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Science, Environmental, Technology, Society Approach (SETS) in Improving Science Literacy of Junior High School Students

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Abstract

Science, Environmental, Technology, Society Approach (SETS) in Improving Science Literacy of Junior High School Students*. This study aims to describe the implementation of science learning with the Science, Environmental, Technology, Society (SETS) approach, improving students' scientific literacy skills. This study uses a descriptive-quantitative research type with a group Pretest Posttest Design and involves 35 students of class VII-K SMP Negeri 1 Wonoayu as subjects. The research instrument is a science literacy test measured using the TOSLS Scientific Literacy indicators developed by Gormally from* the *Georgia Institute of Technology. The results showed a significant increase in students' scientific literacy with an N-Gain value of 0.74 which is included in the high category. In conclusion, the implementation of the SETS-Based Guided Inquiry Learning Model has proven effective in improving the scientific literacy of junior high school students.*

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INTRODUCTION

International Student Assessment Program(PISA), initiated by the Organization for Economic Cooperation and Development (OECD), aims to assess education systems in OECD member countries. In the context of PISA, scientific literacy is defined as the knowledge and skills used to ask questions, acquire new information, explain scientific phenomena, and draw conclusions based on available evidence.(OECD, 2019). In the 21st century, the rapid development of science and technology emphasizes the importance of scientific literacy, namely the ability to think critically scientifically and apply scientific knowledge and methods to understand natural phenomena and make decisions in solving scientific problems.(Erdani et al., 2020). Measurement of scientific literacy in PISA involves four main dimensions: process, content, context, and attitude.(OECD, 2017).

However, the results of PISA 2022 show that Indonesia is ranked 65th out of 80 countries with a score of 383, which is lower than the score in 2018 (OECD, 2023). The low level of scientific literacy indicates weaknesses in the education system, especially in the teaching methods applied. Factors such as non-contextual and teacher-centered learning models, lack of learning tools and facilities, and ineffective teaching materials are some of the main causes (Sutrisna, 2021; Fuadi et al., 2020). For example, in SMP Negeri 1 Wonoayu, the use of learning models that focus on the dominant role of teachers is still very common, which contributes to the low scientific literacy of students. Data shows a decline in scientific literacy

skills by 2.5% in 2023, placing the school in the middle ranking (41-60%) at the Sidoarjo district level.

One solution that is considered effective for improving scientific literacy skills is to choose an appropriate and interesting learning model.(Millenia & Sunarti, 2022)Proposes the use of the concept of guided inquiry as one way to improve students' scientific literacy. This learning model includes aspects of science content, science context, and scientific process and applies experimental methods to glass and chemical materials that have been proven to have a positive impact on students' scientific literacy.(Nasir et al., 2023)Besides that(Wen et al., 2020)They stated that well-designed simulations supported by inquiry can have a long-term impact on students' scientific literacy. Various studies have shown that the application of guided inquiry models can help students improve their understanding of science.

Various efforts have been made to improve scientific literacy, one of which is the development of scientific literacy-based assessment instruments, such as the Test of Scientific Literacy Skills (TOSLS) developed by(Gormally et al., 2012). This instrument covers various important indicators, including the ability to formulate scientific statements, use references appropriately, conduct problem analysis, understand research design, create data graphs, and interpret data and statistics. Development is carried out to create a scientific literacy-based assessment instrument to reveal students' abilities in something that has been learned, understood, and applied.(Sutrisna, 2021). According to(OECD, 2015)Scientific literacy is described into six levels related to basic competencies and scientific competencies that students need to achieve at each level. However, although the indicators of scientific literacy according to(OECD, 2015)Has been widely used, the application of TOSLS indicators in the context of education in Indonesia is still relatively rare, so it has not been utilized optimally to address the problem of scientific literacy in this country.

To address this challenge, this study aims to implement a guided inquiry learning model supported by the Science, Environment, Technology, Society (SETS) approach. This approach not only promotes active and meaningful learning but also allows students to integrate science knowledge with technology, the environment, and society. By using the SETS-based inquiry model, it is expected that students can develop a deeper understanding of science, as well as improve their critical thinking skills (Millenia & Sunarti, 2022;2019;(Fitriyani et al., 2017).

The SETS approach is a method that is relevant to inquiry-based learning. The SETS approach to inquiry learning provides opportunities to implement active and meaningful learning. SETS itself is an integration of conceptual approaches, process skills, and environments.(Permatasari et al., 2019). By using the SETS-based inquiry model, students not only make discoveries and explorations but also examine the application of technology in the context of science, environment, technology, and society that have been studied. (Treasure, 2015). In addition, learning through the SETS approach helps students to understand and deeply feel the knowledge they are learning so that the knowledge is easier to remember and supports a clearer understanding of the content and concepts of science.(Pedretti et al., 2008). Science learning is a designed learning, science learning is not only about skills or theoretical basics but also learning about findings. Where science learning emphasizes more on scientific investigation and provides direct and real experience.(Rahayu et al., 2021). Therefore, the SETS approach is considered a meaningful learning concept, because it allows students to learn natural science (IPA) directly through the impact of technology on the surrounding environment.(Fitriyani et al., 2017). With this approach, students can develop their understanding of science by combining knowledge and critical thinking skills.

This approach is expected to be an effective solution to improve scientific literacy in Indonesia, by utilizing more comprehensive and relevant TOSLS indicators. This study focuses on the integration of guided inquiry learning methods and the SETS approach to produce

significant improvements in students' scientific literacy skills. Based on this, the researcher applied a guided inquiry model with the SETS approach to improve students' scientific literacy by utilizing TOSLS indicators.

METHOD

The type of research used is quantitative descriptive research using a pre-experimental design method. This research was conducted in class VII of the even semester of the 2023/2024 academic year at SMP Negeri 1 Wonoayu involving 35 students. This research was conducted using the Guided Inquiry Learning model. The research design uses a one-group pretest-posttest design, which is described in the following scheme.

Pre-test	**Treatment**	***Post-test***
O1	X	O2

Information:

O1 : Pre-test Score
X : Learning based on the SETS approach in the Guided Inquiry Learning model
O2 : Post-test Value

The data collection technique in this study used a purposive sampling technique, namely a deliberate sampling method based on daily assessment results and similar attitudes.(Sugiyono, 2022). The sampling technique using purposive sampling was used to select classes based on the considerations of science teachers and various student abilities. Based on the considerations of teachers and based on the results of the questionnaire distributed by researchers, it showed that the scientific literacy skills of class VII-K students were still lacking.

The research procedure went through several stages, namely the observation stage which was carried out by interviewing science teachers at the school and collecting data. Data collection was carried out through observations during learning activities. This observation was carried out by two observers. Before conducting the observation, all observers were given a detailed explanation of the observation criteria, how to use the research instrument, and observation simulation, to ensure that all observers had a uniform understanding and could make consistent assessments. Observations were carried out using an observation sheet instrument for the implementation of learning that had been validated by two validators.

Data collection of students' scientific literacy skills was obtained from the results of the pretest and posttest. The instrument for testing students' scientific literacy skills consisted of 9 questions containing sub-indicators of scientific literacy from TOSLS.(Gormally et al., 2012)Analysis of the improvement of science literacy skills was carried out using the results of the pretest and posttest of students using the N-gain test. N-gain is calculated using the formula.

$$< g >= \frac{Score\ posttest - Score\ pretest}{Score\ maximum - Score\ pretest}$$

Then interpreted into improvement categories, as can be seen in Table 1 below.

Table 1. N-Gain Category

<g> Score	**Criteria**
<g> ≥ 0.7	High
0.7 > <g> ≥ 03	Medium
<g> < 0.3	Low

(Hake, 1998).

In this study, the improvement of students' science literacy skills was assessed based on the N-gain value obtained. The threshold of 0.70 was chosen as an indicator of success

because, in the literature, an N-gain score ≥ 0.70 is generally considered a high category, indicating a significant increase in the skills or understanding being measured. (Hake, 1998).

Furthermore, Mastery of scientific literacy skills is classified into 6 Levels. The results of the scientific literacy test are known by calculating the correct answer score divided by the maximum score on the scientific literacy indicator. The calculation formula is adapted from (Elvanisi et al., 2018)

$$Score = \frac{Correct\ answer}{Score\ maximum} X\ 100$$

The results obtained are included in the categorization of scientific literacy levels, to find out what level the students' scientific literacy abilities are at. This categorization of scientific literacy levels refers to previous research, as described by(Anisa & Martini, 2018)Which also uses a similar threshold to measure the success of improving students' scientific literacy. The categorization of scientific literacy levels can be seen in Table 2 below.

Table 2. Science Literacy Level Category

Score	***Science Literacy Level Category***
0 – 13	*Levels 1*
14 – 38	*Levels 2*
39 – 52	*Levels 3*
53 – 63	*Levels 4*
64 – 85	*Levels 5*
86 – 100	*Levels 6*

(Anisa & Martini, 2018)

It should be noted that pre-experimental designs have limitations, especially the absence of a control group, which can affect the internal validity of the study. Without a control group, the results obtained cannot be compared with a group that did not receive the intervention, so causal interpretations must be made with caution. To overcome this limitation, the analysis of the results was carried out by considering other factors that may have influenced the findings, as well as supporting the results with references from previous studies that used similar methods.

RESULTS AND DISCUSSION

The scientific literacy ability of students with the application of the SETS-based Guided Inquiry Learning model is taken from the pretest and posttest scores consisting of 9 questions where each question contains 1 sub-indicator of scientific literacy. The indicators used are; Students can formulate scientific statements, Students can use references appropriately, Students can analyze problems, Students can understand research design, Students can create data graphs, Students can interpret data, Students can solve problems using probability statistics, Students can interpret statistics in a study, Students can make conclusions.

Based on the pretest and posttest scores, it can be analyzed to determine the increase in students' scientific literacy skills by calculating N-Gain. Based on the results of the N-Gain test of students who have been categorized, the percentage of N-Gain science literacy skills of class VII-K students is presented in the following figure.

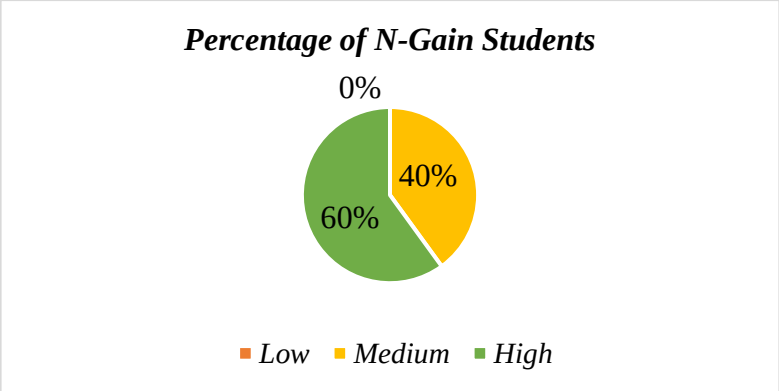

Figure 1. Student N-Gain Percentage Graph

Based on the figure, it is known that there is an increase in students' scientific literacy skills with N-Gain scores in the medium and high categories. Of the number of students, 40% of students experienced an increase in N-Gain scores with a medium category and 60% of students experienced an increase in N-Gain scores with a high category. The average N-Gain value obtained by all students is 0.74 if interpreted into a high category. The high category shows that most students not only understand the material taught well but are also able to apply this knowledge effectively in different contexts.(Oktaviana et al., 2023). The educational impact of this high category is significant, indicating that the learning model used has succeeded in increasing students' understanding in depth. On the other hand, the medium category, although showing improvement, indicates that there is room for further improvement in learning for these students.

If 60% of students are in the high category and 40% are in the medium category, this implies that the majority of students have achieved a very good level of scientific literacy, while some still need additional approaches to achieve more optimal results. The educational implications of this distribution indicate that the learning methods applied are effective, but there needs to be a more individual strategy to support students who are still in the medium category to improve their understanding to a higher level.

These results are consistent with the research.(Agustina et al., 2020)Which states that the application of a guided inquiry learning model assisted by multimedia has a positive influence on improving students' scientific literacy skills, especially on the material of substances. This increase is also reflected in the N-Gain value of each scientific literacy indicator tested, with the results of the increase in the average value presented in the following figure.

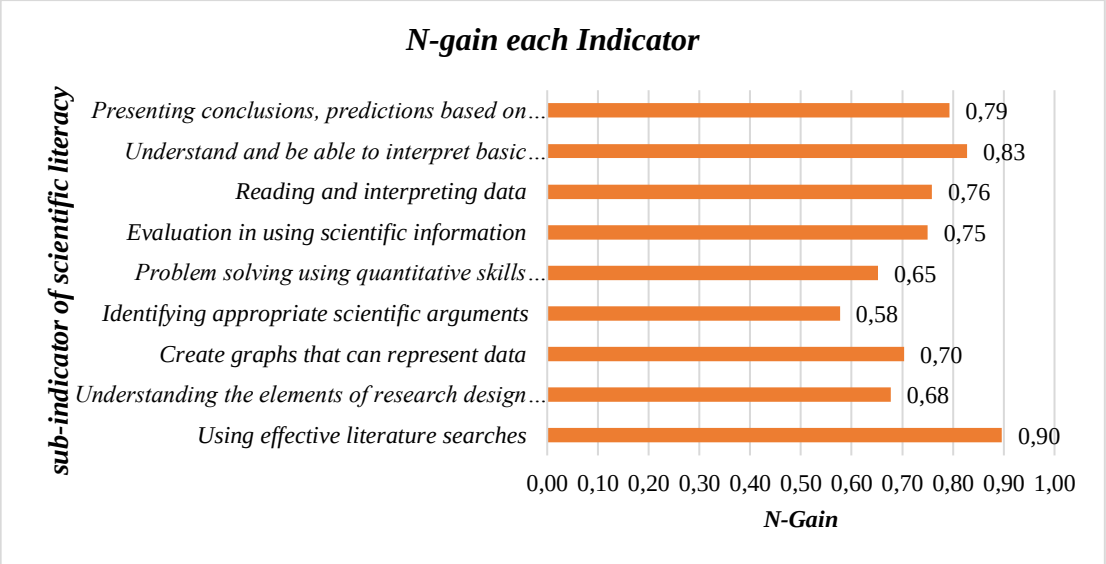

Figure 2. N-Gain Chart Each Indicator

Based on Figure 2, it can be seen that each indicator of scientific literacy that was trained experienced an increase as indicated by the N-Gain value of each indicator. There are 3 indicators in the medium category and 6 indicators in the high category. The results of the N-Gain value of each indicator support the statement that there was an increase in students' scientific literacy skills after the SETS-based Guided Inquiry Learning model was implemented. This is in line with the increase in students' scientific literacy skills as evidenced by the results of the increase in the level of scientific literacy.(Retno & Marlina, 2018). The varying improvements across indicators may be interpreted as a reflection of the aspects of scientific literacy that benefit most from the intervention. Indicators that show high improvements may be related to aspects of learning that are more integrated with the SETS approach, such as understanding scientific concepts in real contexts or students' ability to apply scientific knowledge in solving environmental and technological problems. For example, students' ability to make direct reasoning and general interpretations of the results of scientific investigations may develop more rapidly because the guided inquiry model encourages students to be active in the learning process.

Conversely, indicators that are in the moderate category may indicate areas where students are still struggling, perhaps because the skills require more practice or deeper conceptual understanding. For example, if these indicators relate to students' ability to draw conclusions based on complex data or apply scientific concepts to unfamiliar situations, slower improvement may indicate a need for a more detailed teaching approach or more iteration of learning.

The pretest results showed that the majority of students were at Level 2 on the PISA scale, indicating that they had sufficient basic scientific knowledge to provide explanations or draw conclusions based on simple investigations. After the intervention using the SETS-based Guided Inquiry Learning model, the post-test results showed a significant increase in students' scientific literacy skills, with the majority of students now at Level 5 and some reaching Level 6. This increase from Level 2 to Level 5 indicates a significant shift in students' abilities, where they are now able to identify the components of science in complex life situations, apply scientific concepts in specific contexts, and compare, select, and evaluate relevant scientific evidence to respond to life situations.(OECD, 2015)

This improvement not only indicates an increase in students' scientific knowledge but also reflects their ability to apply this knowledge in practical situations, which is very important in the context of 21st-century education. This finding supports previous research by(Erdani et al., 2020), which shows that the guided inquiry learning model can improve students' scientific literacy attitudes and abilities. In addition, these results are in line with the research.(Kang, 2022)Which emphasizes the effectiveness of inquiry learning in improving students' ability to carry out complex scientific reasoning.

However, these findings also challenge some studies that suggest that inquiry learning may not always be effective without adequate support or adjustments to learner needs.(Paramitha Sinaga et al., 2022). In this study, the SETS approach was shown to provide relevant context for learners, enabling them to connect scientific knowledge to real-world environmental and technological issues, thereby strengthening their scientific literacy.

This increase shows that appropriate educational interventions can have a significant impact on students' scientific literacy skills, especially when supported by relevant and contextual learning models.(Faith & Nurul, 2022). A recapitulation of the increase in the level of scientific literacy of students can be seen in the following figure.

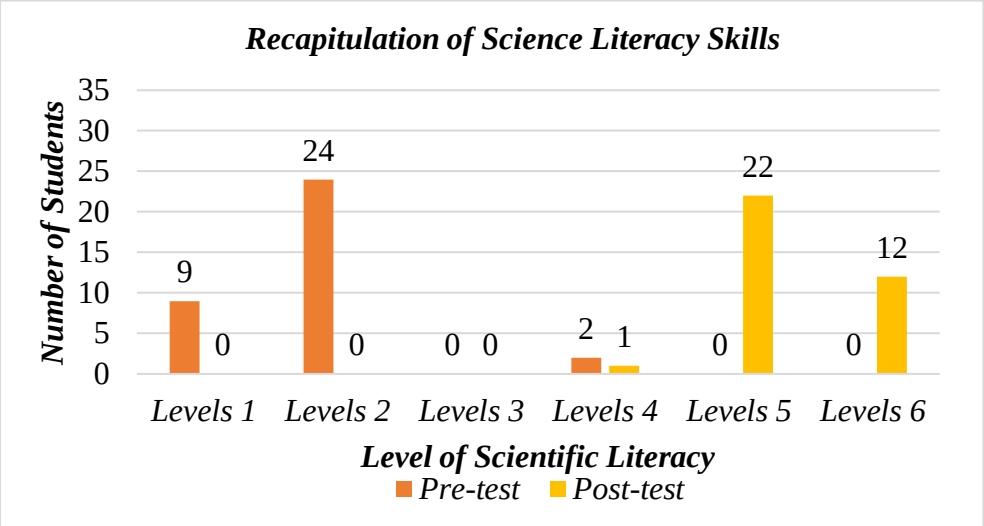

Figure 3. Summary Graph of Student Literacy Levels

The improvement of science literacy skills after the implementation of the SETS-based Guided Inquiry Learning model for three meetings was supported by several factors. One of the main factors was structured observation activities at each meeting.(Retno & Marlina, 2018). For example, during the observation session, students are invited to observe environmental phenomena directly, both independently and in groups, which encourages them to develop critical observation and analysis skills. Another example is the cooperation between students that is manifested when they work in teams to solve a given problem, such as designing a simple experiment to test a hypothesis related to environmental pollution. This collaboration strengthens the understanding of scientific concepts because students share knowledge and develop solutions together.(Yasir & Khoiriyah, 2024).

In addition, the suitability between the material and learning model with the given science literacy questions ensures that students can connect the theories learned in class with practical applications in the questions presented. A good relationship between teachers and students is also an important factor. Teachers actively foster this relationship through a supportive and motivating approach, which is in line with the findings. (Kang, 2022) that

positive teacher-student relationship can moderate the influence of guided inquiry on scientific literacy, making it a strong predictor of scientific literacy success.

The approach taken during these three meetings is also in line with the learning theory of (Bruner, 1960), which states that learning involves three stages: the information extraction stage, the transformation stage, and the learning mastery stage. Bruner emphasized that learning mastery requires more than one meeting to ensure deep understanding. In this context, each meeting aims to take students through these stages gradually, starting from the introduction of basic concepts to their application in more complex situations. For example,(Erdani et al., 2020)Also found that the use of guided inquiry models during several meetings was effective in improving students' scientific literacy, even on different materials but still in a scientific context. Thus, the combination of structured observation, collaboration between students, good teacher-student relationships, and the use of learning models that are consistent with Bruner's learning theory, all contribute to significant improvements in students' scientific literacy.

CONCLUSION

The implementation of the SETS-based Guided Inquiry Learning model has proven effective in improving students' scientific literacy skills, as indicated by a significant increase from pretest to posttest. The N-Gain scores obtained indicate that the majority of students experienced an increase in the high category, reflecting a deeper understanding and better ability to apply scientific knowledge in real-life contexts. Supporting factors, such as structured observation, collaboration between students, and good teacher-student relationships, played an important role in the success of this intervention. These findings are in line with Bruner's learning theory, which emphasizes the importance of mastery of learning through repeated and in-depth stages and supports previous research on the effectiveness of guided inquiry learning in improving scientific literacy. However, the results also indicate that there is room for further improvement for students in the medium category, with the need for a more individualized and iterative teaching approach to achieve more optimal results. Overall, this study strengthens the evidence that relevant and contextual learning approaches can have a significant impact on students' scientific literacy.

SUGGESTION

Teachers need to master effective strategies in implementing the Guided Inquiry Learning model, especially in managing class time and dividing student roles. In addition, teachers are advised to provide clear guidance to students during the inquiry process, by setting concrete steps that students must follow when collecting and analyzing data. The use of structured worksheets and detailed instructions can help students stay focused and achieve the desired results. To address the limitations of this study, future research should explore variations in the duration and frequency of interventions and adaptation of the model to different subjects or classroom conditions, to strengthen the validity of the findings and understand the specific impact of the intervention.

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