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BUILDING LEARNERS' CONCEPTUAL KNOWLEDGE AND DIGITAL LITERACY WITH PBL-BASED E-STUDENT WORKSHEET

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ABSTRACT

The objective of this research was to see the role of the electronic student worksheet based on Problem-Based-Learning (PBL-based E-SW) to build conceptual knowledge and digital literacy. This research used a static pretest-posttest design. The population was students in Padangcermin Public Senior high School, in Pesawaran. Samples were taken by cluster random sampling, and they consisted of 35 students in the experiment classroom and 35 students in the control classroom. The experiment classroom was taught using PBL-based E-SW and the control classroom was taught using worksheet used to teach in the school. The result showed that there was a significant influence of using PBL-based E-SW to build conceptual knowledge and digital literacy of students. Paired sample t-test result was less than 0.05, and this indicated a significant difference in average n-gain scores between the experiment and control classrooms. The average n-gain scores on conceptual knowledge were 0.61 or belonging to a moderate category in the experiment classroom and 0.41 or belonging to a moderate category in the control classroom. The average n-gain scores on digital literacy were 0.89 or belonging to a high category in the experiment classroom and 0.67 or belonging to a moderate category in the control classroom.

Keywords: Conceptual Knowledge, Digital Literacy, Worksheet

1. INTRODUCTION

Physics learning materials are generally divided into two parts: classical and modern physics. Modern physics studies abstract and micro materials. Learning modern physics is modern difficult compared to classic physics because in classic physics any event or phenomenon can be re-proven easily by scientific methods. There are some difficult-to-understand topics in classic physics. It is because an event or phenomenon must be explained with complicated mathematics, for example, wave learning material. Using mathematics in explaining an event must be based on correct conceptual knowledge so this mathematical approach to explaining wave propagation will be as true as the fact Distrik et al. (2022), Putri & Slamet (2021), Mur et al. (2004). Conceptual knowledge is an understanding level of a process, method, or activity concerning a matter, while concept refers to abstraction or notion in specifying an object or event Distrik et al. (2021). Students find difficulties with wave learning material conceptual knowledge, such as categorizing types of waves, explaining the form and direction of wave propagation, and comparing form phases on every spot along the wave propagation. If an event can be identified properly, then this event can be explained verbally, pictorially, and symbolically properly Distrik & Saregar (2022). Physics concepts have a very important role in physics problem-solving. There is a mutual relationship between concept and problem-solving. The more physics problem can be solved, the stronger the physics concept will be Karpudewan et al. (2015), Mestre et al. (2001). Learning physics concepts can be done through experiences of literature studies by books and/or articles that can be acquired from libraries or by online downloading. To download learning material online, students must have digital literacy to use a computer and be connected to the internet. Digital literacy is a skill required to meet challenges in the 21st century, where almost all sectors are using computers. Digital literacy skill relates to using technology to process information and communication. Cordell (2013) Digital literacy. Bawden (2001) refers to the ability to access, evaluate, use, and communicate information effectively using digital technologies. Digital literacy is very important for learners to be able to use information technology effectively in physics learning. It provides the basics for digital environment management required by learners to succeed in information literacy the and subjects that they learn Gruszczynska & Pountney (2013)

In physics learning, especially in those materials involving complicated mathematics and proper conceptual knowledge, learners must have digital literacy so that they will be able to do triangulation through online media upon an event that they are observing. The physics conceptual knowledge is based on facts that can be observed directly or by video to describe the event Distrik et al. (2018) so that there will be no misconception. In physics learning, teachers should be able to present facts to identify any concept that must be understood in an event verbally, pictorially, and symbolically Ainsworth (2006). Teachers also should be able to use online media to do online communication, find out related literature, download and upload videos according to learning materials to discuss, and teach the materials to their students. Teachers should use student worksheets together with video and animation to describe a natural event in teaching physics to facilitate students' understanding of the physics concept.

The result of a preliminary study of physics learning showed that 28.6% of physics teachers used electronic student worksheets (E-SW) and 92.3% of teachers said the unavailability of teaching materials that were able to build conceptual knowledge and digital literacy for learners. 35.7% of teachers used the PBL model. 92.9% of teachers did not use E-SW which presented attractive images, videos, and animations by using PBL syntax to build learners' conceptual knowledge and digital literacy. Low teacher capability in presenting facts in physics learning by using videos or animations or by using online media led to low learners' physics conceptual knowledge and digital literacy. Low learners' digital literacy is also suggested by Rahayu et al. (2019).

An effort to build learners' conceptual knowledge and digital literacy is by using PBL-based E-SW (electronic student worksheet based on problem-based learning).

E-SW is a more effective computerized media presented with images, animations, and videos so that learners will not be bored. Lathifah et al. (2021). E-SW is an interactive learning material consisting of problems that can be accessed with electronic devices such as computers and handphones to support learning processes Nabilla et al. (2022).

Problem-Based Learning (PBL) is a model that employs learners' thinking ability both individually and in groups and it can be done in a real and virtual environment so that the learning can be meaningful, relevant, and contextual Wilson et al.(2015). The PBL model is very appropriate to use to help learners to be active because it presents learning in the real world and it makes learners responsible for their learning Karpudewan et al. (2015).

Learning by using PBL-based E-SW can help learners to build conceptual knowledge and digital literacy by presenting learning materials with *Flip PDF Corporate Edition* software and PBL syntax by inserting youtube videos, hyperlinks, animation texts, images, audio, and flashes to a flipbook, just by a click, drag, and drop.

2. METHOD

This was quasi-experiment research. 2 out of 5 classroom samples of 11 grades from Public Senior High School in Padang Cermin, Pesawaran, Lampung, were taken by custom random sampling. Sampling was based on initial test results of wave learning material and there were two grade 11 classrooms having similar initial ability based on independent t-test results. Those 2 samples were respectively taught by using PBL-based E-SW (the experiment classroom) and by using the student worksheet (SW) that was usually used in that school. Both samples were taught by implementing Problem-Based Learning (PBL). Conceptual knowledge data was taken by conceptual knowledge test by using indicators developed by Depdiknas (2004) consisting of 1) restating, 2) classifying, 3) giving examples, 4) developing, and 5) implementing. Digital literacy data was taken with questionnaires by using 7 indicators developed by. Beetham & Sharpe (2010) consisting of 1) information literacy, 2) digital scholarship, 3) learning skills, 4) information and communication technologies (ICT) literacy, 5) privacy management, 6) communication and collaboration, and 7) media literacy.

The differences in conceptual knowledge and digital literacy skill between the experiment and the control classroom were analyzed with the independent t-test, and n-gain was estimated by using a formula developed by Hake (2002).

3. RESULTS AND DISCUSSION

Before learning, the experiment and the control classroom were pretested concerning conceptual knowledge of wave learning material and questionnaires concerning digital literacy. The conceptual knowledge and digital literacy post-tests were given after the learning finished. Test instruments and questionnaires were tested for validity and reliability to find out the precision and validity of the instrument before they were used in this research Surucu & Maslakci (2020).

3.1. LEARNERS' CONCEPTUAL KNOWLEDGE

Learners' conceptual knowledge of wave learning material in the experiment and control classroom is presented in Table 1 below.

Table 1

Table 1 Physic Conceptual Knowledge of the Experiment and Control Classroom						
Score Description	Experiment Classroom			Control Classroom		
	Pretest	Posttest	N-gain	Pretest	Posttest	N-gain
Maximum	67	90	0.70	75	87	0.48
Minimum	46	78	0.59	46	65	0.35
Average	57.34	83.69	0.62	58.34	75.49	0.41

The normality test of conceptual knowledge pretest and posttest were calculated by using SPSS software. The normality test result showed that the pretest, post-test, and n-gain of conceptual knowledge in the experiment and control classroom were distributed evenly (sig.2-tailed > 0.05).

The paired sample t-test results of the pretest and post-test of conceptual knowledge are presented in Table 2 below.

Table 2

Table 2 The Paired Sample T-Test Results of the Experiment and Control Classroom					
Data Type	Classroom	Mean	t	df	***Asymp. Sig* (*2-tailed*)**
Pretest-posttest	Experiment	-26.343	-20.250	34	0.000
Pretest-posttest	Control	-17.143	-17.436	34	0.000

The paired sample t-test results above in the experiment and control classroom show that *Sig. 2-tailed* < 0.05, and this means that Problem-Based Learning (PBL) can improve conceptual knowledge in the experiment and control classrooms. However, learning by using PBL-based E-SW shows better results compared to learning with PBL without SW based on PBL.

Table 2 shows that the averages of conceptual knowledge of wave learning material before learning belong to the low category in both experiment and control classrooms.

There are conceptual knowledge improvements both in the experiment and control classrooms after the experiment classroom used PBL-based E-SW and the control classroom used SW usually used in schools in Padang Cermin district of Pesawaran regency, Lampung. However, the experiment classroom shows better conceptual knowledge improvement compared to the control classroom (sig. 2 tailed<0.05). The learning material elaboration in the SW in electronic form based on Problem-Based Learning (PBL) can present facts so that it can improve students' physics conceptual knowledge in wave learning material. The same notion is expressed by Tan (2003) stating that the PBL model is a learning model that uses varying students' thinking abilities both individually and in groups in real environments to overcome problems so that learning becomes meaningful, relevant, and contextual. A similar result is also found by Sujatmika et al. (2018). that PBL-based e-LKPD can improve students' cognitive ability and critical thinking in science learning. The PBL role is also important in improving students' physics conceptual knowledge which is shown by students' conceptual knowledge improvement in the experiment and control classrooms.

The students' physics conceptual knowledge in the experiment and control classrooms based on indicators are shown in Table 3 below.

Table 3

Table 3 Indicators of Students' Physics Conceptual Knowledge in the Experiment and Control Classrooms

Indicator	Experiment classroom			Control classroom		
	Pretest	Posttest	N-gain	Pretest	Posttest	N-gain
Restating	58.35	87.71	0.70	59.25	83	0.58
Classifying	60.63	85.75	0.64	63.63	78.75	0.42
Giving example	61.15	82.67	0.55	61.75	79.28	0.46
Developing	55.35	81.66	0.59	55.35	68.75	0.30
Implementing	51.24	80.68	0.60	51.74	67.67	0.33
Average	57.34	83.69	0.62	58.34	75.49	0.41

There are 5 indicators with moderate n-gain scores in the experiment classroom and the restating indicator has a high category of n-gain score. Learning by using PBL-based E-SW can improve students' conceptual knowledge because it presents facts virtually so that students find it easy to understand a concept and easy to remember it. Learning based on data/observation is easier to understand compared to verbal explanation only. The paired t-test n-gain result shows that the conceptual knowledge between the experiment and control classrooms differ significantly. This indicates that PBL-based E-SW can improve students' conceptual knowledge in all indicators. PBL-based E-SW has an important role to improve students' conceptual knowledge in physics learning. The research result is supported by the research result by Wulansari & Nuryadi (2022) stating that using PBL-based E-SW influences students' conceptual knowledge in statistics learning material. In addition, the research results by Basri et al. (2020). Mestre et al. (2001). state that PBL-based E-SW is proven to be effective to improve students' conceptual knowledge of algebra learning material.

The PBL-based E-SW can guide students to do a virtual observation which can be accessed in the student worksheets. Students are much easier to identify and classify the types and forms of the wave.

Figure 1

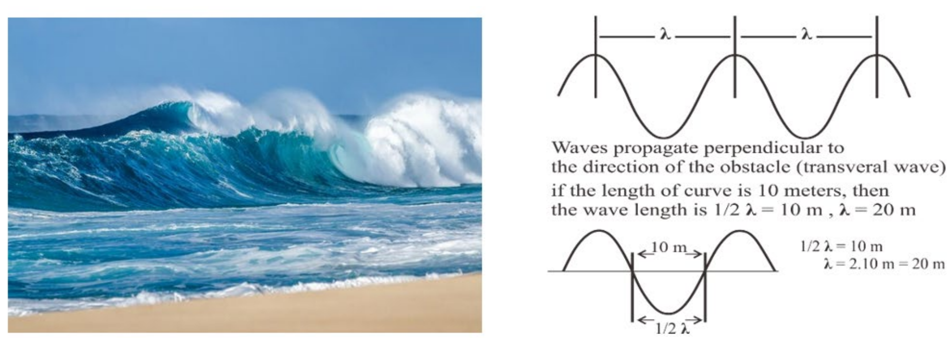

Figure 1 (a) Sea Wave (b) Technical Waveform

For example, in a video showing sea waves, students in groups would draw the waveform technically, identify the wave type, and calculate the wavelength. Most students in the experiment classroom were able to explain, categorize, and calculate wavelength according to the video they observed (Figure 1. b). However, students had a little difficulty in providing examples of waves in the real life.

3.2. DIGITAL LITERACY

Students' digital literacy in the experiment and control classrooms are presented in Table 4 below.

Table 4

Table 4 Students' Digital Literacy in the Experiment and Control Classroom

Score Description	Experiment Classroom			Control Classroom		
	Before (%)	After (%)	N-gain (%)	Before (%)	After (%)	N-gain (%)
Maximum	71.04	91.04	69.06	70.85	79.14	28.44
Minimum	68.85	85.71	54.13	68.19	73.14	15.56
Average	69.79	88.9	63.26	69.68	75.48	19.13

Table 4 shows that before learning the students' digital literacy in the experiment and control classrooms belong to the moderate category. After the experiment and control classrooms respectively taught by using the PBL model with different student worksheets, the experiment classroom shows significant digital literacy better than the control classroom. This is because learning materials in the electronic student worksheet can be tracked by students easily with video links. The detail of students' digital literacy skills on each indicator is presented in Table 5 below.

Table 5

Table 5 Indicators of Students' Digital Literacy Before and After Learning

Digital Literacy Competence	Experiment			Control		
	Before	After	N-gain (%)	Before	After	N-gain (%)
Information literacy	70.28	88.28	69.14	69.14	74.14	0.16
Digital scholarship	70.00	88.28	69.71	69.71	74.57	0.16
Learning skills	68.95	85.71	68.19	68.19	73.71	0.17
Information and communication technologies (ICT) literacy	68.85	88.85	69.42	69.42	74.85	0.18
Privacy management	71.04	91.04	69.71	69.71	73.14	0.11
Comunication and collaboration	69.57	89.14	70.85	70.85	79.14	0.28
Media literacy	69.90	91.04	70.77	70.66	78.85	0.28
Rata-rata	69.79	**88.90**	69.68	69.81	**75.48**	0.19

Using learning material with electronic student worksheets can improve students' physics conceptual knowledge and digital literacy. This research finding is supported by the research result of Sari et al. (2021). that using E-SW influences students' digital literacy improvement. Students will be able to track appropriate learning material and media according to the learning material to discuss. Besides being able to present online media, students are also able to explain facts or concepts within the media. Learning by using PBL-based E-SW will enable students to cooperate with other students to strengthen their understanding of digital literacy such as digital media use ability to find out, interpret, evaluate, manage, and share information with their classmates. Students actively participate in using digital media such as searching for related learning media and using digital media critically and creatively. By using PBL-based E-SW with *Flip Pdf Corporate Edition* application in physics learning, students can combine texts, images, audio, videos, etc. The *Flip Pdf Corporate Edition* application can process *pdf* files into output in forms of HTML, ZIP, EXE, and APP. Sriwahyuni et al. (2019), Riel et al. (2012).

4. CONCLUSION

Learning by using PBL-based E-SW can improve students' conceptual knowledge and digital literacy. This is shown by an average n-gain score of 0.62 for conceptual knowledge (moderate category) and an average n-gain score of 0.63 for digital literacy (moderate category). It indicates a significant influence of PBL-based E-SW on students' conceptual knowledge and digital literacy which is shown by significant differences in average pretest and posttest scores of students' conceptual knowledge and digital literacy.

CONFLICT OF INTERESTS

None.

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