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Application of A Guided Inquiry Learning Model to Improve Students' Scientific Literacy Skills

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ABSTRACT

Objective: This study aims to determine the guided inquiry learning model's effectiveness in improving students' scientific literacy skills. **Method:** This is an experimental research with a one-group pretest-posttest design without using a control class. **Results:** The research results show that applying the guided inquiry learning model significantly increases students' scientific literacy. Data were analyzed using descriptive methods. Evaluation of the learning plan shows a good feasibility level in its implementation. Student learning outcomes have increased significantly, including understanding of science concepts and scientific skills. Most students progress positively in reading, understanding, and analyzing scientific information. These findings are strengthened by direct observations of students' active participation and involvement during learning. Thus, using the guided inquiry learning model positively contributes to increasing students' scientific literacy. **Novelty:** The novelty of this research lies in its new contribution to increasing scientific literacy by applying the guided inquiry learning model. The positive response from students to this learning model emphasizes its relevance in advancing scientific literacy. These findings show that the practical use of the guided inquiry model can improve students' understanding of concepts and scientific skills. Integrating this learning model into the learning context adds essential value to science education. The research results confirm that the effective use of the guided inquiry model can increase students' scientific literacy, making a significant contribution to preparing them to face future scientific challenges.

INTRODUCTION

In higher education, scientific literacy skills are critical because they help students develop a deep understanding of science and scientific methods. This enables them to understand and interpret scientific information critically and recognize and avoid the spread of inaccurate or false information. A deep understanding of science is the foundation for developing solid scientific literacy skills. This includes understanding various scientific concepts and processes, as well as applying science in everyday life (Sigit et al., 2022). In the same context, research conducted by Miarsyah et al. (2021) underlines the importance of a solid scientific understanding as a basis for developing adequate scientific literacy. Students with a solid understanding of science will be better able to evaluate scientific claims, make informed decisions, and actively participate in meaningful scientific discussions. A recent study by Kahar et al.(2022) found that students with solid scientific literacy skills have better academic performance and a deeper understanding of scientific concepts. In addition, scientific literacy skills also prepare students to engage in research and innovation and enable them to provide critical, evidence-based thinking on social and environmental issues. Therefore, higher education institutions need to encourage and develop scientific literacy skills in their students.

Students face several challenges in developing scientific literacy skills. Based on the results of simple interviews, one of the main challenges is the excess of information available in the current digital era. They are often faced with extensive and varied volumes of information, which is challenging to sift through properly. In addition, the existence of unverified information sources and the spread of hoaxes is a severe problem. Students often need help evaluating the reliability of scientific information sources and distinguishing between facts and opinions. Apart from that, a learning approach that only focuses on memorizing scientific concepts is also an obstacle to developing scientific literacy skills. Understanding concepts is a critical element in efforts to increase students' scientific literacy. This involves a deep understanding of the fundamental and complex scientific concepts of various disciplines (Turmuzi & Lu'lu'ilmaknun, 2023). Students need an active learning approach that encourages them to engage in scientific practices, such as reading research articles, asking questions, and applying knowledge in authentic contexts. In the same context, a solid understanding of concepts helps students develop literacy in science by enabling them to relate information, make reasonable predictions, and recognize cause-and-effect relationships in real-world contexts. It is essential to develop the analytical, critical, and creative skills necessary to achieve adequate scientific literacy (Negoro et al., 2023). Therefore, higher education institutions must overcome this challenge by providing comprehensive and in-depth scientific literacy education.

The guided inquiry learning model has been chosen as a practical learning approach to improving scientific literacy skills because it allows students to participate actively in scientific exploration and discovery. This model empowers students to develop critical, analytical, and social thinking skills through exploration, experimentation, and problem-solving activities. The ability to think critically is critical in efforts to increase scientific literacy effectively. This includes the skills to describe, assess, and interpret scientific information carefully and objectively (Made et al., 2023). By strengthening critical thinking skills in scientific literacy, students can become critical readers of scientific information, innovative in solving problems, and focused decision-makers facing complex scientific and technological challenges. This has a crucial role in preparing them to be actively involved in a society increasingly influenced by science and technology (Jamaluddin et al., 2023). They are invited to ask questions, plan experiments, collect data, analyze results, and draw conclusions based on scientific evidence. Through guided inquiry, students can develop a deeper understanding of scientific concepts, scientific methods, and the application of science in real situations. They can also learn to work collaboratively, communicate effectively, and consider their discoveries' ethical and social implications.

Recent research by Nasir et al. (2022) supports using the guided inquiry learning model to improve students' scientific literacy skills. This study shows that students who engage in guided inquiry learning experience significant improvements in their ability to read and understand scientific texts, develop research questions, and analyze scientific data. Apart from that, students also showed an increase in learning motivation, self-confidence, and interest in science. Not only does it directly influence students' academic achievement, but scientific literacy also provides a strong foundation for developing skills and knowledge needed in various aspects of life and career, as stated by Syefrinando et al. (2022). Therefore, guided inquiry was chosen as a practical learning model for improving scientific literacy skills because it allows students to be actively involved in the science learning process, develop a deep

understanding, and develop the critical and analytical thinking skills needed to understand and apply science. According to research by Nasir et al. (2023), scientific literacy significantly influences students' academic achievement at various levels of education.

Scientific literacy skills refer to an individual's ability to read, understand, interpret, and use scientific information critically and contextually. This involves an understanding of scientific concepts and the scientific method and the ability to recognize, evaluate, and integrate scientific evidence. In addition, scientific literacy skills also include the ability to communicate scientific information clearly and effectively and participate in scientific discussions and debates. The contextual learning approach is vital in developing students' scientific literacy. This method places science concepts in real situations relevant to students' daily lives, helping them understand the relevance of science in solving real-world problems (Syabuddin et al., 2020). More than just increasing understanding of scientific concepts, contextual learning also helps students build the skills and motivation needed to become critical readers of scientific information and participate in a society increasingly influenced by science and technology, as expressed by Bachri et al. (2023).

A recent study by Parno et al. (2020) provided a more detailed understanding of scientific literacy skills. The results of this research state that scientific literacy skills consist of several aspects, such as reading and understanding scientific texts, recognizing and evaluating sources of scientific information, and applying scientific methods in solving problems. Problem-solving is essential in scientific literacy because it allows students to use their scientific knowledge and skills in dealing with everyday challenges and problems (Prajoko et al., 2023). Therefore, problem-solving plays a crucial role in efforts to develop students' scientific literacy because it helps them hone the skills, knowledge, and understanding needed to become critical readers, effective problem solvers, and members of society capable of scientific understanding, as explained by Suradika et al. (2023). According to research conducted by Parno et al. (2020), scientific literacy skills involve communicating and participating in the scientific community. Communication skills are critical in improving students' scientific literacy because they enable them to convey ideas, present findings, and engage in scientific dialogue (Rosneli & Ristiana, 2023). According to research by Negoro et al. (2023), communication skills significantly increase students' scientific literacy by facilitating significant learning, productive collaboration, and involvement in scientific dialogue. These abilities help students become critical readers, effective problem solvers, and active contributors to the science community. Scientific literacy skills also include the ability to identify the importance of science and its social implications and make decisions based on a deep understanding of scientific evidence.

Inquiry learning models and scientific literacy skills are interconnected and support each other. In the inquiry learning model, students are actively involved in exploration, discovery, and solving scientific problems, which encourages the development of scientific literacy skills. Through this activity, students are invited to ask questions, search for information, analyze data, and draw conclusions based on scientific evidence, thereby strengthening students' abilities to read, understand, and use scientific information critically and contextually.

Recent research by Juniar et al. (2020) supports the positive relationship between the inquiry learning model and students' scientific literacy skills. The results of this research show that students involved in inquiry learning experience significant improvements in

their reading and understanding skills in scientific texts, ability to identify and evaluate sources of scientific information, and critical thinking skills related to science. These findings confirm that the inquiry learning model improves students' scientific literacy skills.

By integrating inquiry learning models and developing scientific literacy skills, students not only develop a deeper understanding of scientific concepts but can also apply scientific methods, understand the social implications of science, and make decisions based on scientific evidence. The scientific literacy skills acquired through the inquiry learning model equip students with the ability to actively participate in a society that focuses on scientific evidence and faces complex challenges in the scientific world.

RESEARCH METHOD

The research method used in this research was experimental but did not use a control or comparison class group. The research design used is a group pretest-posttest design.

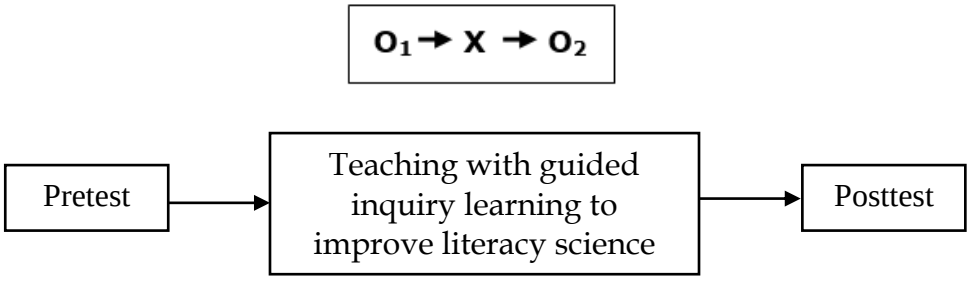

Figure 1. Research flowchart.

The subjects in this research were Physics Education students in class A 2021, Surabaya State University. The data collection method in this research uses scientific literacy skills test instruments on earthquakes, which experts have declared valid based on substance or material aspects, construction, and language or cultural aspects. Data analysis of students' scientific literacy skills tests was carried out by calculating the Normalized percentage with the help of the SPSS program, which was then strengthened with qualitative descriptive analysis (Prahani et al., 2020, 2021).

N-Gain shows increased students' scientific literacy skills before and after participating in learning using the guided inquiry learning model. The N-Gain value obtained is then interpreted to state the effectiveness of the learning model for improving student literacy skills with the criteria in Table 1.

Table 1. Normalized gain criteria.

N-Gain score	Criteria
0.70 > N-Gain	High
0.30 ≤ N-Gain ≤ 0.70	Medium
N-Gain < 0.30	Low

Apart from determining the N-Gain criteria, the effectiveness of the learning model is carried out by conducting inferential statistical tests. Before carrying out inferential statistical tests, the pretest and posttest data that have been obtained are first carried out

with the Test of Normality-Shapiro Wilk to see whether the sample is normally distributed or not based on decision-making as follows:
1. If the Sig. > 0.05, then the data is normally distributed
2. If the Sig. < 0.05, then the data is not normally distributed

RESULTS AND DISCUSSION

Results

Student Scientific Literacy

The students' science literacy skills were assessed before and after implementing the guided inquiry learning model. The guided inquiry learning model involves actively engaging students in learning, allowing them to investigate existing issues and discover solutions independently. To ascertain the average outcomes of students' science literacy skills before and after implementing the guided inquiry learning model, refer to Figure 2.

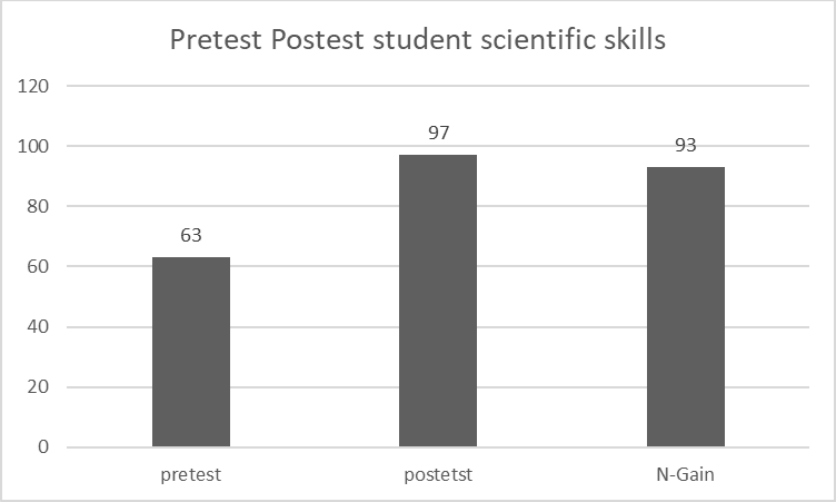

Figure 2. Average pretest-posttest results of students' science literacy skills.

The analysis results confirm that after implementing the guided inquiry learning model, the average student scores were >75 or above the minimum passing grade, with a score of 97. Additionally, the N-gain analysis revealed an average >0.70 or above 70, categorizing it as high, with a score of 93. Based on the average posttest scores and N-gain, the guided inquiry learning model enhances students' science literacy skills more effectively than the previous method. Observation results related to scientific literacy indicators that appear at each stage in the guided inquiry learning model can be seen in Table 2.

Table 2. Guided inquiry phase with indicators of scientific literacy skills.

No.	Guided inquiry phase	Rated aspect	Indicators of emerging scientific literacy skills	Score	Category
1	Planning	Presents problems related to everyday life	Knowledge of science content/context, explaining scientific	90.53	High

No.	Guided inquiry phase	Rated aspect	Indicators of emerging scientific literacy skills	Score	Category
2	Retrieving	Search and collect data regarding problems from various sources	phenomena Designing scientific investigations, procedural knowledge	89.67	High
3	Processing	Test and prove hypotheses by analyzing observation results	Interpret data and scientific evidence	85.37	High
4	Creating	Make conclusions from the results of observations	Interpret scientific data and evidence, content, and procedural knowledge	78.43	High
5	Sharing	Presenting the results of observations	Content knowledge, scientific attitude	75.87	High
6	Evaluating	With the teacher's help, summarize the material discussed and discussed.	Content knowledge	89.98	High

Table 2 displays data regarding students' scientific literacy skills after implementing the guided inquiry learning model. The results of the table show the average score for each aspect of the assessment as follows; (a) Students' ability to present problems related to everyday life, so that the concepts studied are appropriate to the surrounding situation, has an average score of 90.53, which is included in the high category, (b) Students' ability to search and collect data regarding problems from various sources so that the problems studied are in accordance with existing data with an average score of 89.67, which is also in the high category, (c) Students are able to test and prove hypotheses by analyzing the results of observations, so that the problems discussed has been proven to be suitable, with an average score of 85.37, which is included in the high category, (d) Students have the ability to make conclusions based on observations, so they can gain knowledge of the problem with an average score of 78.43 , which is also included in the high category, (e) Students can present the results of observations that have been obtained with an average score of 75.87, which is included in the high category, and (f) Together with instructor guidance, students can summarize the material or concept that have been studied with an average score of 89.98, which is also in the high category. These data reveal that using the guided inquiry learning model has resulted in an increase in students' scientific literacy skills in every scientific literacy indicator. For example, when students were asked to present problems relevant to everyday life, they achieved the highest score of 90.53, which is categorized as a high skill level. Problem solving is the main element of scientific literacy, which involves students' ability to recognize, analyze, and solve problems using scientific knowledge and skills. Problem-solving is essential to scientific literacy because it helps students

develop the skills and understanding needed to become critical readers of scientific information, effective problem-solvers, and active contributors in a society increasingly influenced by science and technology.

The assessment of each student's science literacy improvement can be observed through the average N-Gain scores. Based on the N-Gain test results of 28 students, the average scores fall within the high category. For a more detailed breakdown of the average N-Gain scores for each student, refer to **Figure 3.**

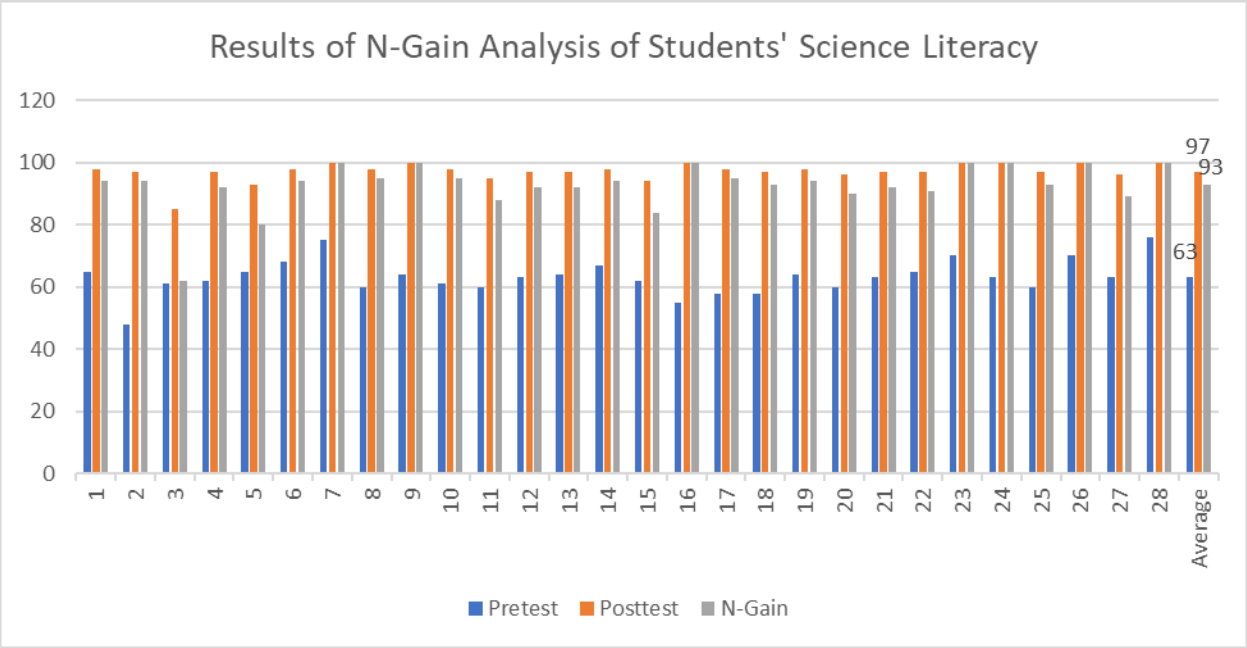

Figure 3. Results of N-Gain analysis of students' science literacy.

The analysis was conducted by testing the significant difference in students' literacy skills' average pretest and posttest scores before and after using the guided inquiry learning model. The statistical test uses the Paired Sample t-test (parametric) because in the previous test, the data obtained met the requirements for a parametric test, or the data obtained came from a normally distributed sample. The test was conducted using the SPSS program with a significance level of 0.05.

Table 3. Test results for the similarity of the average pretest and posttest scores.

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			

Paired Samples Test									
Pair 1	Pretest Science Literacy - Posttest Science Literacy	-33.96	5.59	1.05	-36.13	-31.79	-32.12	27	.00

Based on Table 3, the Sig value can be seen. Is 0.00. This value shows that the Sig value. More petite than 0.05 means H0 is rejected and HI is accepted. In other words, these results show a significant difference between students' scientific literacy skills before and after taking part in learning using the guided inquiry model.

Analysis of Normality Test Result

The normality test is carried out to determine whether the data obtained meets the requirements of a parametric or non-parametric test. Test of Normality-Shapiro Wilk is a type of normality test that will be used to see whether the sample is normally distributed or not, and the basis for decision-making is as follows :

1. If the Sig. > 0.05, then the data is usually distributed
2. If the Sig. < 0.05, then the data is not normally distributed

Table 4. Shapiro-Wilk test of normality test results.

Tests of Normality			
	Shapiro-Wilk		
	Statistic	df	Sig.
pretest science literacy	.946	28	.157
posttest science literacy	.945	28	.147

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on this table, the pretest and posttest significance values for students' literacy skills are 0.157 and 0.147, respectively. Both significance values are more significant than the significance value, namely 0.05, which means the data obtained came from a normally distributed sample. Because it has been obtained and it is known that the data obtained comes from a normally distributed sample, the requirements for parametric statistical tests have been met and can be carried out.

Analysis of The Similarity Test of The Average Pretest and Posttest Scores

This test is used to determine the impact of the learning model on improving students' scientific literacy skills. The analysis was conducted by testing the significant difference in students' literacy skills' average pretest and posttest scores before and after using the guided inquiry learning model. The statistical test uses the Paired Sample t-test (parametric) because in the previous test, the data obtained met the requirements for a parametric test, or the data obtained came from a normally distributed sample. The test was carried out using the SPSS program with a significance level of 0.05, with the hypothesis tested being as follows:

H0 : There is no significant difference between the pretest and posttest scores of scientific literacy skills of students who take part in learning using the guided inquiry learning model

H1 : There is a significant difference between the pretest and posttest scores of scientific literacy skills of students who take part in learning using the guided inquiry learning model

1. If the Sig. < α then H0 is rejected
2. If the Sig. value ≥ α then H0 cannot be rejected

Table 5. Paired sample t-test.

Paired Samples t-Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest Science Literacy - Posttest Science Literacy	-33.96	5.59	1.05	-36.13	-31.79	-32.12	27	.00

Based on Table 5, the Sig value can be seen. Is 0.00. This value shows that the Sig value. More petite than 0.05 means H0 is rejected and HI is accepted. In other words, these results show a significant difference between students' scientific literacy skills before and after taking part in learning using the guided inquiry model.

Discussion

Literacy in science pertains to a student's ability to utilize scientific knowledge for questioning, acquiring new insights, explaining scientific phenomena, and drawing conclusions based on empirical evidence. More specifically, science literacy involves comprehending and applying science in everyday life. Understanding science is an essential basis for developing students' scientific literacy skills. A deep understanding of scientific concepts, processes, and the relevance of science in everyday life helps students become more skilled in reading, understanding, and interpreting scientific information (Widyatmoko et al., 2023). Overall, understanding science is a critical element in developing students' scientific literacy abilities. With a deep understanding of science, students can become critical readers, analytical thinkers, and actors who play a role in a society increasingly influenced by science and technology (Antara et al., 2023). In this study, the domain of science literacy comprises scientific knowledge, competencies, and the contextual aspects of science. Scientific knowledge or knowledge about science is a crucial component in efforts to increase students' scientific literacy. This includes understanding the concepts, theories, principles, facts, and scientific processes that are the basis of various fields of science (Pujawan et al., 2022). Thus, scientific knowledge becomes essential in developing students' scientific literacy.

Through a strong understanding of scientific concepts and processes, students can become critical readers, analytical thinkers, and actors who play a role in science and technology (Dewi et al., 2021). The guided inquiry model learning approach encourages students to hone their scientific abilities through structured and directed investigations (Irdalisa & Akbar, 2022). The guided inquiry model has proven effective in increasing students' scientific literacy by allowing them to be directly involved in the scientific process, developing research and critical thinking skills, and deepening their understanding of scientific concepts (Astalini et al., 2022). Dewi et al. (2020) assert that guided inquiry empowers students to engage actively and independently, fostering the generation of new ideas and thereby improving their science literacy skills. This aligns with a study by Sholahuddin et al. (2020) that found that guided inquiry effectively cultivates science literacy skills.

Ramdani et al. (2021) research indicates that the guided inquiry learning model elicits a more favorable response than conventional teaching methods. Students' responses to the inquiry learning model tend to be positive, with an increase in conceptual understanding, research skills, critical thinking abilities, learning motivation, involvement, communication skills, and problem-solving abilities. This shows that the inquiry model is a practical learning approach to improving student learning outcomes at various levels of education (Yustina et al., 2022). Similar findings are echoed in the study conducted by Nurlaila and Lufri (2021), where integrated learning with the guided inquiry model is shown to enhance science literacy skills in contrast to conventional teaching. The inquiry learning model provides students with a deep and meaningful learning experience, increasing their understanding of science concepts and developing research skills, critical thinking, engagement, motivation, knowledge retention, and the ability to transfer knowledge. All of these things contribute to better student learning outcomes in the long term (Winarto et al., 2022). This is attributed to the learning process using the guided inquiry model, which encourages students to actively work independently in seeking information or solving problems throughout the learning process, ultimately enhancing their science literacy skills.

Scientific literacy is a concept explained as the ability to use scientific knowledge, recognize relevant questions, and formulate conclusions based on existing facts and data to understand the universe and make decisions related to changes that occur. Meanwhile, PISA defines scientific literacy as the capacity to utilize scientific knowledge and scientific abilities, identify relevant questions, and formulate conclusions based on existing evidence and data to understand the natural world and assist decision-making in the context of human interaction with the natural environment (Wayne et al., 2024). The relationship between the inquiry learning model and scientific literacy can be confirmed through the OECD (2013) statement that the guided inquiry learning process is closely related to the scientific literacy competency framework. This scientific literacy competency includes explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence. Students' scientific literacy skills were observed before and after learning using a guided inquiry model about earthquakes and how to deal with them.

Figure 3 presents the improvement in student learning outcomes using the N-Gain formula. Based on the test results, an average N-Gain score of 93 was obtained, categorizing it as high. These findings demonstrate that the learning process utilizing the guided inquiry model effectively enhances science literacy. This aligns with

previous research conducted by Kahar et al. (2022), which concluded that implementing the guided inquiry model effectively improves students' mastery of science literacy. After knowing the increase in students' scientific literacy through N-gain, the next stage is to carry out a hypothesis test in the form of an average difference test. This test is used to determine the impact of the learning model on improving students' scientific literacy skills.

Scientific literacy skills have broad and essential relevance in various areas of life. In an era increasingly influenced by technology and science, having a deep understanding of science helps individuals face complex challenges, from environmental issues to advances in medical technology. Scientific literacy is also crucial in responding to global challenges, such as climate change and the health crisis, because it enables individuals to seek effective solutions. In addition, scientific literacy skills support the development of critical thinking abilities, active participation in public dialogue, and decision-making based on scientific evidence (Malik & Ubaidillah, 2021). In the world of work, scientific literacy is a valuable asset that can improve careers and an individual's ability to adapt quickly in an ever-changing environment. More than that, scientific literacy also encourages innovation, creativity, and the discovery of new solutions to face future challenges (Kharismayuni et al., 2021). Therefore, individuals must develop scientific literacy skills to compete and participate actively in this increasingly complex and dynamic society.

CONCLUSION

Fundamental Finding: The research results show that, in general, the guided inquiry learning model helps increase students' scientific literacy. Choosing a suitable learning model also influences the quality and learning outcomes significantly. Future research needs to pay attention to time efficiency, not overextending the learning process. **Implication:** These findings also have significant implications for guided inquiry learning. Increasing scientific literacy through applying the guided inquiry learning model shows its benefits in developing students' understanding of scientific concepts and skills. Therefore, teachers must consider integrating this learning model into their curriculum structure. In addition, positive feedback from students is emphasized as a crucial factor in creating a learning environment that encourages active participation and the ability to solve problems. Overall, this research highlights the need for education focusing on active exploration and problem-based learning to prepare students to face the complexity of an ever-evolving world. **Limitation**: This research shows that the guided inquiry learning model successfully improves students' scientific literacy skills, as evidenced by the high average N-Gain score. This shows that students have mastered the scientific literacy indicators taught in the learning process. **Future Research:** On the other hand, future research could investigate contextual variables and how they influence the success of the guided inquiry learning model in improving scientific literacy skills. Compared with alternative teaching approaches and models, conducting long-term evaluations and developing curricula are also essential aspects of research and worthy of consideration.

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