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Web-Based Simulation on Physics Learning to Enhance Digital Literacy Skill of High School Students

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ABSTRACT
The study aimed to investigate the effectiveness of Web-Based Simulation (WBS) on Physics learning to enhance digital literacy skills of Grade XI students in high school. The level of digital literacy skills of the students in the experiment and control group before and after they study using WBS learning and none was determined respectively. The comparison of their levels before and after the study was done to determine the effectiveness of the WBS learning. The participants of this study were 49 students of science class, with 14-16 age. The research design in this study were descriptive-comparison and pretest-posttest experimental design. Data analysis using Anova mixed design with significant 5%. The result of this study are level of students' digital literacy skill before learning process is generally very low; but after the treatment these skill was comparatively increased. In addition, there was a significant difference in the level of digital literacy skill of the classes where the WBS learning is the more effective than direct learning to enhance students' digital literacy skill.

INTRODUCTION

The first contribution and urgency of this study was to determine the level of students' digital literacy skill especially in physics learning. Because, the concepts and principles of physics are widely applied in various fields including technology [1]. The core competencies in physics learning is "make use technology" [2] and able to use information technology, including coding in the computer world, through investigation and problem solving [3]. In addition, we offer a new learning method to improve level of students' digital literacy skill in physics learning. Because, there is no study that focus on learning process based on digital literacy in physics. Through this learning, it can increase intellectual property regarding the importance of technology-based learning in the present, especially regarding digital literacy skills of students.

Very rapid technological development has led to the need to rethink content literacy. Thinking about traditional literacy (reading and writing) must be increased to digital literacy thinking (knowledge, skills and strategies in using new technology) [4]. Digital literacy skill is the abilities needed in the 21st century [5,6]. It is not only about knowing how to operate technology, but also having the right information management and critical thinking skills, as well as the right online behavior [7]. Another components that can be identified regarding digital literacy skills include mastery of technology or instrumental, communication, information, critical thinking, and security [8]. Most physics teachers agree that one of the main reasons students are taught physics is to learn critical thinking [9]. But, in Indonesia learning with technology is not yet optimal [10]. Students rarely get the latest information, especially internet usage. Beside, in physics learning all aspects of digital literacy skills are very important. The ability of students to process and utilize technology today is still not optimal. Beside, one indicator of this skill is that students are able to access information well [11].

In order to be digitally literate, one must be able to create and share in various digital modes and formats, effectively create, collaborate, and communicate in a digital environment, and understand how and when technology can support this process [12]. These skills also include basic use of software, the ability to be creative and innovative, solve problems and think critically with the Internet and computers [13]. The basic level of digital literacy includes the ability to send emails, prepare documents using computers, and search for information on the Web, the competencies needed to meet this basic level of digital literacy are increasing along with the use of technology [14]. Viewed from the field of physics, the use of technology-based learning strategies effectively improves student learning outcomes. With the scaffolding application [15] and the Moodle application [16], they found changes in student attitudes in learning physics. Learning and teaching physics-based technology is very interesting for students [17]. In addition, teachers can also improve the quality of teaching through e-learning [18].

There are several learning with simulations applied in physics learning both online and offline simulations. Some examples of offline simulations in physics like Augmented Reality on the concept of style [19] and motion [20], convex mirrors [21], as well as topics of basic characteristics optics [22]. Other offline media simulations such as media flash on the topic of mechanics [23], electricity [24], and several other topics. In addition to using an offline system, simulation media can be run with an online system. This system can be used effectively in physics learning through websites, such as pHet.com, physicsclassroom.com, edu-mediascience.com and other websites that provide simulation learning systems. Learning with this online system can be done independently by students, so that they can explore and develop literacy skills in the digital world.

Web Simulations become one of the effective e-learning media in physics learning. Physics learning with simulation was able to improve students' learning abilities [25]. Through simulation, the interest of students in learning physics also increases [26]. Students who learn with simulation media obtain very high scores even on difficult concepts [27]. Learning with this media can make students actively observe and manipulate various complex phenomena [28]. There are many studies about website learning and digital literacy studies. Such as developing a web-based modules based with associated assessment on the Extensible 3D standard to improve student success and learning [29]. The application of web-based collaborative concept mapping to support group learning and interaction in an online environment [30]. Another studies assesses the effectiveness of web-based learning in paediatric basic life support (P-BLS) training [31]. Therefore, in this study we applied web-based simulation (WBS) learning because it has many positive influence such as on healthy class [32], to assess students' performance [33], enhance students' learning motivation [34].

Despite the recognition that digital literacy has an important influence on learning [35,14], no one has measured these skill when integrated in certain subjects. Therefore, the first contribution in this study was to examine digital literacy skills in WBS learning on physics. In WBS learning, students also doing any activity such as investigation, experiment, and solve problems. We also assess the effectiveness of WBS learning that is applied in the classroom. So, the research questions in this study are (1) How are the levels of digital literacy skills of students before and after learning? (2) Is learning with web-based simulation effective compared to direct learning in improving students' digital literacy skills?

METHOD

Model of Research

This study is a descriptive-comparative research and experimental design pretest posttest. The descriptive part of this study includes student profiles and their level of digital literacy skills. The comparative section includes the comparison of their levels from the results of the pretest and posttest. The experimental part of this study involves student performance in online simulation-based physics learning. Qualitative and quantitative approaches are used in determining the level of digital literacy skills. Quantitative analysis was used to determine the difference between the results of the pretest and posttest of the experimental and control groups

Implementation

The study was conducted in two classes randomly selected from grade 11 science students of MAN 1 Yogyakarta, Indonesia. The first class as an experimental class numbered 23 students who were given lessons with WBS learning. The second class, consist of 20 students was given study with direct learning. Each class was treated for four session with a 60-95 minutes each session. The research tool used is (1) The WBS learning matrix that contains basic competencies, learning topics, learning activities and assessments that have been validated by experts (2) Learning Guide for Teachers based on WBS learning which consists of lesson plans for each meeting. This serves as a guide for teachers to deliver lessons to students with a WBS learning approach (3) Learning Materials WBS learning which is a learning module developed by researchers. This consists of two modules which cover two sub-topics in XI grade physics material (Kinetic theory of Gases). Each module includes several lessons that encourage students in digital technology-based learning, display thinking-provoking problems and require students to determine their goals / objectives, provide reasonable solutions and decide critically the best solutions to solve problems and achieve their identified goals using digital device (4) Digital literacy test instruments are open tests to assess the level of digital literacy abilities of students. Students are asked to complete 10 questions in one session. Rubrics adapted from digital literacy questions developed in previous research. All items have also been validated by experts. The rubric used the 0-3 level. Table 1 shows the description of each level.

Table 1. Level of Digital Literacy Skill

Description	Range of Levels
Very High	2.70 – 3.00
High	2.39 – 2.69
Average	2.08 – 2.38
Low	1.77 – 2.07
Very Low	0 – 1.76

After determining the experimental class and the control class, we gave the pretest to all participants. This pretest aims to measure students' initial digital literacy skill. In the experimental class, students are taught with WBS learning while in the control class students are taught with direct learning in accordance with curriculum guidelines. In the early stages of the experimental class, we gave a brief explanation of some of the websites used in the learning process. This aims to stimulate students to be ready in the learning process. After that students are introduced to several problems in physics and are invited to actively use existing simulation websites. The students were asked to form groups of 4-5 people to discuss and solve the problems using website simulations. In addition they are also allowed to open other websites if needed to add information in solving problems.

During learning process, students actively use digital devices, dig up information, communicate, create, solve problems and be free to open other websites. In the final stage of learning, each group was asked to present the results of their discussion after learning to use the website. At this stage the researcher verifies the findings of the student while providing additional information about the problem solved using a digital device.

There were 10 open-ended test given to all participants, both in the experimental class and in the control class as posttest. These contains the topic of gas kinetic theory related to learning based on WBS learning. The purpose of this posttest is to identify participants' final literacy skills after learning with a WBS learning and learning-based model.

Preparation, Implementation, and Evaluation of the Digital Literacy Skill Test (DLST)

There were 10 open-ended tests prepared by researchers in accordance with the measured aspects of digital literacy. This item was adapted from the development of questions to measure students' digital literacy skill by [36]. Table 2 shows the aspects of each item.

Table 2. Aspect of Item

Component of Digital Literacy	Sub-category of Digital Literacy	Item
Information	to locate the digital information by digital media	1
	to judging its relevance and purpose	2
Communication	to share resources through online tools,	3
	to collaborate through digital tools,	4
Content Creation	to integrate and re-elaborate previous knowledge and content;	5
	to deal with and apply intellectual property rights and license.	6
Safety	personal and data protection,	7
	security measures, safe and sustainable use	8
Problem Solving	to make informed decisions on most appropriate digital tools according to the purpose or need,	9
	to solve conceptual problems through digital means,	10

Data Collection and Assessments

In this study, we used SPSS version 16 to analysis data. For the profile of students' digital literacy skills, we used descriptive and quantitative statistics through frequency and percentage values. The difference in the level of students' digital literacy skill for each class was measured using the dependent sample t-test based on the results of the participants' pretest and posttest. To find out the difference in digital literacy skills of the experimental class and control class using the independent sample t-test. The level of effectiveness of learning in the control class and experiment is calculated based on the gain score with the formula:

$$Gain\ (g) = \frac{\bar{X}_{posttest} - \bar{X}_{pretest}}{maximum\ score - \bar{X}_{pretest}} \qquad (1)$$

Where Gain is gain score of the class, $\bar{X}_{posttest}$ is average score of posttest, and $\bar{X}_{pretest}$ is average score of pretest. The range of effectiveness levels based on the above equation as in the following Table 3 [37]:

Table 3. Gain score

Gain (g)	Description
$g \geq 0.7$	High
$0.7 > g \geq 0.3$	Medium
$g < 0.3$	Low

RESULTS AND DISCUSSIONS

According to Veloo, et al [1], the concepts and principles of physics are widely applied in various fields, such as technology, transportation, communication, electricity, discovery and exploration of space. In addition, the core characteristic of physics learning is "make use of technology" [2]. One of the seven key competencies students must have after learning physics is the ability to use information technology, including coding in the computer world, through investigation and problem solving [3]. Therefore, it is necessary that students' digital literacy skills in physics learning must be improved.

Direct Learning Group

In the test of digital literacy skills, students were given 10 op-ended questions regarding digital literacy during their pre-test and post-test. Their pre-and post-test results are revealed in Table 4. This table shows the level of their digital literacy skills in the pre-test and post-test of their literacy digital skills test.

Table 4. The Level of Digital Literacy skills of the Direct Learning Group

Question	Pretest Mean	SD	Description	Posttest Mean	SD	Description
Question 1 Andi is a student majoring in science. He wanted to learn the theory of gas kinetic concepts through online simulation learning. For this reason, he sought information on the internet. Arrange the right way done by Andi in order to find valid information while searching the internet?	0.90	0.67	Very Low	1.15	0.49	Very Low
Question 2 Doni is very happy to learn the ideal gas concept through the internet. He has collected various sources from the internet in the form of web sites, youtube, and social media education communities. But Doni felt confused in determining whether the source obtained was suitable and in accordance with the legal topic of Boyle-Gay Lussac. Explain what Doni should do?	1.40	0.45	Very Low	1.80	0.77	Low
Question 3 Dina and Dini have always been together since they were in kindergarten to junior high school but separated when in high school. One day she uploaded a relative speed learning situation with an on line simulation to her WA, FB and personal Instagram account. Dini who saw the notification from his social media account was interested in learning the same thing. She then contacted Dina to study online simulations too. Design ways that Dina can do to share information about online simulations with Dini!	0.73	0.45	Very Low	1.35	0.59	Very Low
Question 4 Riko and Riki are studying ideal gas law material with group online simulations. When reading the	0.90	0.59	Very Low	1.65	0.67	Very Low

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Question	Pretest Mean	SD	Description	Posttest Mean	SD	Description
worksheet, they realized that a number of web sites were needed to solve the questions. They then decided to open each laptop. Design a way so they can complete the worksheets together!						
Question 5 Mr. Juli is a physics teacher. When teaching the topic of the theory of energy ekipartisi, he gave assignments to students to learn independently through the website. Students are asked to answer questions based on the learning done through independently selected websites. Explain your opinion, whether or not each participant should write the source of the web site used. Give your reasons!	1.37	0.60	Very Low	2.25	0.79	Average
Question 6 Chiko is learning the ideal gas concept independently through online simulation. During this time, he argued that just the same when cooking needs to be closed or not. However, while studying with online simulations, he found something different. He was then interested in seeking additional information on various web sites, research journals and other sources. Make a conclusion whether Chiko needs to change his mind, or just let the new information he gets. Considering the information does not match what is known so far. Give Your Reason.	1.20	0.83	Very Low	1.80	0.77	Low
Question 7 When doing learning with the internet, it does not rule out the possibility of a laptop, computer or android being infected with a virus, infection with this virus can damage files or even eliminate existing document files. Explain your design, how to protect data on your laptop so that it is not easily infected with viruses when studying with the internet!	0.73	0.45	Very Low	1.10	0.55	Very Low
Question 8 In learning the theory of gas kinetic concepts using on-line simulations	1.53	0.86	Very Low	1.95	0.89	Low

Question	Pretest Mean	SD	Description	Posttest Mean	SD	Description
can be found the latest applications. Among these applications there are types of applications that are safe and there are also types of applications that are detected as viruses but still provide several benefits. From these conditions, make your decision about the type of application used and include your reasons						
Question 9 Mrs. Kana wants to teach ideal gas learning using online simulation. But he was confused in determining what digital devices were used to teach simulation learning. Gather any digital devices that can be used by Ms. Kana to be able to teach simulation on line according to their goals and needs. Write along with your reasons	1.17	1.02	Very Low	1.55	1.19	Very Low
Question 10 Andi wants to do an experiment to measure the pressure, volume and temperature of the ideal gas. But he was confused about how to determine the value of the three variables because it was very difficult to measure directly. Arrange an activity plan through digital means that Andi did to be able to know the value of the three variables without measuring directly.	0.90	0.67	Very Low	1.15	0.59	Very Low
Overall	**1.10**	**0.66**	**Very Low**	**1.62**	**0.74**	**Very Low**

Note: 0 – 1.76 = “Very low”, 1.77 – 2.07 = “Low”, 2.08 – 2.38 = “Average”, 2.39 – 2.69 = “High”, 2.70 – 3.00 = “Very High”

Among the 10 digital literacy questions given at the pretest, it was found that item 8 shows the highest average of 1.53 (very low). Items 3 and 7 show the lowest average of 0.73 (very low). In the posttest results it was found that item 5 shows the highest average of 2.25 (average) and item 7 shows the lowest average of 0.55 (very low). Table 5 presents the level of digital literacy skills before and after they are taught using direct learning in grade 11 physics concepts.

Table 5. Level of Digital Literacy Skill of Direct Learning Group before and after study

Level	Before		After	
	F	**%**	**f**	**%**
High	0	0	0	0
Average	0	0	2	10
Low	0	0	3	15
Very Low	20	100	15	75
Overall	**Mean = 1.63 (Very Low), SD = 0.27**		**Mean = 1.58 (Very Low), SD = 0.39**	

Note: 0 – 1.76 = “Very low”, 1.77 – 2.07 = “Low”, 2.08 – 2.38 = “Average”, 2.39 – 2.69 = “High”, 2.70 – 3.00 = “Very High”

Based on the table it was found that students in the direct learning class had low digital literacy skills (mean = 1.63 Very low, SD = 0.27) on the results of the pretest. All students have a very low level of digital literacy skill. After being taught with the direct learning model, the number of students at very low levels actually decreased (75%) and the number of students at low levels increased (15%) and at average level too (10%). In addition, the level of students' digital literacy skills remained after learn with direct learning at a very low level with mean of 1.58 (SD = 0.39). This shows that the direct learning does not have a significant effect to improve students' digital literacy skills. However, it because students experience limitations in utilizing technology for the learning process. A related study was conducted by [38] and found that students' digital literacy skills were not fully enhanced by only using traditional or direct teaching methods, because they needed a good digital literacy environment in the classroom. Finally, we propose WBS learning to create a learning environment that is in line with digital literacy needs.

The results of the pretest and posttest digital literacy skills of class XI students in direct learning groups were then compared. By using paired sample t-test analysis, differences in the results of students' digital literacy skills were based on pretest and posttest as shown in Table 6.

Table 6. Paired Sample t-test Analysis of Digital Literacy Skill of Direct Learning Group

	Mean	**SD**	**t-value**	**Df**	**Sig**
Pretest	1.63	0.27	0.610	19	0.549
Posttest	1.58	0.39			

Table 6 shows that there were no significant differences based on the results of the pretest and posttest on students' digital literacy skills after being taught with direct learning. The average difference in the results of the pretest (1.63) and posttest (1.58) is -0.05 shows that direct learning is not effective in increasing the students' digital literacy skill.

WBS Learning Group

Students in the WBS learning Group were also given pretest and posttest with the same questions as in direct learning (Table 4). Their answers are analyzed and the results are presented in Table 7.

Table 7. The Level of Digital Literacy skills of the WBS Learning Group

Question	**Pretest**		**Description**	**Posttest**		**Description**
	Mean	**SD**		**Mean**	**SD**	
Question 1	0.96	0.77	Very Low	2.10	0.90	Average
Question 2	1.92	0.69	Low	2.69	0.66	High
Question 3	1.08	0.63	Very Low	1.79	1.11	Low
Question 4	1.77	0.59	Low	2.48	0.69	High
Question 5	2.42	0.50	High	2.10	0.67	Average
Question 6	2.19	0.90	Average	2.66	0.81	High
Question 7	1.62	0.75	Very Low	1.79	0.90	Low
Question 8	2.27	1.15	Average	2.10	1.08	Average
Question 9	1.35	1.16	Very Low	1.69	1.20	Very Low
Question 10	0.88	0.59	Very Low	1.45	1.18	Very Low
Overall	**1.65**	**0.79**	**Very Low**	**2.09**	**0.92**	**Average**

Note: 0 – 1.76 = "Very low", 1.77 – 2.07 = "Low", 2.08 – 2.38 = "Average", 2.39 – 2.69 = "High", 2.70 – 3.00 = "Very High"

Table 7 shows that class XI students in the WBS learning group generally show a very low level of digital literacy skills based on pretest results with an average of 1.65. Among the 10 open-ended tests given at the pretest, the students' answers showed the highest level of digital literacy skills in item 5 with an average of 2.42 (high). Students' answers to item 10 show the lowest level with an average of 0.88 (very low). The very low level of digital literacy skills from students in the class before they study with WBS learning shows that their skills in digital literacy have not been improved. Table 8 presents the level of digital literacy skills before and after they are taught using WBS learning in grade 11 physics concepts.

Table 8. Level of Digital Literacy Skill of WBS Learning Group before and after study

Level	Before		After	
	F	%	F	%
Very High	0	0	3	10.34%
High	0	0	8	27.58%
Average	3	11.53%	6	20.68%
Low	8	30.77%	7	24.13%
Very Low	15	57.7%	5	17.24%
Overall	**Mean = 1.90 (Low), SD = 0.38**		**Mean = 2.4 (High), SD = 0.60**	

Note: 0 – 1.76 = "Very low", 1.77 – 2.07 = "Low", 2.08 – 2.38 = "Average", 2.39 – 2.69 = "High", 2.70 – 3.00 = "Very High"

Based on the results in Table 8, the level of students' digital literacy skills in WBS learning before learning is carried out is at the average level (11.53%), low (30.77%) and very low (57.70%). In general, this class has a low level of digital literacy skills with an average level of 1.90 with SD = 0.38 based on the results of the pretest. None of the students showed a higher level of digital literacy skills.

In addition, the level of digital literacy skills based on post-test after they are exposed to WBS learning is at a high level which is indicated by the average level of 2.40 with a standard deviation of 0.60. In particular, the majority of students experienced an increase from the moderate level (20.68%), high (27.58%) to very high (10.34%). It should be noted that the number of students at low levels comparatively also decreased (24.13%) after they were exposed to WBS learning. On the other hand, the number of students at very low levels comparatively decreased (17.24%). The significant difference in the level of literacy skills of the students in the WBS learning class before and after they were taught was determined using paired sample T-test analysis. The results are shown in Table 9.

Table 9. Paired Sample t-test Analysis of Digital Literacy Skill of WBS Learning Group

	Mean	SD	t-value	df	Sig
Pretest	1.64	0.37	-2.761	25	0.011
Posttest	2.04	0.61			

Based on the data in Table 8, there are significant differences in the results of the pretest and posttest class of WBS learning. There is a difference in the average yield of 0.40 from the results of the average posttest and pretest. This shows that WBS learning is effective in improving students' digital literacy skills. This is also evidenced by the increase in their level, from the low level (1.64) at the pretest and increasing to a high level (2.04) during the posttest. This is similar to the finding [39], where the study that is integrated with technology has a positive influence on learning. Through learning with the website make students accustomed to collecting and searching for information on the web. This is in accordance with one of the indicators of digital literacy skills, that students are able to access information well [11].

Comparison of the Direct Learning and WBS learning Group

Student gain scores in direct learning and WBS learning groups obtained from tests of digital literacy skills are presented in Table 10.

Table 10. Gain score of digital literacy skill of Direct and WBS learning

	Direct Learning Group (N = 26)				WBS Learning Group (N = 29)			
	Pre-test Average	Posttest Average	Gain*	Description	Pre-test Average	Posttest Average	Gain*	Description
Digital Literacy Skill	1.63	1.58	-0.05	Low	1.64	2.04	0.3	Medium

*Note: g < 0.3 = "low"; 0.7 > g ≥ 0.3= "medium"; g ≥ 0.7 = "High"

The gain score is obtained from the students' average pre-test and post-test scores on the question of digital literacy. It should be noted that students in both classes are heteregon. At the beginning (pretest), students in the direct learning class had a very low level of digital literacy skills (0.63) while the WBS

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learning group was at a low level (1.93) as in tables 5 and 8. All students in the direct learning class had very low levels, while in the WBS learning class there were 11.53% at the average level, 30.77% at the low level and 57.7% at the very low level. This difference in the initial capabilities of digital literacy shows that at first the WBS class had better digital literacy skills compared to direct learning groups. Based on the gain score kateogri by [37] Table 9 shows the results that there is an increase in the WBS Learning group with the gain score only at the average level (0.30) while the direct learning group is negative (-0.05) which indicates a decline. This decrease in the gain score proves that direct learning cannot be used to improve students' digital literacy skill. In this group, students are not accustomed to using digital devices during the learning process. In addition, the increase in students' digital literacy skills that are still low can also be caused by the teacher's ability to implement WBS learning to students and the facilities of digital devices that are not yet available properly.

Student score results from DLST, then analyzed by independent sample t test to determine the significant differences in digital literacy skills of students from the value of the pretest and posttest. The results of the analysis are shown in Table 11.

Table 11. Comparison of gain score direct learning and WBS learning Group

Groups	N	mean	SD	T	df	P	Description
Direct learning	20	-0.05	0.27	-2.887	47	0.006*	Significant
WBS learning	29	0.304	0.50				

*Significant at 0.05

Based on the data presented, there were significant differences regarding the level of students' digital literacy skills between the direct learning and WBS learning groups ($t = -2.887$, $p < 0.05$). The average difference of direct learning groups (-0.05) with WBS learning (0.30) is 0.35 shows that the level of digital literacy abilities of students in WBS learning groups is better than direct learning groups. Improvements in the WBS learning group because students get the experience surfing the internet. Through this learning students can find information, communicate, solve problems, and other activities related to digital devices.

ANOVA Mixed design test was used to determine the greatest influence between direct learning and WBS learning on students' digital literacy skills. Analyzed data are pretest and postets for all groups. The results of the analysis are presented in Table 12.

Table 12. ANOVA Mixed design result

Group	Sig.	Partial Eta Squared
Direct Learning	0.771	0.002
WBS Learning	0.000	0.283

Based on Table 12, the Partial Eta Squared value for direct learning is 0.002 and WBS learning is 0.283. According to Leech, et al [40], the meaning of this value is direct learning is only able to improve students 'digital literacy skills by 0.2% while WBS learning is able to improve students' digital literacy skills by 28.3%. These results indicate that the WBS learning approach seems to be more effective than direct learning in improving students' digital literacy skills.

In the aspect of information, students are given the freedom to explore various kinds of new information about the topic being taught. This activity proves that learning resources are not only from a book or a web site. The teacher can show online simulations on the topics presented while students observe the simulation. Students are asked to express opinions about how or why the event occurred. This activity can improve digital literacy skills in aspects of information. This is because students are given new information so that they can assess the suitability and purpose of the information delivered. This is in accordance with the findings [41] that digital literacy skills are characterized by being able to recognize the type of information presented or to be delivered to the audience.

Another aspect that is increased is communication. In the learning process, students are asked to work together and collaborate using digital devices to collect data. Learning with web-based simulation provides stimulus to students during the learning process. This communication ability is in accordance with the physics learning competencies that must be achieved by students, namely being able to communicate based on written reports, presentations, and explanations directly and using information technology including computers, conducting investigations and solving problems [2,3].

The third aspect that can be improved through web-based simulation learning is content creation. This is because students can directly integrate and reconstruct their knowledge during the activity. This activity is in accordance with the indicators of the aspect of content creation, reconstruct the knowledge. This is in accordance with [42] where in the process of communication with digital devices, users must use their understanding of the structure of content to express knowledge. This is very important because the main competencies that need to be possessed in physics learning are digital competencies by involving themselves confidently and critically in using information and communication technology [2].

The fourth aspect is safety. Students can recognize several sites or applications that are detected by viruses when collecting data through the internet. They try to personally protect the device used, such as using an antivirus. Safety aspects are very important because of cyber security behavior in preventing the loss of individual digital assets and ensuring the important security of daily online activities [43]. The last aspect that can be improved through this learning is problems solving. Applying problem solving skills is a key factor in the world of science [44] or a critical element of physics [45]. At the stage of data collection, students can find problems when running simulations or reading simulation results. Therefore, this activity can train their ability to solve problems.

CONCLUSION

Based on the results of the study, it can be concluded that students' initial digital literacy skills are very low. Through web-based learning simulation students' digital literacy skills can be improved. In addition, this learning method is more effective than direct learning. All aspects of digital skills measured in this study also increased. These aspects include information, communication, content creation, safety and problem solving.

Physics learning with web-based simulation can be an alternative problem solving for students' digital literacy skills. This method can improve students' abilities on cognitive and affective aspects according to the applicable curriculum in Indonesia. Physics learning with web-based simulation is able to improve all aspect of students' digital literacy skills. The suggestion for further research is to develop a learning model that is not only based on online simulation. But it also facilitates students to design their own simulations in physics learning. This certainly can add insight and experience of students regarding digital literacy skills. In addition, research can also be carried out to measure other aspects of digital literacy skills in physics with different topics.

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