JPPIPA 9(8) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effectiveness of E-LKPD IPA through Socioscientific Inquiry Based Learning (SSIBL) Model to Improve Students' Scientific Literacy Skills

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Received: May 21, 2023
Revised: August 6, 2023
Accepted: August 25, 2023
Published: August 31, 2023

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DOI: 10.29303/jppipa.v9i8.3957

Abstract: The aim of this study was to test the effectiveness of E-LKPD IPA through Socientific inquiry-based learning (SSIBL) Model in improving students' scientific literacy skills. The research type used is pre-experimental with one group pretest-posttest design. The effectiveness test was undertaken at SMP Negeri 3 Kubutambahan in the even semester of the 2022/2023 school year. The research subjects were students of class VII A, it consisted of 36 students. The research instrument used was a scientific literacy test which adjusted for scientific literacy indicators in PISA 2018. The data analysis used was descriptive analysis in the form of an average score (mean) and a normalized n-gain score obtained from the pretest and posttest results. The results indicated that a normalized n-gain was 0.59 in the medium category and the results of the one-sample proportion test showed that students' mastery of scientific literacy was more than or equal to 75%. Thus, E-LKPD of SSIBL model is effective in improving student's scientific literacy skills.

Keywords: E-LKPD; Scientific Literacy; Socioscientific Inquiry Based Learning

Introduction

Technological developments encourage the emergence of controversial issues, such as sperm banking, IVF or test-tube baby, cloning, Artificial Intelligence (AI) technology and others. Controversial issues related to this are issues or problems that do not yet have a definite solution, thus, it needs scientific, social, moral and ethical perspectives. The latest issue that still discussed is Covid-19. The SARS Cov-2 virus is the cause of the Covid-19 outbreak which has had a significant impact on various fields in the world, not only in the health sector, but in the economic and educational fields (Atabey, 2021). People will use their scientific knowledge to analyze the best solutions that can be implemented (Subiantoro et al., 2021) by considering various perspectives.

Regarding to these problems, education has an important role in providing an understanding of scientific concepts and being able to apply them to various scientific problems. Students are expected to have the ability to reason, think critically and creatively to deal with contradictory issues. Scientific literacy is part of the skills that can support students in revealing solutions to face many challenges in their daily activities. Scientific literacy involves someone who is involved in scientific issues to become a reflective reflection of society (OECD, 2019). Scientific literacy includes knowledge content, how science works, interpretation of scientific evidence, and the relation of science to the social dimensions of the world (Ke et al., 2021). The scientific literacy ability of person is not only limited to the competencies that students must achieve in learning science, however, it is more than that, a students' scientific literacy ability can guide them in making the

How to Cite:
Putra, I.M.T.P., Sudiatmika, A. A.I.A.R., & Suardana, I.N. (2023). The Effectiveness of E-LKPD IPA through Socioscientific Inquiry Based Learning (SSIBL) Model to Improve Students' Scientific Literacy Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6337–6344. https://doi.org/10.29303/jppipa.v9i8.3957

right and wise decisions in various situations as a responsible citizen. It is in line with scientific literacy skills are honed at the educational level, especially in science learning (Ke et al., 2021).

The government has attempted efforts to improve the quality of education in Indonesia, namely through the independent curriculum and the AKM (Minimum Competency Assessment) program. The independent curriculum provides flexibility for educators to improve the quality of education according to the needs and learning environment of students. AKM is a program implemented to improve reasoning skills through literacy and numeracy, as well as strengthening character education. In term of increasing literacy skills in Indonesia, schools have also intensified the School Literacy Movement (GLS) program since 2016. Students are accustomed to reading before starting learning through the reading corner in the classroom (Ni'mah, 2019). The implementation of these programs is predicted to increase literacy capacity, one of which is scientific literacy in Indonesia.

However, dealing with the data has been obtained, there is a lack of literacy skills of all students in Indonesia. One of these data sources is PISA 2018. Regarding to the results of the 2018 PISA data, it indicates that students' scientific literacy capabilities in Indonesia in 2018 are ranked 70 out of 78 participating countries (OECD, 2019). Likewise, research by Hasan, Ani, & Budi (2018), scientific competence shows low to moderate scores on four aspects, namely IPA as the body of knowledge, IPA as a method of investigation, and IPA as a way of thinking and interaction between science, environment, technology and society. Research was also conducted by Hasasiyah et al. (2020) which shows the low ability of students' scientific literacy in the aspects of identifying scientific opinions, understanding research designs, solving problems based on scientific phenomena, understanding and interpreting basic statistics, and concluding data. Research data by Maulina et al. (2022) and Sujudi et al. (2020) showed the same result. students' scientific literacy skills are still low in the aspects of explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and evidence scientifically

Similar issues were also undergone by class VII students of SMP N 3 Kubutambahan. Dealing with the previous tests, the results of students' scientific literacy were in the low to moderate category. There are three indicators of scientific literacy that were used, namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. In the first indicator, the number of students who completed was 36.27%, in the second indicator, the number of students who completed was 46.47%, while in the third indicator, the number of students who completed was 61.76%.

There are three factors, namely learning strategies, assessment instruments, and teaching materials used could affect students' low scientific literacy skill. The lack of learning preparation provided by the teacher has an impact on the effectiveness and meaningfulness of student learning (Kembara et al., 2020). Learning strategies need to be improved, not limited to knowledge transfer, but students are given the opportunity to solve problems using the concepts they have learned. Various models or methods of learning science can be applied to provide interesting learning experiences for students (Ke, Troy D, Laura, & Patricia, 2021). The use of monotonous learning models or methods can make students bored. Various innovations are needed in conveying learning, thus, it can be understood and applied to everyday life, such as presenting learning videos, controversial issues, smartphone-based learning, practicum and so on (Asriadi, 2021; Putri, Anna, Nanang, & Nur, 2021; Khasanah & Beni, 2022).

Assessments carried out at school still refer to questions that require memorization (Sutrisna, 2021). Measurement of scientific literacy is not limited to measuring scientific knowledge, but also understanding related to scientific processes and applying them to real situations. Assessment based on PISA questions is also needed to familiarize students with scientific literacy questions (Hasasiyah et al., 2020). In the current industrial era, it is very easy for students to find rote answers, so it would be better if students were presented with problems that are close to life. Starting from simple to complex, so as to train scientific literacy and make the right decisions on problems. Therefore, learning science through scientific investigation is more recommended so that students can apply their knowledge in everyday life (Jufrida et al., 2019).

Seeing from the teaching materials used, students use teaching materials in the form of textbooks and LKPD which are distributed to schools. The LKPD or known as student worksheet does not guide students in carrying out investigations, because only a collection of questions is included (Sari et al., 2020). The use of textbooks and worksheets such as LKPD has not fully encouraged the souls of students to learn, so that students have a tendency to get bored and do not understand the delivery of the material. Scientific literacy competence in science learning can be achieved if students learn through contextual problems related to everyday life.

Regarding to the gap between expectations and reality, an alternative solution is needed, especially to improve scientific literacy skills. An alternative solution that can be provided is to use E-LKPD. In accordance

with Prastowo (2015), there are 5 missions of using LKPD, namely 1) facilitating to find the concepts; 2) helping to apply and integrate concepts into problems; 3) guideline in learning; 4) strengthening the concepts that have been learned; and 5) practical instructions. LKPD packaging electronically can give an interesting and innovative impression, and keep up with the times. The use of E-LKPD or known as electronic student worksheet in science learning provides benefits including: 1) easy access via smartphone, laptop or computer; 2) it is equipped with learning videos to attract students' interest in learning; and 3) reducing the use of paper (paperless).

The presentation of LKPD as a teaching material needs to be optimized according to 21st century competencies. LKPD should be able to train students' problem-solving skills with various controversial issues given, not limited to students' skill to remember. The issue of controversy will guide students to various opinions, so they can think wisely in making decisions. To achieve this goal, LKPD needs to be integrated with a learning model that can direct students to solve problems not only from a scientific point of view, but also morals and ethics. The learning model is Socioscientific Inquiry Based Learning (SSIBL).

The main point of SSIBL is the activity of investigating and identifying problems, and also reviewing solutions from various scientific disciplines related to common problems in the world (Ariza et al., 2021). The SSIBL model is a new pedagogy developed by a European project and it is called PARRISE. SSIBL learning is appropriate for science learning (Putra, 2022) because it presents controversial issues that are unstructured, does not have definite solutions, and it is related to science, social, morals, and ethics. There are 7 (seven) steps in the SSIBL model, namely 1) introduction of dilemmas, 2) formation of initial opinions, 3) asking questions, 4) investigation, 5) dialogue, 6) conclusions, and 7) reflection (Knippels & Michiel, 2018).

The SSI aspect of the SSIBL model provides issues that relate to scientific knowledge and social and cultural dimensions, presents conflicts and dilemmas faced by society and creates multi-perspective confrontation between individuals (Levinson, 2018). SSI is a real-life phenomenon applied to education (Dominguez & Barajas, 2021). For example, SSI include climate change, genetic engineering, genetically modified food, and organ transplantation. These issues are complex partly due to their strong associations with moral and ethical considerations (Chen & Sihan, 2021). This can be interpreted as the need to acquire the existing SSI conceptualization in formal education. The use of scientific social issues that occur in the world supports the development of reasoning skills needed to achieve scientific literacy goals (Cian, 2020). Various studies reveal the positive results of the SSIBL model research on students' scientific literacy skills.

Research by Wiyarsi, Prodjosantoso, & Anggiyani (2021) found that inquiry learning with POEEd (Predict-Observed-Extend-Extend) based on SSI has showed significant results to students' chemical literacy. The use of SSI as a context in inquiry learning facilitates students in identifying and analyzing scientific information about controversial issues. This finding is supported by research by Arizen & Suhartini (2020),who assert that E-LKPD based on SSI is effective to increase scientific literacy capacity by obtaining an n-gain of 0.75 with high criteria. Research by Putri et al. (2021) has indicated that the integration of LKPD with the inquiry model effectively has showed an increase in students' scientific literacy capacity with an n-gain of 0.44 with moderate criteria.

Dealing with this study, the development of E-LKPD IPA using the SSIBL model has never been undertaken. Previous research on inquiry models still uses SSI as context. Thus, a teaching material is developed in the form of the E-LKPD IPA with SSIBL Model to increase the scientific literacy capacity of students. The aim of this research was to test the effectiveness of the E-LKPD IPA with SSIBL Model by improving the scientific literacy abilities of all students.

Method

This type of research is research and development to create an E-LKPD IPA model SSIBL product. The effectiveness test was carried out at SMP Negeri 3 Kubutambahanin the even semester of the 2022/2023 academic year. Class VIIA with a total of 36 students was used as the subject of this research. Test product effectiveness using pre-experimental research through a one-group pretest-posttest design. The effectiveness test is to measure the effectiveness of the SSIBL E-LKPD IPA model in advancing students' scientific literacy capacity. The research instrument used a scientific literacy test of 15 multiple-choice questions. The instrument is prepared based on three indicators of scientific literacy (OECD, 2019) which are namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. The material used in the effectiveness test is science material for class VII of the even semester Kurikulum Merdeka, namely ecology and biodiversity in Indonesia. The test instrument used in the effectiveness test has gone through expert testing and validation to determine the consistency of the items and the validity of the instrument. The effectiveness test design is presented in Figure 1.

O_1 x O_2

Figure 1. One group pretest-posttest design

Explanation:
O_1: The results of students' scientific literacy before being given treatment
O_2: The results of students' scientific literacy after being given treatment
X: the treatment using SSIBL E-LKPD

This research analysis uses descriptive analysis which provides an explanation presenting a description of the average score and n-gain which is processed from the results of the pretest and posttest. Increasing scientific literacy skills through the use of the SSIBL IPA E-LKPD model can be seen from the n-gain scores in the pretest and posttest. In this study, the E-LKPD IPA model SSIBL is said to be effective in increasing scientific literacy skills if it meets the n-gain score above or the equivalent of 0.3 with moderate criteria. In addition to using the n-gain score, the effectiveness test analysis also uses the one-sample proportion test. The one-sample proportion test aims to determine the proportion of students' scientific literacy completeness. The classical completeness used is 75%. Test the proportion of one sample using the SPSS 16 for Windows.

Result and Discussion

The effectiveness test analyzes the effectiveness of the SSIBL E-LKPD IPA model in increasing scientific literacy through field implementation actions. The E-LKPD that has been implemented is an E-LKPD that has been declared valid and practical. The chapter studied is Ecology and Biodiversity of Indonesia, which is designed for three face-to-face meetings and two meetings for the pretest and posttest. Learning with the E-LKPD IPA SSIBL model was carried out at Class VIIA of SMP Negeri 3 Kubutambahan with a total of 36 students. The research instrument was a scientific literacy test consisting of 15 multiple-choice questions with 2 hours of lessons or 80 minutes.

The pretest and posttest score data are then processed using the n-gain score. The data were compared according to the Learning Objectives Completeness Criteria (KKTP) at SMP Negeri 3 Kubutambahan, which was 70. Data on scientific literacy before and after the test is shown in Table 1.

Table 1. Science Literacy Pretest and Posttest Data

Descriptive Data	Pretest	Posttest
Average value	42.59	76.67
Lowest value	26.67	53.33
The highest score	73.33	100
N-gain score is normalized	0.59 (moderate)	
N-gain score is normalized in the low category	3 students (8.33%)	
The N-gain score is normalized in the moderate category	22 students (61.11%)	
N-gain score normalized high category	11 students (30.56%)	

Based on Table 1 data, it shows that the normalized n-gain score is 0.59 with moderate criteria. The average value of pretest scientific literacy was 42.59, while in the posttest it increased to 76.67. Posttest results were also tested with a one-sample proportion test. However, before carrying out the test, a posttest result data normality test was carried out using the SPSS 16 for Windows. The normality test used is the Shapiro-Wilk. The Shapiro-Wilk test is used because the amount of data is relatively small or less than 50 respondents. The normality test results are shown in Table 2.

Table 2. Posttest Normality Test Results

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
POST-TEST	0.176	36	0.006	0.942	36	0.059

Based on table 2 data, a Shapiro-Wilk significance of 0.059 is obtained which is greater than 0.05. The normality test shows that the posttest results are normally distributed so that it can be continued with the one sample proportion test.

Decision making on the one sample proportion test, namely H_0 is accepted if the significance (1-tailed) ≤ 0.05, while H_0 is rejected if the significance (1-tailed) is > 0.05. The hypothesis tested is as follows.

H0: The percentage of students' scientific literacy completeness is classically smaller than 75%.

Ha: The percentage of students' scientific literacy completeness is classically greater than or equal to 75%.

The results of the one sample proportion test using SPSS 16 for Windows are shown in Table 3.

Table 3. One Sample Proportion Test Results

	Category		N	Exact sig. (1-tailed)
PostTest	Group 1	<=70	8	0.436[a]
	Group 2	>70	28	
	Total		36	

a. Alternative hypothesis states that the proportion of cases in the first group < 0.25.

Based on Table 3, the significance (1-tailed) is 0.436. These results indicate that if the significance is > 0.05, then H0 is rejected or Ha is accepted. Thus, it can be stated that the percentage of students' scientific literacy mastery is classically greater or equal to 75%. These

results also show that the SSIBL model IPA E-LKPD is effective in increasing students' scientific literacy skills. The n-gain score is also calculated for each scientific literacy indicator. Table 4 shows the n-gain score for each indicator of scientific literacy.

Table 4. Scientific Literacy N-gain Score Results

Science Literacy Indicator	N-gain	Qualification
Explain phenomena scientifically	0.53	Moderate
Evaluating and designing scientific investigations	0.61	Moderate
Interpret data and evidence scientifically	0.67	Moderate

Based on Table 4 data, the three indicators of scientific literacy obtain n-gains at moderate qualifications. The largest n-gain score is seen in the indicator of scientifically interpreting data and evidence of 0.67. The indicator explaining scientific phenomena obtains a n-gain of 0.53. These results indicate an increase in students' scientific literacy skills in that aspect. This is because the developed E-LKPD presents scientific phenomena as a basis for students' thinking to be able to relate them to scientific concepts. Presenting questions that contain scientific phenomena can help increase students' scientific literacy (Azizah, et al. 2021). The use of the SSI context also guides students to be able to express opinions and explain phenomena systematically (Fadilah, et al., 2022). On the indicator evaluating and designing scientific investigations, it obtained an n-gain of 0.61 in the moderate category. These results indicate an increase in students' scientific literacy skills on this indicator. Based on the initial phenomena they get, students are asked to design scientific investigations to help them find solutions to the given phenomena. The SSI aspect of the E-LKPD helps students make wise decisions by paying attention to various points of view. This also trains students' argumentation skills in presenting solutions (Azizah, et al. 2021). The indicator interprets data and scientific evidence to obtain an n-gain of 0.67 in the moderate category. In this indicator, students have been able to interpret data in various forms, so they are able to draw conclusions on the data obtained.

The effectiveness of the SSIBL model E-LKPD IPA on students' scientific literacy skills was seen based on the normalized n-gain score and the results of the one-sample proportion test. E-LKPD is said to be effective in increasing scientific literacy due to several factors. First, E-LKPD IPA contains scientific concepts related to controversial scientific and social issues. Learning science in the SSI context is effective in increasing students' scientific literacy (Cian, 2020; Ke et al., 2021; Saija, Rahayu, Fajaroh, & Sumari, 2022). Thus, SSI-based science learning gives students the opportunity to test and evaluate the information they receive, so that they can make the right decisions about certain problems.

Second, E-LKPD IPA uses SSIBL learning steps that help students solve the given scientific social issues. SSIBL learning can support efforts to increase scientific literacy (Knippels & Michiel, 2018). This is in line with the research of Suwono, Ndzani, Muhammad, & Rifka (2021) and Georgiou & Eleni (2023) that the application of SSIBL learning results in efforts to significantly increase students' scientific literacy. The SSIBL model tries to find answers to interrelated social and scientific questions by considering the accompanying moral and ethical aspects (Levinson, 2018). Inquiry strategy plays a positive role in improving students' science process skills (Herlanti, et al., 2019). Inquiry activities in SSI learning refer to activities of asking questions and gathering information about issues that are currently being discussed. SSIBL learning is based on scientific methods and social considerations.

Third, E-LKPD IPA is an interactive online learning media, making it easier for students to access E-LKPD from anywhere and anytime. E-LKPD IPA is equipped with pictures and videos that can be accessed by students to help solve the problems given (Arizen & Suhartini, 2020). Through the pictures and videos presented, students can feel the real situation of the problem being solved. In line with the research of Sahronih, Agung, & Syarif (2020), interactive learning media provides more effective results in learning science. Students as subjects are millennial generations who are familiar with technology, thus increasing their interest in learning. Research reveals the advantages of using interactive media in science learning, one of which can develop increased student scientific literacy (Widodo, et al., 2020; Maullidyawati, et al., 2022). Interactive media helps students understand the issues presented, so that students can explore information widely.

Fourth, E-LKPD IPA is equipped with practice questions that play a role in supporting efforts to increase students' scientific literacy. The questions presented in the E-LKPD refer to the scientific literacy indicators in PISA. The types of PISA literacy questions can be used as a reference for preparing scientific literacy questions. Presentation of scientific literacy-based questions according to PISA indicators can familiarize students with international standard questions (Hasasiyah, et al., 2020), so that they can improve the quality of Indonesian education at the world level, especially in the field of scientific literacy. Not only that, practice questions that support scientific literacy skills can train thinking skills and problem-solving so that they are useful in students' daily lives.

The results of this study are supported by research by Wiyarsi et al. (2021) that learning inquiry in the SSI

context provides significant results for students' chemical literacy. Inquiry activities emphasize the activeness of students in constructing knowledge and practicing scientific habits to ask questions and solve problems. Meanwhile, SSI encourages students' sensitivity to issues in their surroundings. In addition, Khasanah & Beni (2022) state that the use of E-LKPD with the SSI approach can increase students' scientific literacy with an n-gain of 0.85 in the high category. The use of the E-LKPD with the SSI approach was positively responded by 98% of students. This indicates that students are interested in learning to use the E-LKPD with the SSI approach. Putri et al. (2021) found that inquiry-based learning packed in virtual laboratory activities effectively increased students' scientific abilities, with an n-gain of 0.441 in high school classes. The use of steps in inquiry learning has an impact on students' scientific knowledge. Students can compose questions, conduct experiments, and determine conclusions on the problems given.

Obstacles in the research namely 1) At the initial meeting, students had difficulty following the learning steps on the E-LKPD. These difficulties were experienced by students, especially in the part of forming initial opinions and reflections. This is because students are not used to using the SSIBL model IPA E-LKPD. This obstacle can be overcome by accompanying and explaining how to answer the E-LKPD. 2) Youtube videos played in class can disturb other students. This obstacle can be overcome by giving students the opportunity one day before learning to watch videos at home or use a headset when accessing it in class or watch together using a projector. 3) Limitations of smartphones and internet networks used by students. Some smartphones used by students are slow in accessing the E-LKPD. This obstacle can be overcome by using wifi.

Conclusion

The SSIBL model IPA E-LKPD was developed as an alternative solution to overcome students' low scientific literacy skills. The effectiveness test uses 15 scientific literacy questions that are valid and reliable. The average value of the pretest and posttest has increased. The pretest average value was 42.59, while the posttest average value was 76.67. The normalized n-gain score is 0.59 with moderate criteria. In accordance with the proportion test of one sample, it shows that students' scientific literacy mastery is greater than or equal to 75%. Thus, the SSIBL model IPA E-LKPD is effective in increasing students' scientific literacy abilities.

Author Contributions

I Made Tri Pramana Putra: Conceptualization, methodology, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review and editing. A. A. Istri Agung Rai Sudiatmika: Conceptualization, writing—review and editing, supervision. I Nyoman Suardana: Conceptualization, methodology, formal analysis, writing—review and editing, supervision.

Funding

This research received no external funding

Conflicts of Interest

The authors declare no conflict of interest

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