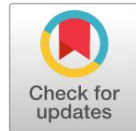








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## Analysis Narratives of Improving Students' Scientific Literacy Through Socio-Scientific Issues-Based Science Learning in Elementary Schools

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### ABSTRACT

**Background.** This research is motivated by the low scientific literacy of elementary school students caused by science learning that is still oriented towards memorization and lacks contextualization.

**Purpose.** This study aims to analyze the improvement of students' scientific literacy through the implementation of Socio-Scientific Issues (SSI)-based science learning.

**Method.** This study uses a quantitative approach with a quasi-experimental design and a one-group pretest-posttest design. The subjects of the study were 30 fourth-grade elementary school students.

**Results.** The data collection technique used a science literacy test, while data analysis was carried out using the N-Gain test. The results showed that the average pretest score of 56.3 increased to 82.7 in the posttest, with an N-Gain value of 0.60 which is included in the moderate category. This indicates that SSI-based learning is effective in improving students' scientific literacy, especially in the aspects of conceptual understanding, data interpretation, and evidence-based decision making.

**Conclusion.** Thus, Socio-Scientific Issues-based learning can be an alternative, innovative and contextual learning strategy in improving elementary school students' scientific literacy.

### KEYWORDS

Elementary School, Science Learning, Scientific Issues

### INTRODUCTION

The introduction is generally well written and clearly explains the importance of scientific literacy in elementary education. However, the research objectives should be described in greater detail so that readers can better understand the direction, focus, and expected contributions of the study. Although the introduction successfully presents the research problem, the discussion regarding the significance of the issue still needs to be expanded to strengthen the academic urgency of the study (Setiawan, 2023). In addition, the introduction requires substantial revision. While it introduces the importance of scientific

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literacy and Socio-Scientific Issues (SSI)-based learning, it does not yet provide a strong and up-to-date review of previous studies, a clearly identified research gap, explicit research questions, a well-defined scope of the study, or a convincing statement of contribution. The authors are encouraged to reorganize the introduction by first presenting the broader educational issue, then identifying the specific problems related to scientific literacy in elementary schools. Furthermore, prior studies should be reviewed more critically to highlight unresolved issues and research limitations.

The introduction should also clearly explain the research gap that this study intends to address, specify the focus and scope of the research, and formulate explicit research questions or objectives. Finally, the authors need to emphasize the theoretical, contextual, and practical significance of the study, particularly in relation to the development of students' scientific literacy through SSI-based learning approaches in elementary education. Therefore, science learning in elementary schools must be systematically designed to optimally foster literacy skills (W. Y. Hwang, 2023; Lovett, 2024).

However, on-the-ground conditions indicate that the level of scientific literacy of Indonesian students remains relatively low. This is reflected in various international studies that rank Indonesia at the bottom in terms of scientific literacy (Mitchell, 2024; Purnama, 2023). This low achievement is inextricably linked to learning practices that are still oriented toward theoretical mastery of concepts, without being balanced with contextual understanding. Students tend to memorize material without being able to relate it to phenomena occurring in everyday life. As a result, students' abilities to analyze, evaluate, and interpret scientific information are underdeveloped (Abrori, 2024; Villan, 2023).

At the elementary school level, science instruction should be a means of introducing students to scientific thinking through meaningful learning experiences. However, current learning is still dominated by lectures and the use of textbooks as the sole learning resource (Cantlon, 2024; Ramón-Bautista, 2023). This situation results in students being less active in the learning process and lacking the opportunity to develop higher-order thinking skills. Furthermore, the lack of connection between learning materials and real-life situations is also a factor hindering the improvement of students' scientific literacy (Jin, 2024; Kumar, 2024).

To address these issues, innovations in science learning are needed that connect scientific concepts to everyday life contexts. One approach that can be used is Socio-Scientific Issues (SSI)-based learning. This approach emphasizes the use of social issues related to science as a learning context. This way, students not only learn scientific concepts theoretically but also understand how these concepts are applied in real life, as well as their impact on society and the environment (Garcia, 2023; Retno, 2025).

SSI-based learning provides students with opportunities to actively engage in discussions, arguments, and decision-making based on scientific data and facts. Through this approach, students are trained to develop critical and reflective thinking skills and to view problems from multiple perspectives. Furthermore, SSI encourages students to develop a concern for social and environmental issues around them. This makes learning more meaningful and relevant to students' lives (Fong, 2025; Halimah, 2024).

Several previous studies have shown that implementing SSI-based learning can have a positive impact on improving students' scientific literacy. Students who learn using this approach tend to have better abilities in understanding scientific concepts, interpreting data, and constructing scientific arguments. Furthermore, they also show improvements in their ability to make evidence-based decisions. This suggests that SSI is a potential approach to improving the quality of science learning in elementary schools (Menendez, 2023; Witarsa, 2023).

However, the implementation of SSI-based learning in elementary schools remains suboptimal. Many teachers are unfamiliar with this approach, preventing them from effectively integrating it into their lessons. Furthermore, limited learning resources and a lack of training also hinder SSI implementation. Therefore, research is needed that more deeply examines the effectiveness of SSI-based learning in improving elementary school students' scientific literacy (Mozelius, 2023; Yáñez-Pérez, 2025).

Based on the above description, this study aims to analyze the improvement of students' scientific literacy through Socio-Scientific Issues-based science learning in elementary schools (Li, 2023; Naidoo, 2023). This research is expected to contribute to the development of more innovative and contextual learning strategies and serve as a reference for teachers in improving the quality of science learning. Furthermore, the results of this study are also expected to enrich scientific studies related to scientific literacy and the implementation of SSI in elementary education (Cabrera, 2024; Murai, 2023).

## RESEARCH METHODOLOGY

The methodology section is generally well explained and provides a clear overview of the research design, variables, instruments, and data collection procedures. The use of a quantitative approach with a quasi-experimental design is appropriately described, and the stages of the research procedure are presented systematically. In addition, the inclusion of relevant references such as (Rich, 2024; Torres-Torres, 2024) and other supporting studies strengthens the methodological foundation of the study.

However, the explanation regarding the sampling procedure requires further clarification to improve transparency and methodological rigor. Although the study states that purposive sampling was employed, the specific criteria used for selecting the participants are not sufficiently detailed. The authors should clearly explain the inclusion criteria, the characteristics of the selected students, the school context, and the exact research location. Providing this information is important to help readers understand the context of the study and assess the transferability of the findings.

Furthermore, the study is described as a quasi-experimental study; however, it only utilizes a one-group pretest-posttest design without a control group. This design limits the ability to conclude that the observed improvement in students' scientific literacy was solely caused by the implementation of SSI-based science learning. Other external factors may also have influenced the results during the intervention process. Therefore, the authors are encouraged to explicitly acknowledge this methodological limitation and avoid making overly strong causal claims regarding the effectiveness of the treatment.

Additionally, the sample size of only 30 fourth-grade students from a single classroom, selected through purposive sampling, substantially limits the generalizability of the findings. The manuscript should explicitly state that the results cannot be generalized broadly to other educational settings or student populations. The authors are also encouraged to discuss this limitation in the methodology or discussion section to provide a more balanced interpretation of the findings.

The explanation of the research instruments, including the scientific literacy test and observation sheets, is sufficiently clear. Nevertheless, additional details regarding the validity and reliability testing procedures would further strengthen the methodological quality of the study. For example, the authors may specify the type of validity testing conducted, the number of expert validators involved, and the reliability coefficients obtained from the instrument testing process (G. J. Hwang, 2023; Lara-Alvarez, 2023). Overall, the methodology section is adequately organized,

but several aspects related to sampling transparency, research limitations, and instrument validation need to be elaborated further to enhance the credibility and academic quality of the study.

The data analysis techniques used were descriptive and inferential statistical analysis. Descriptive analysis was used to determine the average value, percentage, and improvement in students' scientific literacy scores. Meanwhile, inferential analysis was conducted using the N-Gain test to determine the categories of student improvement. The N-Gain formula used is as follows:

$$N - Gain = \frac{Skor\ posttest - Skor\ pretest}{Skor\ maksimum - Skor\ pretest}$$

The N-Gain calculation results were then categorized into three categories: high, medium, and low. Thus, this analysis can provide a clear picture of the effectiveness of Socio-Scientific Issues-based learning in improving elementary school students' scientific literacy (Sonnenschein, 2023; Tang, 2024).

## RESULT AND DISCUSSION

The Results section is currently too limited to adequately support the conclusions drawn by the study. The authors only report the mean scores, highest scores, and lowest scores of the pretest and posttest results. Such presentation is insufficient for a quantitative pretest–posttest study. To strengthen the validity and reliability of the findings, the authors should include additional statistical analyses, such as standard deviations, minimum and maximum scores, N-Gain score distributions, and the percentage of students categorized into low, medium, and high improvement levels. Furthermore, the results for each scientific literacy indicator should be presented in detail to provide a more comprehensive understanding of students' learning progress.

In addition, the manuscript should incorporate appropriate inferential statistical tests, such as the paired sample t-test or the Wilcoxon signed-rank test, to determine whether the differences between pretest and posttest scores are statistically significant. Without these additional analyses, the claim that Socio-Scientific Issues (SSI)-based science learning improves students' scientific literacy remains insufficiently supported.

The manuscript also demonstrates an imbalance in the composition of its sections. The Introduction section is relatively extensive and contains many general statements, whereas the Results and Discussion sections are underdeveloped. In empirical studies, the Results and Discussion sections should represent one of the strongest parts of the manuscript, ideally accounting for approximately 35–45% of the article when combined. At present, the results are only presented through simple tables containing mean scores, highest scores, and lowest scores, without including standard deviations, statistical significance testing, effect sizes, individual N-Gain distributions, or analyses based on scientific literacy indicators.

Moreover, the Discussion section remains overly descriptive and does not sufficiently compare the findings with recent and relevant previous studies. The authors are encouraged to provide deeper analytical interpretation by relating the findings to existing literature, explaining possible factors influencing the results, and highlighting the theoretical and practical implications of SSI-based learning for the development of scientific literacy among elementary school students.

**Table 1.** Results of the pretest and posttest of students' scientific literacy

Category	Pretest	Posttest
Average value	56.3	82.7
The highest score	75	95
Lowest value	40	70

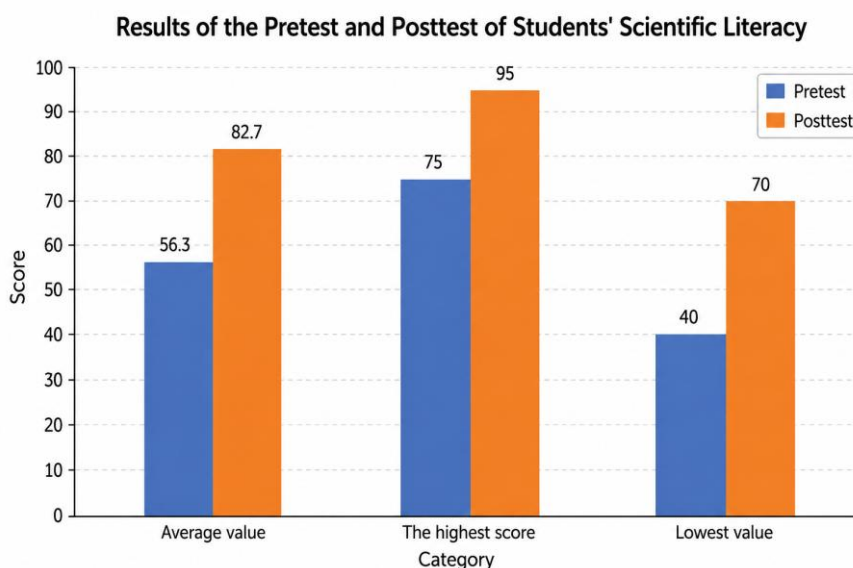
Table 1 shows a significant increase in students' scientific literacy scores after the treatment. The average student score increased from 56.3 to 82.7. Furthermore, the lowest student score also increased from 40 to 70, indicating that nearly all students experienced improvements in their abilities. To determine the level of improvement in more detail, an analysis was conducted using the N-Gain test. The calculation results show that the average N-Gain value for students is:

$$N-Gain = \frac{82,7 - 56,3}{100 - 56,3} = 0,60$$

This value is included in the moderate category, which shows that SSI-based learning is quite effective in improving students' scientific literacy.

The improvement in students' scientific literacy observed in this study indicates that Socio-Scientific Issues (SSI)-based learning positively impacts students' ability to understand scientific concepts. This is evident in the significant increase in average scores between the pretest and posttest. This improvement occurred not only among high-ability students but also among low-ability students, as indicated by the increase in the lowest scores after the treatment.

SSI-based learning provides a more contextual learning experience than conventional learning. Students not only passively receive information but also actively participate in the learning process through discussions, issue analysis, and argumentation. This active engagement encourages students to think more critically and connect scientific concepts to everyday phenomena. This McGill, (2023) findings, which suggest that the SSI approach can improve students' critical thinking skills and scientific literacy.



**Figure 1.** Comparison of students' scientific literacy pretest and posttest scores

The graph illustrates the comparison between students' scientific literacy scores before and after the implementation of Socio-Scientific Issues (SSI)-based science learning. The results

indicate a significant improvement in students' performance across all categories. The average score increased from 56.3 in the pretest to 82.7 in the posttest, demonstrating an overall enhancement in scientific literacy skills. Similarly, the highest score improved from 75 to 95, while the lowest score rose from 40 to 70. These findings suggest that SSI-based learning contributed positively to improving students' understanding, reasoning, and application of scientific concepts in elementary science education.

Furthermore, improved scientific literacy is also evident in students' ability to interpret data and make evidence-based decisions. During the learning process, students are exposed to various social issues related to science, such as environmental or health issues. Through these activities, students are trained to analyze information, consider multiple perspectives, and determine appropriate solutions based on available data. This process indirectly develops students' scientific literacy skills comprehensively (Restini, 2024).

The results of this study also show that SSI-based learning can create a more engaging and meaningful learning environment. Students appear more enthusiastic about participating in learning because the material presented is directly relevant to their lives. This results in increased student motivation to learn, which ultimately contributes to improved learning outcomes. These findings align with research by Boz, (2023), which states that SSI-based learning can increase student engagement and motivation.

Despite this, the improvement achieved is still moderate. This indicates that several factors still need to be considered in implementing SSI-based learning. One such factor is limited learning time, which prevents all students from exploring issues in depth. Furthermore, the teacher's ability to manage discussions and guide students is also a crucial factor influencing learning success (Davis, 2023).

Thus, it can be concluded that Socio-Scientific Issues (SSI)-based science learning has significant potential for improving elementary school students' scientific literacy. However, achieving optimal results requires careful planning and support from various parties, including teachers and schools.

## CONCLUSION

Based on the research results and discussion, it can be concluded that the implementation of Socio-Scientific Issues (SSI)-based science learning can improve elementary school students' scientific literacy. This improvement is demonstrated by the significant difference in average pretest and posttest scores, as well as the results of the N-Gain analysis, which are in the moderate category. This indicates that the SSI approach makes a positive contribution to developing students' abilities in understanding scientific concepts, interpreting data, and making evidence-based decisions.

SSI-based learning has been proven to create more contextual and meaningful learning experiences for students. By integrating social issues relevant to everyday life, students become more active in the learning process and develop critical and reflective thinking skills. Furthermore, student engagement in scientific discussions and argumentation is also a crucial factor in improving scientific literacy.

However, the implementation of SSI-based learning still faces several challenges, such as limited time and teacher preparedness in managing learning. Therefore, more systematic efforts are needed to develop teacher competencies and provide learning resources that support optimal SSI implementation. Thus, science learning in elementary schools is expected to be more effective in improving students' scientific literacy.

## DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Google Gemini to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

## AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; Investigation.

Author 3: Data curation; Investigation.

## DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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