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Scientific Literacy Improvement Using Socio-Scientific Issues Learning

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ABSTRACT
Objective: This study aimed to describe the improvement of scientific literacy after learning based on Socio-scientific Issues using the Problem-Based Learning model. **Method:** This study was analyzed quantitatively descriptively using N-Gain to determine the student's scientific literacy improvement. Using a one-group pre-posttest design, 29 undergraduate students of the science education department from a university in Indonesia participated in this pre-experimental study. The data was collected using an observation sheet of learning implementation and scientific literacy tests given before and after the learning. **Finding:** The results of this study showed that students' scientific literacy was improved after participating in learning based on Socio-scientific Issues using the Problem-Based Learning model. The scientific literacy was improved from (category low) in the pretest to (category medium) in the posttest, and the average N-gain score was 0,64 (medium category). Improving scientific literacy is also supported by the Socio-scientific Issues of learning using the Problem-Based Learning model implemented very well. **Novelty:** This study's novelty was to describe each indicator of scientific literacy of the undergraduate students that was improved by using Socio-Scientific Issues in Problem-Based Learning. Hopefully, this study will be helpful for further research and give a solution for science teachers to improve students' scientific literacy.

INTRODUCTION

Learning activities are one of the most essential needs in 2022. The quality of students has experienced a decline in education due to the COVID-19 pandemic that has hit the whole world. Our activities have been minimal for almost two years, causing no optimal implementation of various areas of our lives, one of which is education. Learning previously carried out face-to-face must be adapted to distance learning with minimal interaction. Students experience lost learning when studying from home due to the COVID-19 pandemic (Engzell et al., 2021). The decline in students' awareness of social and environmental issues has also arisen due to the COVID-19 pandemic, so the education needed at this time is education that maximizes exploration activities on social issues.

This exploration provides a broader space for students to recognize, understand, and explore actual and factual issues, likewise with science learning, where learning is expected to develop student competencies to understand scientific issues in everyday life. This aligns with scientific literacy's aspects or components (Angelina, 2019). Scientific literacy is the ability of each individual to understand and apply knowledge in solving problems related to science and technology in everyday life (OECD, 2018). This ranking is a hard blow to Indonesian education, which awakens students and institutions to build scientific literacy maturity in learning activities as capital to face future global challenges. Science learning must be oriented towards scientific literacy and make scientific literacy and the development of scientific literacy one of the outputs that must be achieved in science education. Increasing students' scientific literacy skills can be supported by raising social issues that occur in society and are close to students which will later be associated with science learning (Azizah et al., 2022). Social issues related to science are called Socio-Scientific Issues (SSI). SSIs are currently of concern to science educators and global science education researchers. Many scientific issues are easily obtained and shared through digital media (Erman et al., 2022).

Teachers only implement literacy with the habit of reading textbooks, not directly confronted with problems that exist in everyday life (Yaumi et al., 2019); of course, these conditions have an impact on students, where science learning cannot direct students to improve their problem-solving skills (Erman & Sari, 2019). Using SSI context in learning basically facilitates students to use their knowledge and technology in a problem-solving orientation so that students feel that their knowledge is relevant to what they are facing. Scientific literacy will be achieved if someone has a scientific knowledge of real life. Therefore, learning science based on Socio-scientific Issues will train students to be scientifically literate (Erman et al., 2019). Problems that are contextual and occur in the environment of students can trigger students to reason to provide solutions related to these problems, and students' scientific literacy skills will also increase. Using SSI, students also have the opportunity to actively argue and collect information from the references collected so that a relative answer to a problem will naturally appear, and the discussions between students will be facilitated by educators (Muhammad, 2023). The educator orients the SSI context that students will find according to the topic to be studied. After getting SSI, students are expected to be able to recognize aspects of science and recognize the social context of SSI (Erman et al., 2021).

SSI-based learning certainly requires a model to be applied in learning. One learning model that can include SSI in it is the problem-based learning (PBL) model. Through the PBL model, students will be given a problem close to their daily life. Educators guide students more precisely according to their abilities to identify existing problems and find the right solution based on the studied knowledge. Therefore, it will produce students' critical thinking in associating problems with relevant material so that the content of the material being taught will be easier to understand and the learning outcomes obtained will also satisfy students (Ernawati et al., 2016; Badi'ah et al., 2023). PBL would be very appropriate if it is directly related to life problems. This is per what was conveyed by Hartati (2016), where PBL allows students to improve students creative thinking skills, followed by a sense of responsibility in solving problems that also exist in their daily lives. The competencies that are expected to arise from within students after learning with the PBL method can be focused on scientific literacy abilities (Adiwiguna et al., 2019; Wilsa et al., 2017), where the expectations to be achieved from science learning lead to high scientific literacy abilities so that in their daily lives students can consciously utilize their knowledge to solve problems around them responsibly (Purwani, 2018).

Students will have a more significant portion of learning by utilizing the SSI approach combined with the PBL model in learning. That way, students can build their knowledge independently and create meaningful learning. Then the learning provided is directed to achieve scientific literacy competency indicators for each individual. Seeing this potential, the author wants to apply SSI in PBL. This study aims to describe the improvement of scientific literacy after learning based on Socio-scientific Issues using the Problem-Based Learning model. The novelty of this study is to describe each indicator of scientific literacy of the undergraduate students that was improved by using SSI in a PBL. Hopefully, this study will be helpful for further research to give a solution for science teachers to improve students' scientific literacy.

RESEARCH METHOD

This research used a pre-experimental with one group pretest-posttest design to determine scientific literacy skills before and after SSI in PBL with a path as shown in Figure 1.

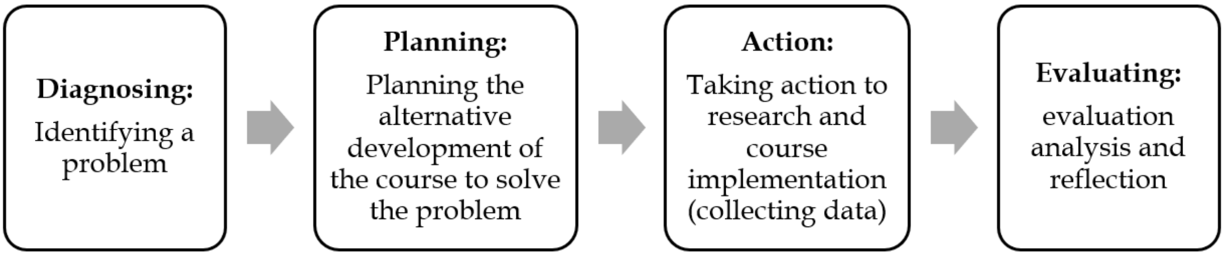

Figure 1. Research flowchart.

The learning was applied in a limited way with a purposive sampling technique to obtain heterogeneous students. SSI in PBL applied to 29 undergraduate students of the science education department from a university in Indonesia. Research data collection was carried out using observation and test techniques. Three observers carried out the observation technique during the learning process using the learning implementation sheet—observations aimed to identify the implementation of SSI-based learning with PBL as a learning model. The learning implementation sheet consists of 19 questions according to aspects of learning activities for meetings 1 and 2, with details in Table 1.

Table 1. Learning activities aspect.

Aspect	Item Number
Introduction	1, 2, and 3
Problem orientation **(Phase 1)**	4, 5, 6, 7, 8, and 9
Organizing **(Phase 2)**	10, 11, and 12
Guiding individual and group investigations **(Phase 3)**	13
Develop and present the work results **(Phase 4)**	14 and 15
Analyze and evaluate the problem-solving process **(Phase 5)**	16 and 17
Closing	18 and 19

Data collection using test techniques was carried out twice with the aim of measuring scientific literacy skills before (pretest) and after (posttest) SSI-based learning with PBL as a learning model using scientific literacy tests. The test is based on scientific literacy with the topic of Optical Devices. The scientific literacy test consists of 5 description questions that refer to indicators of scientific literacy competency, with details as shown in Table 2.

Table 2. Indicator of scientific literacy competency.

Indicator	Number
Identify scientific issues	3
Explain scientific phenomena	1 and 5
Using scientific evidence	2 and 4

Data were analyzed by descriptive quantitative. The results of observing the implementation of learning are described based on the Likert scale, which is 1 for less, 2 for enough, 3 for good, and 4 for the outstanding category. Observation data were analyzed by looking for the mode of the values the three observers gave to obtain the feasibility criteria. Scientific literacy ability can be known from the results of scientific literacy tests, which are analyzed by calculating the total score obtained by each student during the pretest and posttest. Then, from these results, the N-Gain score is calculated to obtain an increase in scientific literacy and interpreted according to the N-gain score <0.30 is a low category; 0.30 ≤g> 0.70 is the medium category; and 0.70 ≤g< 1.00 is a high category (Prahani et al., 2020; Saphira et al., 2022).

RESULTS AND DISCUSSION

Results

Three observers observed whether the lecture activities had been carried out correctly and their suitability with the learning plan the author had developed. The results of the observations of all observers are presented as shown in Figure 2.

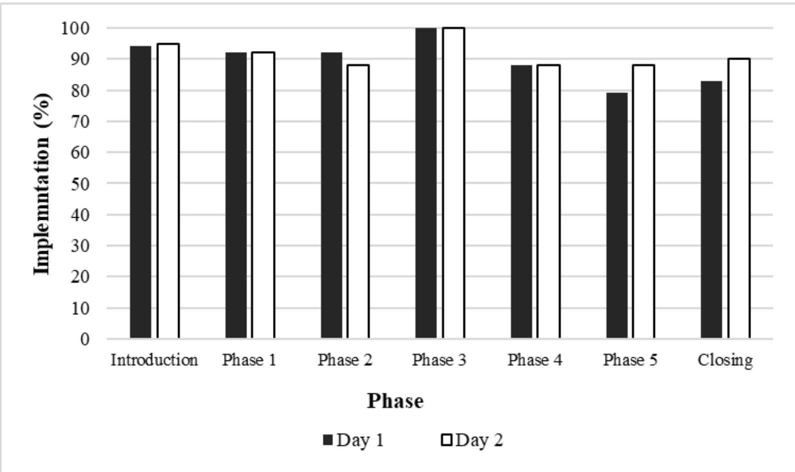

Figure 2. Learning implementation graph.

The observation data in Figure 2, when calculating the overall average value, obtained a percentage of 91.00%, which means that the SSI-based PBL learning process can be carried out based adequately on each meeting. Figure 1 shows that in Phase 3, namely guiding individual and group investigations, the highest percentage of implementation was obtained, namely 100.00% in the very good category. Meanwhile, the lowest percentage in Phase 5, namely analyzing and evaluating the problem-solving process, obtained 79.00%. Even though it only got 79.00%, the result is still in the well-executed category. Riduwan (2013) states that implementing learning that obtains a percentage above 75.00% falls into the well-implemented category.

Then, the SSI in PBL can improve students' scientific literacy. Data on students' scientific literacy abilities resulting from the pretest and posttest by 29 students are presented in the form of descriptive statistics in Table 3, and the increase in each indicator of scientific literacy is presented in Table 4.

Table 3. Statistic descriptive scientific literacy test.

	Valid	Missing	Mean	Median	Mode	Std. Dev.	Minimum	Maximum
Pretest	29.00	0.00	47.40	45.00	80.00	21.10	0.00	80.00
Posttest	29.00	0.00	81.20	80.00	80.00	12.10	60.00	100.00

Table 4. Scientific Literacy Results Per Competency Indicators

Indicator	Number	Students Answer Right (%)		Improvement (%)	Average (%)
		Pretest	Posttest		
Identify scientific issues	3	72.40	96.60	24.10	24.10
Explain scientific phenomena	1	34.50	69.00	34.50	37.90
	5	27.60	69.00	41.40	
Identify scientific issues	2	51.70	89.70	37.90	37.90
	4	31.00	69.00	37.90	

Table 3 shows that students' scientific literacy skills on the topic of Optical Devices have increased on average from the pretest to the posttest. The average score obtained during the pretest, where the test is given before SSI-based learning activities with the PBL model applied, is 47.40. Then the posttest value in which the test is given after the learning activities are implemented is 81.20. Based on these results, the effect of SSI-based learning with the PBL model on students' scientific literacy can be significant. Data from student scientific literacy test results analyzed by N-Gain calculations obtained an average of 0.64 in the medium category.

The scientific literacy test given to students contains three dimensions of scientific literacy competence dimensions (1) identifying scientific issues, (2) explaining scientific phenomena, and (3) using scientific evidence. If we look at each indicator of scientific literacy, the three indicators have increased, as shown in Table 4. The increase is seen in the number of students who answered correctly from pretest to posttest. The highest increase occurred in the indicator explaining scientific phenomena and using scientific evidence, with the same percentage of 37.90%, while the lowest was identifying scientific issues, with a percentage of 24.10%. Even though the increase in indicators identifying scientific issues was low during the pretest, the percentage of students who answered the question correctly showed a reasonably high percentage, namely 72.40%. Then after implementing SSI-based PBL learning, the percentage of students who answered correctly became 96.60. That is, almost all students answered correctly during the posttest.

Discussion

The results show that SSI in PBL was well implemented on the first and second days/meeting. The SSI in PBL begins with preliminary activities. Preliminary activities can be carried out very well. Phase 1, namely problem orientation, is included in the preliminary activities; the teacher provides apperceptions regarding authentic social issues in the surrounding environment. Authentic issues the teacher raises can increase student attention and trigger students to think about the problem (Tanjung, 2019). PBL is very suitable when it is based on social issues directly related to students' daily lives (Wilsa et al., 2017). Then, followed by the delivery of learning objectives, Putri & Qosyim (2021) stated that in the preliminary activities, motivation must be given in the form of apperception to students, as well as providing information regarding the objectives of learning so that students are enthusiastic and know the direction of learning.

Furthermore, in Phase 2 of Organizing, students are formed into several groups to discuss working on student worksheets. Organizing students went well, but at meeting 2, it experienced a decline due to a discrepancy in time with the prepared lesson plans. In Phase 3, guiding individual and group investigations is carried out very well, meaning that the teacher guides students to carry out investigations very well. Group cooperation can run well when teachers can guide investigations well (Utomo et al., 2020). Students in groups share information, collect, and discuss some data in making decisions and completing assignments on student worksheets. In Phase 4 of presenting their work, students are given the freedom to present the results of the discussions that have been made. This also happened to other groups who were very enthusiastic in asking questions. Then in Phase 5, analyze and evaluate student-centered activities where educators only provide clarification and reinforce material to students (Wilsa et al., 2017). In general, the specified learning outcomes can be achieved well. It is just that some students still need clarification about painting shadows using special rays because they need to understand the actual function of these special rays. The learning was closed by making conclusions about learning outcomes for each meeting and giving a posttest as a student evaluation.

Based on the PBL phases, identifying, analyzing, and making conclusions on daily phenomena could improve students' scientific literacy skills (Winarni, 2019; Alvina et al., 2022; Budiarti & Tanta, 2022). That result impacts the student's scientific literacy, as shown in Table 3 and Table 4. These results are consistent with Azizah's research (2020); learning using the PBL model in the SSI context significantly affects scientific literacy abilities. Utomo et al. (2020) stated that the PBL model emphasizes providing problems that students must solve through independent investigations to form solutions to these problems. Learning using the SSI-based PBL model raises problems in the form of issues in society related to science, then students are given the opportunity to explore issues by conducting group discussions to find solutions to problems. So, students can understand and develop the knowledge that is being studied in everyday life (Prastowo, 2019). Learning that elevates SSI and prioritizes scientific literacy is urgently needed to protect students from misleading information and misunderstandings related to problems that occur (Erman et al., 2022). Developing scientific literacy was very important because it could contribute to social and economic life and improve decision-making skills at the community level and persona (Fakhriyah et al., 2017).

If we look at each indicator of scientific literacy improvement, all indicators have increased. The highest increase occurred in the indicator explaining scientific phenomena and using scientific evidence, while the lowest was identifying scientific issues. Even though the increase in indicators identifying scientific issues was low, during the pretest, the percentage of students who answered the question correctly showed a reasonably high percentage, more than half of all of the students. Then after implementing SSI-based PBL learning, almost all students answered correctly during the posttest. The issue raised for question number 3 concerns the condition of the eyes of people with different eye defects. These results mean that students can identify the eye defects suffered along with their assistive glasses.

In the indicators explaining scientific phenomena, students are asked to explain the differences in mirrors used on dressers and street corner mirrors and explain how the process of light enters to form an image in a person living with astigmatism. During the posttest, as many as 69.00% of students could answer the questions correctly. Most students have been able to explain the scientific phenomena presented in the scientific literacy test questions after learning to use the SSI-based PBL model. Students' ability to interpret data and make assumptions is crucial in scientific literacy. As Yudhistira et al. (2022) said, interpreting data is necessary to explain scientific phenomena. Likewise, in the opinion of Rini et al. (2021), things that need to be considered in indicators explaining scientific phenomena include describing events, making assumptions about changes, and identifying information. Indicators of using scientific evidence also show an increase after applying the SSI-based PBL model learning; students can interpret scientific evidence needed in scientific investigations to conclude (Rini et al., 2021). Students can interpret scientific evidence from the data presented in the scientific literacy test questions (Harlina et al., 2020).

The increase in the three indicators of scientific literacy is supported by the exploration and discussion activities included on SSI in PBL to identify scientific questions, obtain new knowledge, explain scientific phenomena, and draw conclusions (Arizen & Suhartini, 2020). The PBL model can improve students' scientific literacy because learning facilitates the development of students' scientific literacy and understanding of solving problems presented by the phenomena they encounter daily (Nuzula & Sudibyo, 2022). Problem-Based learning based on Socio-scientific Issues provides opportunities for students to conduct investigations and investigations about social and scientific issues in group discussions, which can improve students' scientific literacy (Wiyanto et al., 2017).

CONCLUSION

Fundamental finding: Students' scientific literacy has increased after learning based on SSI with the PBL model. The scientific literacy score increased with an average N-Gain score in the medium category. The increase in scientific literacy is also supported by implementing learning based on SSI with the PBL model, which is going very well. **Implication:** The low increase in students' scientific literacy is due to several factors, such as the limitations of textbooks that are relevant to SSI, and students are only able to explain SSI macroscopically, not in detail. **Limitation:** This study only describes an improvement in students' scientific literacy competency indicators, even though there are attitude indicators of scientific literacy. **Further Research: Hopefully,** This research finding can be beneficial for further research to improve students' scientific literacy.

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