and the coefficient of restitution. In the practical law of conservation of momentum, objects are presented in the form of two boi balls and three teal fractions with different masses. In the restitution coefficient practicum, objects are presented in the form of two boi balls placed at a certain height with different masses. The product is designed by compiling a story board and flowchart. The design of a computer-assisted local wisdom-based virtual physics laboratory is shown in Table 3.

Table 3. Computer-assisted local wisdom-based physics virtual laboratory design

Part of the virtual physics laboratory based on local wisdom	Explanation in the virtual physics laboratory based on local wisdom
Virtual laboratories start page	Contains agency logo, home text, virtual laboratory menu, and developer profile menu
Virtual lab	Contains the first meeting practicum menu, the second meeting practicum menu, and practice questions menu
First meeting practicum	Contains the title of the practicum, student worksheet menu, lab menu, table menu, conclusion menu, and material menu
Second meeting practicum	Contains the title of the practicum, student worksheet menu, lab menu, table menu, graph menu, conclusion menu, and material menu
Exercises	Contains questions to measure science process skills and multi-representation abilities integrated with local wisdom of the traditional game boi
Developer profile	Contains photos and personal data from the developer

3.3 Develop Stage

At this stage, the final product of a virtual physics laboratory application based on computer-assisted local wisdom is produced. Some of the results obtained at this stage are as follows:

a. Validation results from validators

In this study, experts and practitioners evaluate products in the form of lesson plan and computer-assisted local wisdom-based virtual physics laboratory media. Lesson plan assessment is carried out by taking into account several aspects, namely identity clarity, competency achievement indicators, learning objectives, descriptions of learning materials, learning activities, assessments, media, learning resources, and language. The results of the lesson plan feasibility test are shown in Table 4.

Table 4. Lesson plan feasibility test results

Aspect	Score	Category
Identity clarity	3.56	Very good
Indicators of Competence Achievement	3.88	Very good
Learning objectives	3.63	Very good
Description of learning materials	3.83	Very good
Learning Activities	3.67	Very good
Evaluation	3.75	Very good
Media and learning resources	3.63	Very good
language	3.75	Very good
Average score	**3.71**	**Very good**

Table 4 shows that the results of the developed lesson plan feasibility assessment are categorized as very good with an average value of 3.71. This means that the developed lesson plan is suitable for use in research. The assessment of computer-assisted local wisdom-based virtual physics laboratory media is carried out by taking into account several aspects. These aspects are appearance, content, presentation of material, use, language, and images. The results of the feasibility test of the computer-assisted virtual physics laboratory based on local wisdom are shown in Table 5.

Table 5. The results of the virtual physics laboratory media feasibility test based on computer-assisted local wisdom

Aspect	Score	Category
Appearance	3.75	Very good
Contents	3.69	Very good
Material presentation	3.58	Very good
Media use	3.38	Very good
Language and pictures	3.50	Very good
Average score	**3.58**	**Very good**

Table 5 shows that the results of the product feasibility assessment are categorized as very good with an average value of 3.58. this means that computer-assisted local wisdom-based virtual physics laboratory products are suitable for use in research.

b. The results of student responses to the product

Student response questionnaires have been given to students in a limited trial. Students give an assessment by paying attention to several aspects of the response questionnaire. These aspects are the display, presentation, language, and operation of the media, and benefits. The results of students' responses to computer-assisted local wisdom-based virtual physics laboratory media are shown in Table 6.

Table 6. The results of student responses to the product

Aspect	Score	Category
Appearance	3.39	Very good
Presentation	3.30	Very good
Language	3.32	Very good
Media Operation	3.43	Very good
Benefit	3.37	Very good
Average score	**3.36**	**Very good**

Table 6 shows that the results of the assessment of student responses to the product are categorized as very good with an average value of 3.36. This means that computer-assisted local wisdom-based virtual physics laboratory media products get a good response and are suitable for use in practical activities.

c. The results of product develop

The development of a virtual physics laboratory based on local wisdom is carried out by taking into account the initial design of the product. The final product has been developed in the form of software that can be installed on a computer or laptop. The results of product development are displayed in the form of screenshots in Figure 3.

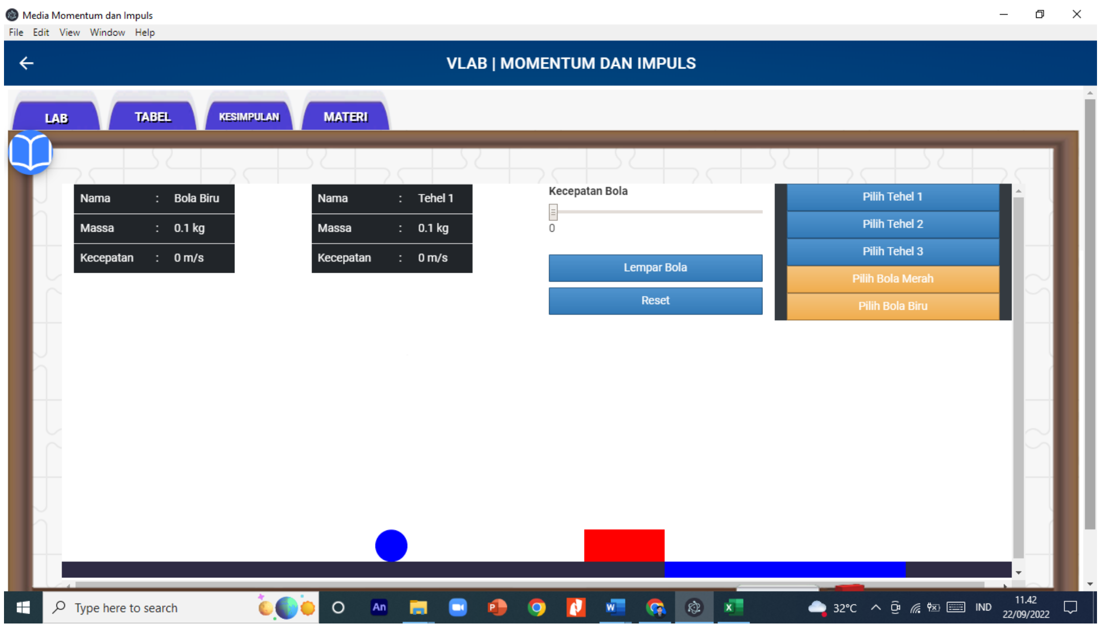

Figure 3. Display of computer-assisted virtual physics laboratory based on local wisdom

Figure 3 shows the appearance of a computer-assisted virtual physics laboratory based on local wisdom. Indonesian is used in the development of a virtual physics laboratory based on local wisdom. This is done by paying attention to its use and application to high school students in

Indonesia. The use of Indonesian is useful so that students can understand and interpret the concept of momentum and impulse to integrate local wisdom easily. Various features developed in the virtual physics laboratory based on computer-assisted local wisdom are expected to improve students' various skills.

3.4 Disseminate Stage

At this stage, the product that has been developed has been disseminated to the physics teachers of SMA Negeri in Central Maluku involved. The publication of research results in the form of articles has been submitted to the Journal of Specialusis Ugdymas.

4. Discussion

The development of a virtual physics laboratory product based on local wisdom with the type of research and development is carried out to overcome the problems of learning physics in high school. Physics learning in high school can be in the form of theory and practice. Integrating physics material with everyday life is rarely done by teachers in learning. This is one of the problems that are often found in learning physics in high school. Several teachers have attended training on physics learning integrated with local wisdom by a lecturer at a state university in Maluku. However, teachers still rarely carry out physics learning that is integrated into local wisdom [21,22]. Some teachers think that integrating local wisdom in physics learning will take a long time. This is because several variations of learning that have been carried out by teachers still require a long time in delivering the material [23–26]. The need for a long time to understand physics is also caused by some relatively abstract physics material. In addition, practical activities are also rarely carried out by teachers. This is because some practical equipment is not available in the physical laboratory and the assembly of KIT equipment takes a long time [27–30]. Practical activities that are rarely carried out by teachers cause various skills that can be mastered by students to be hampered. Therefore, through this research and development, we have developed a virtual physics laboratory product with a regional context and technological insight. The development of this product is one of the novelties in research and development as an alternative solution in physics practicum activities. The products developed in this research are lesson plans and a virtual physics laboratory based on computer-assisted local wisdom. Some local wisdom can rarely be integrated with physics learning both in theory and practice. The traditional game of Bola Boy was chosen from various kinds of local wisdom in Maluku. This is because this game has similarities with the modern game, namely bowling ball. Online games which are now widely available on smartphones and computers have resulted in the game Bola Boy being rarely played by children in the Maluku region [31,32]. Several facts related to the Bola Boy game became an idea as the development of a virtual physics laboratory that was integrated with local wisdom. This laboratory was developed to make it easier for students to understand and carry out practical activities on momentum and impulse topics. The development of this laboratory was developed on a computer device.

The results of the feasibility test of the RPP and the virtual physics laboratory based on local wisdom that have been developed in this study obtained very good results. The results of this development are suitable for student practicum activities on momentum and impulse materials.

The use of computers has been widely applied in the fields of industry, offices, education, and others. The use of computers is often seen in the administration of computer-based school exams. Several studies [33–36] reveal that student learning outcomes can be optimal with integrated physics learning technologies such as computers. Moreover, what is being developed is a virtual laboratory on a computer that is integrated with everyday life, which will significantly optimize practicum activities and develop students' skills. A virtual physics laboratory based on local wisdom makes it easier for students to do practicum and reduces the cost of purchasing equipment. Students' skills in practical activities also increase. Practical activities using a virtual physics laboratory based on local wisdom also help the teacher deliver physics material.

5. Conclusion

Based on the results of the assessments of experts and teachers, all aspects show the "very good" category. The product that has been developed has received a positive response from students by showing the "very good" category in every aspect. This shows that a computer-assisted local wisdom-based virtual physics laboratory is appropriate to be used as a support for student practicum activities on momentum and impulse material.

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