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Development of Virtual Simulation to Reduce the Number of High School Students' Misconceptions about Fluid Topics

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ABSTRACT

Teachers in learning activities should carry out practicum activities to facilitate students' learning, so there are no misconceptions. The facts in the field say that many teachers still do not do practicum because of the availability of tools and materials at the school, so virtual simulations are needed as a medium in practicum activities. The development model used in this study consists of three stages, namely the definition stage, the design stage, and the development stage. The results showed that the virtual simulation was feasible to use in the learning process. The validation analysis on the developed virtual simulation with very achievable criteria. In the student's opinion, the virtual simulation feasibility with very feasible criteria. Teachers in learning to remediate misconceptions can use the virtual simulation that has been developed.

INTRODUCTION

There are many phenomena in everyday life that students can learn. Phenomena that occur in everyday life are studied in physics subjects. There needs to be more than just learning physics to remember the material studied. Learning physics is insufficient to remember the material studied (Berek *et al.*, 2016). However, it requires understanding and analysis to solve problems because physics is a collection of laws, theories, principles, rules or equations, and concepts that are interconnected (Carbonell *et al.*, 2014; Buteler & Coleoni, 2016; Çepni & Çiğdem, 2013; Chen *et al.*, 2013). Judging from the complexity of learning physics, of course, the creativity and activeness of teachers are needed. The originality of teachers in designing learning will undoubtedly impact many things, including students' understanding of concepts (Kamilah & Suwarna, 2016). In addition to being creative, teachers must also be active in learning physics (Gurel *et al.*, 2015; Foley *et al.*, 2015; Gurel *et al.*, 2015; Gurel *et al.*, 2017). In addition to designing learning, the next step is to apply what the teacher has designed in class. The teacher's activeness in teaching can also affect students' conceptions (Sibel *et al.*, 2015; Smith *et al.*, 2015; Young, 2017; Yalcinkaya *et al.*, 2014; Sutraja *et al.*, 2016; Yetilmezsoy, 2017). A good teacher is a teacher who becomes a facilitator when teaching in the classroom. Thus, students must be active in the classroom to create student-centered learning.

One method that can make students active in class is the practicum method (Saputra *et al.*, 2019; Saputra *et al.*, 2020; Saputra *et al.*, 2019; Samsudin *et al.*, 2020; Samsudin *et al.*, 2017; Samsudin *et al.*, 2018). Practicing is one way to hone students' thinking skills in studying physics. Students can solve science problems by connecting the results of observations in practicum with their theoretical constructions to build a conceptual structure well. There are at least four reasons for the importance of practical activities in learning science. First, a practicum can increase motivation to study science. Second, practicum can improve the basic skills of experimenting. Third, practicum can be a means of scientific learning. Fourth, practicum supports understanding the material (Seyid *et al*., 2015).

One of the activities that can cause cognitive conflict in students is to use practicum activities. However, based on preliminary research (Hamdani, 2015; Imre, 2017), it was found that practicum activities were not carried out in fluid learning because the availability of practicum tools was incomplete, teachers had difficulties in designing practicum activities, and teachers did not have much time to learn activities in conducting practicums. Based on the problems above, we need a learning media that can overcome these problems. The way that can be used to overcome the problem of limited tools in the practicum is to use virtual equipment (virtual apparatus) in the form of interactive computer simulations (virtual lab) (Kamcharean & Wattanakasiwich, 2016). The impact of Information and Communication Technology (ICT) on education is increasing rapidly. This is evidenced by the many online learning programs developed in all educational domains (Jordan, 2013; Potvin & Cyr, 2017). Today, computers are increasingly playing a significant role in learning, such as (virtual) simulation programs.

Using virtual labs could provide financing efficiency, can visualize abstract and macroscopic concepts, and the potential to improve conceptual understanding (Pujayanto *et al*., 2018). This is supported by Kusairi *et al*. (2017), who said that another way to reduce misconceptions in the classroom is to use virtual simulations in the learning process. Many studies have used the help of virtual simulation media in teaching. This shows that media use in learning is essential (Potvin & Cyr, 2017). Virtual media simulations are expected to make students who have misconceptions about a static fluid material experience a conflict of conceptions they have to allow the change of concepts into scientific knowledge (Petrosino & Mann, 2017; Purwanto *et al*., 2018).

Virtual simulations are very beneficial for teachers when teaching. The simulation can be repeated by students not only in the classroom and laboratory but at home as long as a computer is available. With the media, students also better understand the concepts taught by the teacher in learning so that the teacher and media factors in learning will be minimized in remediating misconceptions. The media that will be developed in this research is a media that can be accessed by students anywhere (without internet access) so that students can use it, have the ability to time efficiently when practicum is in the learning process, does not require laboratory equipment, does not have to be used in the laboratory. Because it is a virtual laboratory, free from potential accidents in conducting practicum, low cost, structured and systematic, and the media to be developed in this study does not require an expensive and sophisticated computer/laptop because the media developed in this study is in the form of flash so that it can be accessible for all types of computers/laptops (Ahmad *et al*., 2016; Ajaja & Ochuko, 2012; Ali, 2019).

RESEARCH METHOD

Participants / Group

The media designs were made by experts and validated by media experts and material experts, and the trial was limited to 20 students. The main activities at this stage are media analysis by media experts, media studies by material experts, data analysis and revision, review revision results, media validation, and limited trials. Data analysis from validation, limited trials, and media feasibility results (Sugiyono, 2012).

Instrument and Procedures

In developing interactive multimedia-based learning media, a descriptive procedural development model is used because interactive multimedia-based learning media requires steps to be followed to produce an interactive multimedia-based learning media product. The model of developing interactive multimedia-based learning media is attempted as operationally as possible as a reference in developing interactive multimedia-based learning media products. The interactive multimedia-based learning media development model consists of three stages, namely the definition stage, the design stage, and the development stage.

Figure 1. Media development procedure

In this stage, the researcher will analyze the needs needed before designing interactive multimedia-based learning media. Things that need to be considered in this stage are front-end analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives. At this stage, the researcher makes a media design that will be tested. The main activities at this stage include defining, designing, and developing (Sugiyono, 2012). The development stage consists of studying learning media at one of the schools in Bandung.

Data Analysis

The value was obtained by calculating the questionnaire using a Likert scale. Calculations using the Likert scale are as follows (Riduwan, 2013). The results of the assessment of the validators can be analyzed descriptively and quantitatively (Arikunto, 2013). The results of the student response questionnaire assessment can be analyzed quantitatively (Arikunto, 2013). The results of these percentages can be concluded about the feasibility of the media using a Likert scale with criteria that can be seen in the Table 1.

Table 1. Categorization of validation criteria.

Percentage	Criteria
0-20	Very Unworthy
21-40	Not feasible
41-60	Decent enough
61-80	Worthy
81-100	Very worth it

The media is said to be feasible and gets a positive response from students if the interpretation result is 61% with robust criteria.

RESULTS AND DISCUSSION

The data were analyzed using quantitative descriptive analysis techniques consisting of validation data analysis and trial data.

Table 2. Analysis of validation results and limited trial results.

No	Rated Components	Expert Validation	Students' Opinion
1	Media clarity component	95	100
2	Grammar component	95	90
3	Material components	95	85
	Average	95	91,2

Data analysis was divided into two sources and three assessment components. The first component is media clarity, the second is grammar, and the third is material used as a virtual simulation. In expert validation, the media clarity component was obtained with a score of 95, the grammatical component with a score of 95, the material component with a score of 95, and the average value or score based on sources from expert validation obtained a score of 95 or with a very feasible category to be implemented into learning to change students' conceptions are correct. Analysis of student responses related to the virtual simulation developed obtained the media clarity component with a score of 100, the grammatical component with a score of 90, the material component with a score of 85, and the average value or score based on sources from expert validation obtained a score of 91.2 or by category very worthy.

This virtual simulation is developed using three stages: definition, design, and development. The definition stage, at this stage, begins with a front-end analysis based on a preliminary study of the fundamental problems that occur, namely the media used by teachers when the learning process cannot change students' conceptions into scientific conceptions. Furthermore, the analysis of students in this development research became the subject of research, namely high school students at one of the public schools in the Lembang sub-district, West Bandung Regency, West Java Province, Indonesia, who still experienced misconceptions on the topic of fluid. After analyzing the students, then the task analysis, at this stage, the researcher identifies the nature of the procedure to determine the learning objectives to be achieved. This starts with identifying core competencies, essential competencies, and indicators in a fluid material. The analysis of the curriculum concept used in this virtual simulation is the 2013 curriculum, where students are required to think scientifically. So that students must be able to understand each concept of physics lessons correctly (Irwansyah *et al*., 2018; Piaget, 1970).

At the design stage, starting with pre-production, at this stage, the development makes a virtual simulation design. The design of making virtual simulations to reduce the number of students misconceptions on the topic of fluid starts from analyzing which concepts in the fluid are not facilitated to change their misconceptions. After the materials needed to create a virtual simulation are complete, the next step is the production stage. The researcher enters the material. Finishing, the virtual simulation entered into the computer application is transferred to the form of phet simulation to be run. In the development stage, after the initial concept of the media has been completed, the initial concept is reviewed by a material expert consisting of three experienced lecturers in physics education. Final virtual simulation is shown in Figure 1.

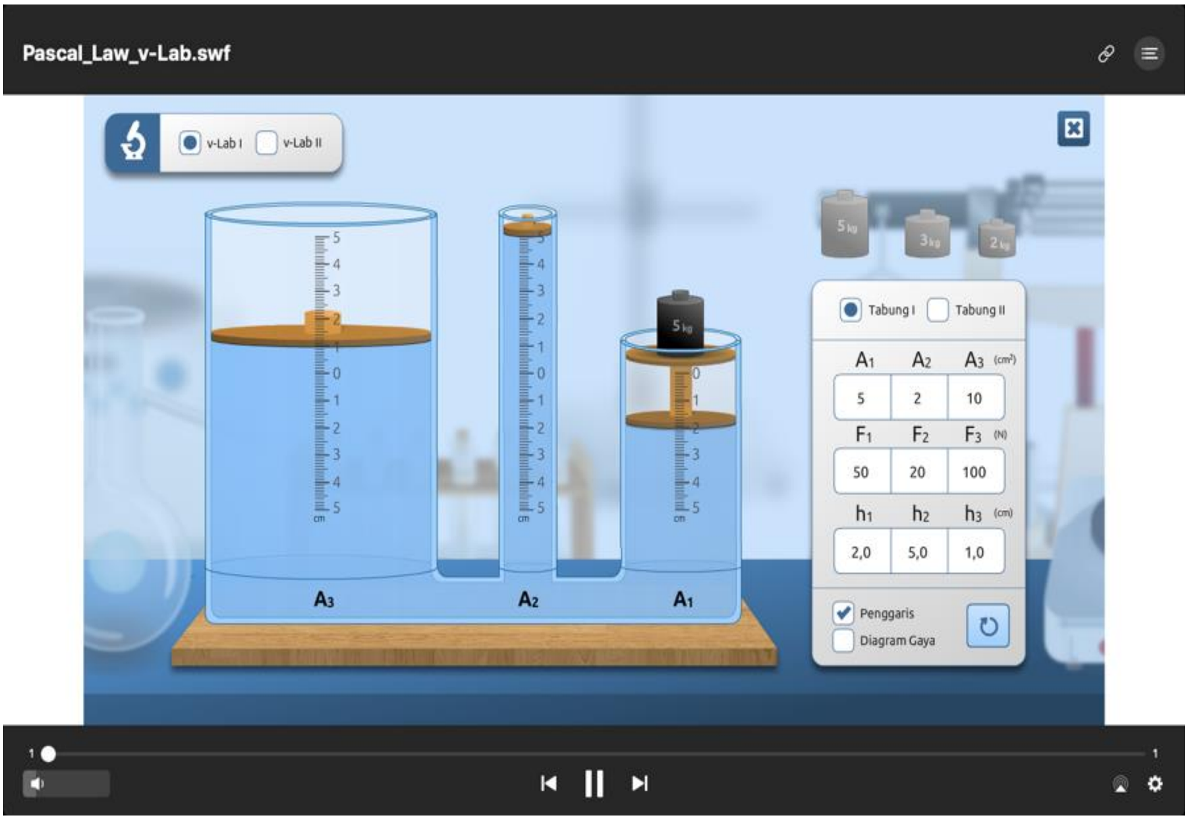

Figure 1. Example of virtual simulation.

The feasibility of the virtual simulation can be seen in Table 2, the validation analysis, and limited trial results. It is known that the feasibility of the media from media experts, material experts, and student responses who assess interactive multimedia-based learning media through three components of eligibility criteria obtains an average score of 95 with very feasible criteria. This is to Riduwan's (2013) theory regarding the media feasibility interpretation, where if 81%, it is classified as feasible. Student responses to interactive, as shown in Table 2, multimedia-based learning media received a positive response of 91.2. This is to Riduwan's (2013) theory regarding the media feasibility interpretation, where 81% of it is classified as feasible.

Many studies have used the help of virtual simulation media in teaching. This shows that media use in learning is significant (Yetilmezsoy, 2017). The use of virtual media simulations is expected to make students who have misconceptions about a static fluid material experience a conflict of conceptions they have to allow the change of concepts into scientific knowledge. Virtual simulations are very beneficial for teachers when teaching. The simulation can be repeated by students not only in the classroom and laboratory but at home as long as a computer is available. With the media, students better understand the concepts the teacher teaches so that the teacher and media factors in learning will be minimized in remediating misconceptions.

CONCLUSION

Only some schools have laboratories, so most teachers only use the lecture method in teaching, which can lead to misconceptions in students. One way to remediate misconceptions is to provide virtual simulations that can confuse students. The development of virtual simulation learning media on fluid material was developed using a development model consisting of three stages: the definition stage, the design stage, and the developing stage. Based on the assessment given by the validator, namely material experts, media experts, and student opinions, the learning media developed is feasible to be used as an alternative media in the learning process. The student's response to the virtual simulation is good or positive. After the developed media is declared feasible to be implemented, it becomes an opportunity for further research to integrate the media developed into the learning model.

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