Development of Virtual Laboratory (VL-IPA) Learning Media on Lens Experiment Simulation

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ABSTRACT
Practical-based learning during the Covid 19 pandemic was not optimal. Therefore, researchers developed science media for distance learning by harness virtual laboratories in applications that run computers. The purpose of the research are: (1) to specify the validity of the VL-IPA; (2) to specify the practicality of VL-IPA from science teachers; and (3) to specify students' responses to VL-IPA. VL-IPA development uses the ADDIE development model. The instruments use are media validation sheets, student response sheets, and science teacher assessment sheets. The results showed that: (1) the validity of the VL-IPA is good category; (2) the practicality of VL-IPA is good category; and (3) students' response to VL-IPA was good. In short, it can be concluded that the VL-IPA is appropriate for use in science learning.

Keywords: *Science learning, Virtual laboratory*

1. INTRODUCTION

The appearance of the Coronavirus outbreak interferes with educational activities that cause institutions to use other means of content delivery methods. Virtual laboratory media can extand everyday life via electronic devices such as computers in the era of globalization [1]. The challenge is to teach practicum to be more significant. Physics experiments have evolved from optical kits that you can buy and try anywhere, to virtual computers or cloud-based technical experiments today.

Virtual Laboratory is a collection of interactive multimedia-based laboratory equipment in the form of software that operates on computer hardware to simulate activities in the laboratory as if the user were practicing in a real laboratory [2]. The installed applications require a large computer space with each workstation equipped with expensive licensed software, some problems, and miscellaneous equipment that is out of date. Currently available virtual laboratory experiments offer the latest technology that students can access which is regularly upgraded by educational sponsors.

During this lockdown for the Covid-19 pandemic, virtual laboratories are available for students and scientists to access virtual experimental programs, obtain results, create data graphs or data tables, and prepare experimental reports to be submitted online. It only takes an internet connection and a computer to access the virtual lab and users can work freely at their own pace. Switching to a virtual lab in the Covid-19 era has other advantages such as speed, elasticity, procurement process time, cost-effective chemicals, equipment costs and no need for internal or external dependence on other parties. Users can work from a preferred location and at their own pace. The resulting weakness is the loss of physical observation, sound, and direct instructional interaction.

This experiment was designed in preparation for an experiment looking for lens image properties in a virtual laboratory. The lenses used are convex and concave. By doing shift the lens so that it produces a shadow with certain properties. From these experiments data will be generat later into a report. Technological advances in the era of globalization make science learning more enjoyable for students because it has its own role and is able to control learning [2].

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Currently, technology has an crucial part in the online learning process. Teachers use media in online learning, in fact they want to attract students' attention and make it easier for teachers to deliver material, so that it can improve effective learning. In fact, it is very unpleasant for students whose lives are completely technological to learn in a traditional way the material they are new to. Therefore, changing the learning environment is the solution [4].

The science laboratory is an atmosphere that encourages the science learning process. The opportunity is given to students to learn confusing concepts that are implemented through the media of 'real' material in the Science Laboratory. Teachers and students interact with each other to discuss learning material, sharpen their memory and develop the basic attitudes and manipulative skills necessary to gradually acquire advanced knowledge in science. Most of the science curriculum emphasizes the process of science skills rather than just the acquisition of knowledge, experiments in virtual laboratories are preoccupied to investigative activities [5].

In reality, during online learning, not all schools carry out learning activities optimally, due to limited school media. Most of science learning only uses Microsoft PowerPoint media. Based on these problems, the researchers developed science learning media for virtual laboratory applications (VL-IPA) which can be easily run on the desktop. This study is to develop appropriate learning media based on expert validity, science teacher practicality, and student responses.

2. RESEARCH METHOD

Research on the development of VL-IPA media uses the ADDIE model. The research stages were: (1) Analysis; (2) Design; (3) Develop; (4) Applying; (5) Evaluation. Discussion Research is at the development stage. The product developed in this media development research is the Virtual Laboratory IPA (VL-IPA) application that contains optical materials. The research was conducted by validating by experts, teachers and collecting response sheets to specify student responses to the product. The number of students who became respondents was 32 students of class VIII at SMPN 1 Singaraja Kendal. The instruments used in this study were (1) expert validation sheets, (2) student response sheets, and (3) teacher assessment sheets.

Data analysis used for expert validation results and science teacher assessment sheets was carried out by (1) tabulating the data, (2) calculating the average score ; (3) converting the average score of each aspect into a qualitative scale value. Furthermore, the conversion of the product appropriateness interval score can be seen in table 1.

$$x = \frac{\sum x}{n} \tag{1}$$

Notes: x = total score, $\Sigma\ x$ = average score, n = number of validators.

Table 1. Convert product category criteria intervals

Score Interval	Category
Xi+ 1.7 Isd < X	Good
Xi + 0.5 Isd < X ≤ Xi + 1.7 Isd	Good
Xi - 0.5 Isd< X≤ Xi + 0.5 Isd	Enough Good
Xi – 1.7 Isd < X≤ Xi - 1.5 Isd	Less Good
X□≤ Xi - 1.7 Isd	Not Good

Notes: X = average score, Xi = ideal mean, calculated by using the following equation ($Xi = \frac{1}{2}$ (*ideal highest score* + *ideal lowest score*) and Isd = ideal standard deviation, calculated by using the following equation (Isd = $\frac{1}{6}$ (*ideal highest score* − *ideal lowest score*).

Meanwhile, to analyze the data used for the results of the student response sheets, it was done by (1) tabulating the data, (2) calculating the average score, (3) matching the average score of each aspect with the criteria in table 2.

$$\sum x = \frac{\text{Total Score}}{\text{Total Maximum Score}}\ x\ 100\% \tag{2}$$

Table 2. Students' response category criteria

Range (%)	Category
81-100	Good
61-80.9	Good
41-60.9	Enough Good
21-40.9	Less Good
0-20.9	Not Good

3. RESULTS AND DISCUSSION

Conducting interviews with science teachers at SMPN 1 Singaraja is the first step in development research and from the results of the interviews it is revealed that online science learning practicum is still rarely done. The teacher stated that the science practicum learning media, especially Lens material, had not been implemented because they did not have interactive online media that could be used.

At the stage of designing the VL-IPA learning media, the researcher take several parts in the Lens material, namely (1) concave lenses and (2) convex lenses. The selection of subsections on Lens material is based on material related to science events that usually occur in everyday life and consideration of the opinions of science teachers. VL-IPA is an application that runs on a computer. The design of VL-IPA media can be seen in the following figure.

Figure 1 Theory lens design

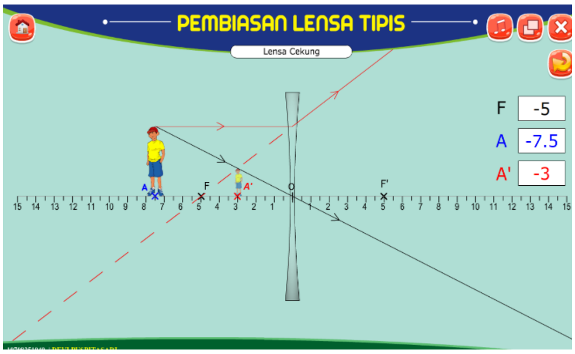

Figure 2 Concave lens experiment screen display

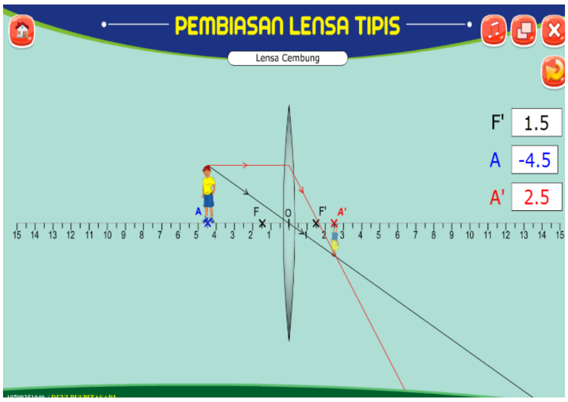

Figure 3 Convex lens experiment screen display

Furthermore, media validation is validated by experts to specify the suitability of the product being made. Validation of VL-IPA media, there are two validators who will validate, namely the validator of learning media experts and validator of material experts. Learning media experts review the components in the Virtual Laboratory media in the manipulation, navigation and visual aspects. The results of the validation assessment of two laboratory virtual media validators are presented in table 3.

Table 3. The results of learning science media expert validation

Aspect	Average (X)	Interval	Category
Manipulation	2	1.50<X<2.50	Good
Navigation	1	0.67<X<2.10	Good
Visual	8	7.10<X<8.20	Good

Each aspect falls into the good category, this is shown in table 3. According to the learning media expert the product is categorized as good. It is further explained on the visual aspects, the demonstration of attractive colors of the environment and virtual objects, the appearance of real 3D experiments, namely the ability of objects to stand out so that they appear to function, the changes in the feedback given are clearly visible; on the navigation aspect, it makes it easier for users to run applications while moving people; and in the manipulation aspect, it allows the user to change the size of the object distance and focal length. Meanwhile, the material expert examines the content of the VL-IPA media material on the aspects of Conspicuousness of instructions for media use, suitability of objectives, Conspicuousness of performance, and material. Table 4 below shows the results of the validation assessment carried out by material experts.

Table 4. The results of material science expert validation

Aspect	Average	Interval	Category
Conspicuousness of Instructions for Use	3	2.10<X<3.40	Good
Conspicuousness of Performance	3	2.45<X<3.21	Good
Conformity of Objectives	3	2.10<X<3.40	Good
Material	6	4.50<X<6.80	Good

According to the material expert, all aspects are in the good media category so that VL-IPA is in the good category shown in table 4. It can also be seen that the aspect of interest in the instructions for using the media looks easy, coherent and concise to understand; aspects of practicum objectives match the basic competences and core competences of science; the acuity aspect of performance includes data collection procedures that stimulate students' motor skills; and material aspects are easy to understand, according to basic competencies and core competencies so that they are correct. Furthermore, the practicality test was assessed by three science teachers. The results of the free assessment by the teacher can be seen in table 5.

Table 5. Practicality test results by science teachers

Aspect	(X)	Interval	Category
Conspicuousness of Instructions for Use	4	2.10<X<3.40	Good
Conspicuousness of Performance	4	2.10<X<3.40	Good
Conformity of Objectives	4	2.10<X<3.40	Good
Manipulation	1	1.50<X<2.50	Good
Material	5	4.50<X<6.80	Good
Navigation	2	0.67<X<2.10	Good
Visual	8	7.10<X<8.20	Good

This can be seen from all aspects that fall into the good category. The good category of practicality of the VL-IPA media is shown in Table 5. While Table 6 shows the results of students' responses to the VL-IPA media. According to students, the science material in the VL-IPA media has excellent virtual laboratory appearance and excellent facilities. Students are very interested and excited about using VL-IPA media in this science lesson. This is considered good because students are excited before the teacher gives the concept and successfully attracts students' attention to start learning [6]. Students express that they are very passionate about navigating in a virtual laboratory environment. Students find it easy to use the VL program and provide learning enjoyment, ease of understanding concepts and a sense of reality. Students participate actively and immerse themselves in learning activities when assisted by a virtual laboratory so it is preferred over other multimedia programs [7].

Virtual laboratory media can be used as practical learning media during the Covid-19 pandemic. To repair the quality of online learning due to the Covid-19 pandemic, it is highly recommended to use science learning media, one of which is simulation media including virtual laboratory media. The virtual laboratory is one of the effective methods in the science learning process for junior high schools to continue implementing the 2013 curriculum [8]. Students get scientific concepts that are hard to directly observed through learning experiences using virtual laboratories [9]. The virtual laboratory provides material that contains theory which is equipped with animation, pictures [10]. This is motivated by the trend of students now to prefers computer-related things.

Table 6. Results of student responses to VL-IPA media

Aspect	(X)	Interval	Category
Conspicuousness of Instructions for Use	4	2.10<X<3.40	Good
Conspicuousness of Performance	4	2.10<X<3.40	Good
Conformity of Objectives	4	2.10<X<3.40	Good
Manipulation	1	1.50<X<2.50	Good
Material	5	4.50<X<6.80	Good
Navigation	2	0.67<X<2.10	Good
Visual	7	7.10<X<8.20	Good

By using learning strategies, Virtual Laboratory Technology (VL) can increase student interest and learning abilities. In the learning process students actively participate in conducting experiments and interpret the meaning of each experimental information obtained afterward [11]. To support a wide variety of interactive learning environments, technology innovations such as Virtual Laboratories (VL) are presented which can help teachers create new things that attract students. Instead of learning to use 2D technology, it is better to learn using a Virtual Laboratory (VL) which acts as an interactive learning atmosphere. Students who do studying with 2D technology get lower learning outcomes compared to Virtual Laboratory (VL). The simulation techniques in the Virtual Laboratory (VL) used in research also get better learning outcomes so that they are more effective in helping students [12].

Table 7. Results of student responses to VL-IPA

Indicator	Statement	Score	Total (%)
Ease of Materials to be Understood by Students	The brightness level of the object	100	97
	Color matching object	100	
	The environmental brightness is not dazzling to the eye	88	
	The attractiveness of material to be studied	100	
	Media is easily accessible in learning	97	
	Media operating instructions are easy to understand	91	
	The presented materials are clear	97	
The display in VL-IPA is attractive	Environmental colors adapted to reality	88	94
	Matched environment colors	100	
	The button is in the same place	94	
	The font size is well read	91	
	Appropriateness of feedback	94	
	The appropriate size of the object to be observed	97	

Advantages of virtual laboratory technology for science learning. First, virtual laboratory (VL) technology can increase student participation andmotivation in learning. Students study 3D models through virtual laboratories which can enhance their learning experience and gain immersive experiences. Second, virtually attractive objects that encourage students to explore, develop, and get in return so as to create a constructive learning approach. on objects in the Virtual Laboratory (VL). Third, globalization with the latest technological advances makes access easier a Virtual Laboratory (VL) with computers, tablets and laptops. Students do not need complex devices and can access Virtual Laboratory (VL) content shared via public online platform. Finally, with the help of using Virtual Laboratory (VL) hardware, students feel more deeply when interacting with objects, processes, and concepts.

Nevertheless, students often experience some weaknesses in the application of Virtual Laboratory (VL) technology. One of them is the difficulty in operating the Virtual Laboratory (VL) application or program when learning. The Virtual Laboratory System (VL) requires users to start adapting to specific operating methods. They recommend ensuring that before applying a Virtual Laboratory (VL) in the classroom, teachers must be given training before learning.

Meanwhile, students should also be given a manual on the use of media and relevant exercises before using the Virtual Laboratory system (VL) for the smooth use of media [13].

4. CONCLUSION

Media Virtual Laboratory IPA (VL-IPA) optical material developed appropriate for teacher or student in science learning in schools. Can be seen based on the results of good validity, good student response and good practicality. So that the Virtual Laboratory media can be a new innovation in the development of learning media because it can provide real experiences for them to make students excited about learning.

ACKNOWLEDGMENTS

The author thanks the lecturers, teachers and all respondents who have been involved in this research.

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