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The Effect of the Problem-Based Learning Model with the Help of Digital Comics on Students' Scientific Literacy Skills

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Abstract

Background: The low scientific literacy of students is caused by the selection of models and learning media that are less varied. This study aims to analyze the effect of the PBL model with digital comics on students' scientific literacy on environmental pollution material. **Methods:** This type of research is a quasi-experimental nonequivalent control group design. The research sample used classes, namely class VII A and VII F, with 55 students selected using a purposive sampling technique. **Results:** The experimental class's average N-Gain of scientific literacy ability (0.42 ± 0.171) is moderate, while the control class (0.26 ± 0.17) is low. **Conclusions:** The results of this study indicate that Sig. (2-tailed) 0.001 < 0.0, meaning that the PBL model using digital comics model cs influences students' scientific literacy skills.

Keywords: Problem-Based Learning; Digital Comics; Science Literacy.

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Introduction

21st-century education is becoming increasingly important to ensure that students have the skills and innovation in learning g, the skills to use technology and information media, and can work and survive using the skills to live. The 21st century requires the global community to have scientific reasoning so that all aspects of life it is associated with science (Desmita, 2012).

Reported the World Economic Forum that there are 16 skills needed in the 21st century, one of which is scientific literacy (Agenda, 2015). Scientific literacy can be defined as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence, to understand and make decisions regarding nature and the changes made to nature through human activities (OECD, 2015). In this case, PISA distinguishes scientific literacy into four dimensions: content (knowledge), process (competence), context, and attitude. Scientific literacy is essential for students in the current era to understand various things ranging from problems, phenomena, or environmental facts. The benefits and objectives of the importance of scientific literacy for students are from what they have learned, including the ability to use scientific knowledge and scientific understanding and interpret and obey facts (Rusmiyati & Saptaningrum, 2017).

The Ministry of Education and Culture (Kemendikbud) released the achievement of students' scientific competence through the Program for International Student Assessment (PISA), followed by 78 countries joining an institution called the Organization for Economic Cooperation and Development (OECD). PISA is an international scientific literacy study that periodically evaluates education systems worldwide every three years for children aged 15. From 2000 to 2018, PISA placed Indonesia as one of the countries with a low scientific

literacy rating (Fuadi et al., 2020).

This shows that there is a need to be more treating science education. The low ability of scientific literacy in Indonesia is influenced by several factors, namely the curriculum and education system, the selection of models and methods in learning, learning facilities and facilities, learning resources, teaching materials, and so on (Kurnia et al., 2014). One of the efforts that can be made to improve students' scientific literacy skills is using various models and media.

The preliminary study was conducted at SMP Negeri 12 Bandar Lampung. Currently, the school is conducting an online learning process (on the network). The Minister of Education and Culture of the Republic of Indonesia issued a circular letter (No. 4 of 2020) explaining that teaching and learning are carried out at home through virtual or distance learning (Dewi, 2020). Educators have yet to use specific models or methods in the learning process. Educators tend to use the lecture method through Google Meet and explain through PowerPoint media, and sometimes carry out discussion methods through WhatsApp groups. Still, it is rarely done because it takes quite a long time.

Scientific literacy in SMP Negeri 12 Bandar Lampung, mainly grade VII, has not yet to implement. The results of the interview with one of the educators said that he had never applied scientific literacy during the learning process. However, when given indicators covering aspects of content and process, students claimed to have applied some of the indicators provided. These indicators are identifying terms contained in the material, classifying, and illustrating problem-solving. It can be said that educators still need to learn what the indicators of scientific literacy are, so the ongoing learning process does not refer to scientific literacy guidelines. Educators also said they needed to learn how to measure students' scientific literacy skills. Then, educators' test questions are not yet oriented toward scientific literacy skills. This means that the students of SMP Negeri 12 Bandar Lampung, especially class VII, have not been implemented according to the guidelines contained in scientific literacy.

Students' scientific literacy is said to be low if students do not meet the four aspects of scientific literacy competence. In line with the statement (Sumartati, 2010), which states that the low scientific literacy of students in Indonesia is due to several things, among others, namely teacher-centered learning and the low positive attitude of students in studying science, several competencies need to be bake. Students related to aspects of content, process, and scientific evidence. Efforts to improve students' scientific literacy skills by choosing a suitable learning model to build students' scientific literacy. One of the learning models that can overcome these problems is a problem-based learning model (PBL). PBL, or problem-based model, is learning that involves students solving problems with the stages of scientific strategies so that students gain knowledge of the problems they face and can solve problems (Fathurrohman, 2015).

On learning at the school Babalola (2013); Nevrita et al. (2019), stated that four strategies could improve scientific literacy skills, namely 1) Educators identify interesting topics; 2) Encourage students to read the research results; 3) Teach students to read like scientists; 4) Guiding students to analyze the data. Of the four suggested strategies, the suitable model is integrated into the Problem-Based Learning (PBL) model. The PBL model is a learning strategy that exposes students to practical problems as a foothold in learning (Surya, 2017). According to Imaningtyas et al. (2016) research, scientific literacy can be improved by applying the PBL model in schools. The PBL model is a constructivist-based learning model, so it helps to mature students' concepts.

The results of research from Mundzir et al. (2017) show that increasing scientific literacy with problem-based learning (PBL) is nothing more than the activity of students who are active in ongoing learning because, in problem-based learning, students are trained to think critically to solve problems. In addition, research by Giriyanti, (2017) states that the process of the problem-based model stages that students go through can fulfill the indicators used in students' scientific literacy. The PBL model can significantly improve scientific literacy skills in every aspect.

This study not only uses problem-based learning (PBL) models but in the learning process, digital comics will be assisted. A digital comic is an illustrated story with certain characters which present information or messages through electronic media. Research conducted by Marlina et al. (2020) states that digital comics learning media can improve students' scientific literacy in science learning. So far, educators need to become more familiar with digital comics, their functions, and their uses in learning. Educators only know that comics are just entertainment or commercials. Digital comics that are educational can be a tool to form concepts and realize students' knowledge. Several relevant studies have tested the effectiveness of PBL-based comic media and have proven feasible and effective for learning (Fatimah & Widiyatmoko, 2014; Ayuni, 2018). Previous studies that combined digital comic media with PBL learning models generally focused on improving student learning outcomes. Meanwhile, in this study, the authors examine scientific literacy in terms of content aspects, including the ability of students to define terms, classify, understand natural phenomena, and illustrate problem-solving. Then, the process aspect includes identifying scientific questions, explaining scientific phenomena, and using scientific evidence.

Based on the problems described, the researchers are interested in studying and analyzing the PBL model assisted by digital comics by applying scientific literacy to environmental pollution materials. The motivation of researchers to conduct research with the title "The effect of the problem-based learning model with the help of digital comics on students' scientific literacy skills."

Method

This Research Design

This type of research is a quasi-experimental design with a nonequivalent control group design. A quasi-experimental design is an experimental research using a control group, but it cannot function fully to control external variables that affect the implementation of research (Sugiono, 2019). The experimental class was given treatment using the PBL model with the help of digital comics, and the control class used the lecture or conventional method. The research design can be seen in Table 1.

Table 1. Research Design

Class	Pretest	Predictor Variables	Post-test
Experiment	Y_1	X	Y_2
Control	Y_1	-	Y_2

Note. Y_1: Pre-test; Y_2: Post-test; X: Treatment with digital comic-assisted PBL model; -: No digital comic-assisted PBL model

Population and Sample

The population is all 7th-grade students of SMPN 12 Bandar Lampung for the 2020/2021 academic year. In this study, two classes were used, namely class 7A, with 27 students as the experimental class, and class 7F, with 28 students as the control class. The total sample was 55 students. Classes 7A and 7F were chosen as the experimental and control classes because these two classes have a high degree of heterogeneity. So, the technique used in selecting the sample is a purposive sampling technique.

Research Instrument

The test instrument for scientific literacy skills is 20 multiple-choice questions for reasoning. In addition, there are supporting instruments, namely student responses regarding digital comic learning media. Before the test instrument is used, a trial is carried out first. Good or bad, a test or evaluation tool can be viewed from the validity, reliability, level of difficulty, and distinguishing power (Solichin, 2017). The validity test results showed that 20 of the 30 items were declared valid. The reliability test obtained a correlation

coefficient of 0.92 with a very high category. The results of the difficulty test obtained the question categories, namely 4 (difficult), 23 (medium), and (easy). The difference strength test results obtained nine excellent questions, 11 good questions, six good ones, and four bad ones. Aspects of the provisions of PISA can be seen in the following Table.

Table 2. PISA Aspects of Scientific Literacy

Aspects	
Content	**Process**
Define the terms contained in the material	Identify scientific questions
Classify the things contained in the material	Explain scientific phenomena
Understanding natural phenomena based on several key concepts	Using scientific evidence
Illustrate troubleshooting	

Data Analysis

Hypothesis testing is done by calculating the N-gain score and using the Independent Sample T-Test test. The hypothesis was tested using the Independent Sample T-Test by passing two prerequisite tests: the normality test using the Kolmogorov-Smirnov test and the homogeneity test using the Levene test. All tests were assisted by SPSS V 25.0 software. Then, the student response data were analyzed descriptively to support quantitative data.

Result

The research results that have been obtained are described as follows:

Science Literacy Skills

Data on scientific literacy ability were processed statistically. The results of the statistical tests are in the following Table.

Table 3. Pretest-Postest Scores

Value	Class	$\bar{x}$ ± Sd
Pretest	Class	55,89 ± 10,871
	Experiment	45,36 ± 7,842
Posttest	Class	75,44 ± 6,417
	Experiment	60,29 ± 9,828

Viewed from table 3, the average value of the experimental class got a higher score than the control class. Furthermore, the pretest-posttest values will be transformed into the form of N-gain. The n-gain statistical test, in table 4, is as follows.

Table 4. Statistical Test Results

Class	$\bar{x}$ ± Sd	Normality	Homogenous	T-test
Experiment	0,42 ± 0,17173	0,200	0,639	0,001< 0,05
Control	0,26 ± 0,17054	0,200	0,639	

Hypothesis testing on the Independent Sample T-Test obtained data of 0.001 < 0.05, which means that there is a significant effect on the scientific literacy ability of students in the experimental class. The average N-gain value in scientific literacy is assessed based on two content and the competence (process) aspects; the average value of the N-gain aspect of content can be seen in Table 5.

Table 5. Average N-gain Value of Content Aspect

Indicator	Experiment Class		Control Class	
	Value	Category	Value	Category
C1	0,44	Medium	0,27	Low
C2	0,50	Medium	0,30	Low
C3	0,41	Medium	0,33	Low
C4	0,42	Medium	0,30	Low
Average	**0,44**	**Medium**	**0,30**	**Low**

Note: C1: Identify; C2: Classify; C3: Understanding natural phenomena; C4: Illustrate troubleshooting

The average N-gain value in the experimental class got 0.44 in the medium category, while the control class got an average of 0.30 in the low category. The average value of N-gain in the aspect of competence (process) can be seen in Table 6.

Table 6. Average N-gain Value of Process Aspect

Indicator	Experiment class		Control class	
	Value	Category	Value	Category
P1	0,53	Medium	0,32	Low
P2	0,55	Medium	0,28	Low
P3	0,45	Medium	0,15	Low
Average	**0,51**	**Medium**	**0,25**	**Low**

The average value of N-gain in the competence aspect of the experimental class got 0.51 in the medium category. In contrast, the control class got an average of 0.25 with the low category. The content aspect and the competence (process) aspect of the experimental class are superior to scientific literacy skills.

Student Response Questtionnaire

The use of digital comics as a learning medium was assessed through a student response questionnaire. The student response questionnaire is calculated based on three indicators, then interpreted as a percentage descriptive category. The results of the dent questionnaire data analysis can be seen in Table 7.

Table 7. Student Response Questionnaire

Indicator	Experiment Class	
	%	Category
Demonstrate the ability to participate in science learning using digital comics as learning media	89	Excellent
Show interest in learning science using digital comics as a learning medium	88,5	Excellent
Shows the usefulness of participating in science learning using digital comics as learning media	90	Excellent
Average	89	Excellent

The highest percentage of student response questionnaires in the experimental class is found in the third indicator, which shows the usefulness of participating in science learning using digital comic media. Meanwhile, the lowest percentage is found in the second indicator, which shows interest in learning science using digital comic media. Questionnaire data on student responses to digital comic media from the three indicators received an "excellent" category response with an average of 89%. This shows that digital comic media can be accepted in learning by students.

Discussion

The data was analyzed from the pretest and post-test scores, then transformed into N-gain. The experimental class scored 0.42, and the category was medium. The control class scored 0.26, and the category was low. The scientific literacy ability of students who are assessed based on the N-gain transformation gets the "medium" category in the experimental class, which means that there is an influence of the PBL model with the help of digital comics on the scientific literacy skills of the experimental class students.

The scientific literacy ability of students in the experimental class increased due to the PBL model assisted by digital comics. The PBL model provides opportunities for students to be active in participating in learning. Using the PBL model on environmental pollution material can encourage students to learn and work together in groups by solving real problems or from various sources in the learning environment so that students know the steps to be taken to solve a problem. In line with Pujiastutik's (2018) research, implementing the PBL model significantly improves scientific literacy skills.

Applying the PBL model with the help of digital comics affects students' scientific literacy skills. In the content aspect, students understand scientific concepts and remember, explain, apply, and analyze the problems found. Through the PBL model's learning process, students are required to solve a problem related to everyday life. The problems presented are arranged in the form of content in the form of digital comics, as well as discourse texts contained in the worksheet. The worksheets presented are taken from everyday life, then students can use relevant sources of information to solve problems. The high average value of N-gain (Table 5) in the second indicator's content aspect shows students' ability to classify material concepts. The following is one of the students' answers to question number 5 (Figure 1.).

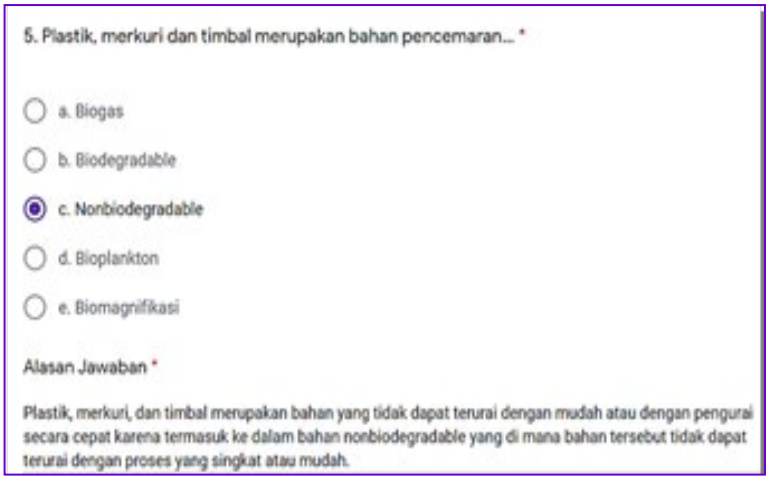
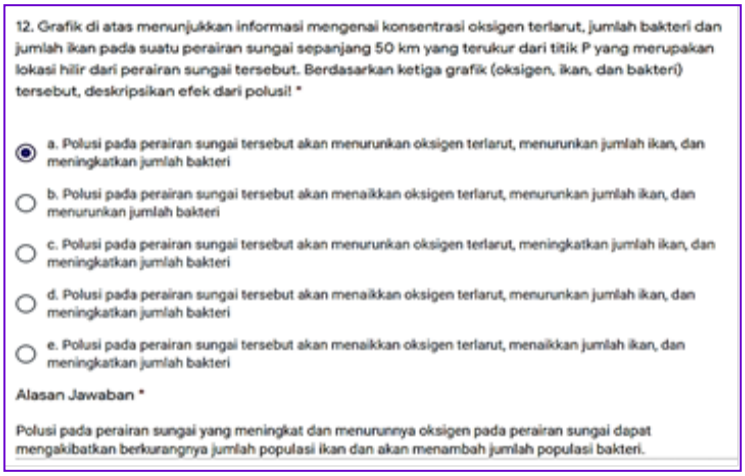


Figure 1. Student Answers Second Indicator on Content Aspect

In these questions, students can achieve indicators of classifying the things contained in the material because the stages of organizing in the PBL Model can improve students' understanding by reading so that by itself has grown students' scientific literacy skills. Then, students are given digital comics for learning, and this aims to help students solve problems, especially in everyday life. Digital comics that are served to students explain the phenomena and facts that occur in the surrounding environment so that indirectly students can see the problems that occur. Not only digital comics, but the worksheet presented also provides an overview to students in solving existing problems. In solving problems on the worksheet, students can collect information from various sources to find links between previously obtained information. It can be said that the PBL model at the guiding stage encourages students to collect relevant literature during the group discussion process.

Students are not only required to understand scientific knowledge but also various aspects of scientific competence and the ability to apply scientific knowledge in real life. The

process aspect in science implies scientific activity in describing natural phenomena so that science is obtained from principles, law, fact, or theory. Seen from every aspect of scientific literacy, the value of the experimental class's competence (process) aspect is higher than that of the content aspect. The high average value of the N-gain score shows the ability of students to apply the scientific knowledge they have understood. Based on the N-gain value (Table 6), the second indicator, explaining scientific phenomena, gets the highest N-gain value. In this indicator, students can describe or interpret scientific phenomena and predict changes, one of which is in answer number 12, as follows:


12. Grafik di atas menunjukkan informasi mengenai konsentrasi oksigen terlarut, jumlah bakteri dan jumlah ikan pada suatu perairan sungai sepanjang 50 km yang terukur dari titik P yang merupakan lokasi hilir dari perairan sungai tersebut. Berdasarkan ketiga grafik (oksigen, ikan, dan bakteri) tersebut, deskripsikan efek dari polusi! *

a. Polusi pada perairan sungai tersebut akan menurunkan oksigen terlarut, menurunkan jumlah ikan, dan meningkatkan jumlah bakteri

b. Polusi pada perairan sungai tersebut akan menaikkan oksigen terlarut, menurunkan jumlah ikan, dan menurunkan jumlah bakteri

c. Polusi pada perairan sungai tersebut akan menurunkan oksigen terlarut, meningkatkan jumlah ikan, dan meningkatkan jumlah bakteri

d. Polusi pada perairan sungai tersebut akan menaikkan oksigen terlarut, menurunkan jumlah ikan, dan meningkatkan jumlah bakteri

e. Polusi pada perairan sungai tersebut akan menaikkan oksigen terlarut, menaikkan jumlah ikan, dan meningkatkan jumlah bakteri

Alasan Jawaban *

Polusi pada perairan sungai yang meningkat dan menurunnya oksigen pada perairan sungai dapat mengakibatkan berkurangnya jumlah populasi ikan dan akan menambah jumlah populasi bakteri.

Figure 2. Student Answers Second Indicator on Process Aspect

Students can answer and express opinions on these questions because, in the PBL model, students are required to investigate and hone their thinking skills in solving a problem. Students use the ability to make decisions based on the questions' criteria more; students are also trained in solving a problem to solve problems in the worksheet, which students can remember, understand, and analyze the learning process following the opinion of Abidin (2017); Widiana et al. (2020), that explaining scientific phenomena is needed to remember and use theories about the role of proving the knowledge obtained by science. Furthermore, in the learning process, digital comics are given to assist in developing students' thinking skills. In digital comics, students cannot only imagine events or events but can directly see the problems, phenomena, or facts contained in digital comics. Using digital comics makes it easier for students to observe and understand the problems provided because students are more motivated to learn by using new media, thus making students more interested in understanding all the material being taught.

Digital comics are comics that contain messages or information about learning. The choice of comic media is based on the characteristics of the comic itself, which packs messages into a story accompanied by pictures and words that attract students' attention. According to Daryanto (2013), students tend not to like textbooks, especially those not accompanied by exciting pictures and illustrations; empirically, students tend to like picture books full of color and visual or cartoon forms. The combination of digital comic media with PBL learning models will be very suitable if used in learning. According to Rossana et al. (2019), the PBL model contains problems from everyday life, and comic stories are presented with language dialogues used in everyday conversation. With the images/visuals in digital comics, students are not only asked to imagine events or events but can see firsthand what problems are being shown to them. An example of presenting digital comics can be seen in Figure 3.

Figure 3. Soil Pollution Digital Comic

The use of digital comics in improving scientific literacy skills was assessed using a student response questionnaire. The experimental class students very well received digital comics. This is evidenced by the average percentage of student responses, 89%, in the excellent category. Students show the ability, interest, and usefulness of applying digital comic media. The responses of students in the experimental class using digital comics on environmental pollution materials got positive results, which means that the role of digital comics as learning media can be accepted and effectively used in learning, especially environmental pollution materials. In line with Nugroho (2016); Irfana et al. (2017), using digital comic media in learning is more effective than using PowerPoint.

The results of this study are strengthened by research by Widiana et al. (2020) that the PBL model requires students to read to get a solution so that unwittingly students are trained in solving problems, then indirectly form scientific literacy skills. In line with the research of Nursholihat et al. (2017), digital comic media is very influential in increasing students' scientific literacy skills. This is viewed from various aspects containing learning materials oriented towards scientific literacy.

Conclusions

Based on the results of research that has been carried out, the scientific literacy ability of students by applying the Problem Based Learning model assisted by digital comic media is in the medium category (N-gain 0.42), so it can be concluded that the PBL model assisted by digital comics has a significant effect on students' scientific literacy skills class VII at SMP Negeri 12 Bandar Lampung.

Declaration statement

The authors reported no potential conflict of interest.

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