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Scientific Literacy Profile of Prospective Science Teacher Students

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ABSTRACT

Objective: This research aims to describe and analyze the scientific literacy achievements of prospective science teacher students. Scientific literacy is one of the skills that prospective science teacher students must master to promote scientific literacy at the primary and secondary education levels. **Method**: This research is a quantitative descriptive research. Data was collected using a purposive sampling technique so that a sample of 65 students from the Bachelor of Science Education Study Program at Ganesha University of Education was obtained. The research instrument used was the Test of Scientific Literacy Skills (TOSLS) which consisted of 28 multiple-choice questions. This research is a preliminary study of research and development (R&D) of innovative science learning models to increase students' scientific literacy. **Results**: The results of the research show that the literacy achievement of prospective science teacher students is very low with the scientific literacy achievement in the aspect of identifying and assessing inquiry methods that contribute to scientific knowledge at very low and the aspect of compiling, analyzing, and understanding quantitative data and scientific information of very low. **Novelty**: This research provides an overview of the scientific literacy achievements of prospective science teacher students which can be used as a basis for developing innovative science learning models to increase the scientific literacy of prospective science teacher students.

INTRODUCTION

Various complex problems as a result of the rapid development of science and technology in this era of globalization require everyone to master 21st-century skills. Scientific literacy is identified as one of the 21st-century science skills (Hanifha et al., 2023; Lu-ong, 2023) which is very important to master because society is often faced with various problems related to science and technology in daily life (Kelp et al., 2023). According to Nuangchalerm, et al. (2022), scientific literacy is not only related to reading or writing skills but also related to the skills of knowing and understanding science and being able to communicate science. Scientific literacy refers more to what scientific knowledge people must master to live more effectively and be responsible (Al Sultan et al., 2021). Scientific literacy is more focused on the application of knowledge and skills in various situations to make decisions and solve problems in everyday life (Husamah et al., 2022; Sholahuddin et al., 2021).

Scientific literacy is a socially constructed concept that changes according to context and time so scientific literacy has various meanings (Čipková et al., 2020). There is no universally accepted definition of scientific literacy to date (Wang et al., 2024). Scientific literacy is the knowledge and understanding of scientific concepts and processes necessary for personal decision-making, participation in civic and cultural

affairs, and economic productivity. The Program for International Student Assessment (PISA) define scientific literacy as a skill possessed by reflective citizen to engage in issue and ideas related to science (OECD, 2019). There are two main aspects of scientific literacy, including the ability to identify and assess inquiry methods that contribute to scientific knowledge; and the ability to compile, analyze, and understand quantitative data and scientific information. A scientifically literate person can participate in scientific discussions as demonstrated through three scientific literacy competencies, namely: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically (OECD, 2019).

The progress of a country is largely determined by the level of scientific literacy among its citizens. Scientific literacy provides a strong foundation of knowledge for the citizens of a country and is the foundation for the country's progress in various areas of life. By mastering scientific literacy, citizens have a wider opportunity to adapt (Adnan et al., 2021) and be more aware and informed so that it is easier and more effective to make personal decisions in everyday life (Kelp et al., 2023; Mahardika et al., 2022; Ploj Virtič, 2022) and can solve various problems related to science and technology (Kahar et al., 2022; Yuliana et al., 2021). The role of scientific literacy is so important that it has become the primary objective of science education reform in various countries (Chang et al., 2024; Forbes et al., 2020) as well as a measure of the quality of a given education country (Dewi et al., 2021). Balitikian et al. (2024) emphasized the increasing importance of scientific literacy in today's dynamic world, making it a top priority for science education reform. Educators also agree that scientific literacy must be fostered as early as possible through science education to create scientifically literate citizens in the future (Cansiz & Cansiz, 2019). The scientific literacy achievements of Indonesian students are still low (Adnan et al., 2021; Mahardika et al., 2022; Rusmansyah et al., 2023). From the PISA report, it can be seen that the scientific literacy achievements of Indonesian students are always below the average PISA score, with a ranking in the bottom 10 (Sholahuddin et al., 2021). PISA 2022 data shows that the scientific literacy ability of Indonesian students has decreased from 396 in 2018 to 383 in 2022 (OECD, 2023). The low achievement of students' scientific literacy shows that the quality of Indonesian education still needs to be improved.

Many factors influence students' low scientific literacy skills, one of which is the teacher factor. This is closely related to the role of teacher reform as an important element in education (Al Sultan et al., 2021) as well as an agent of change in society (Sholahuddin et al., 2021). Teachers are key agents in facilitating students to develop scientific literacy skills (Adnan et al., 2021; Pahrudin et al., 2019; Suwono et al., 2022). Therefore, science teachers must have good scientific literacy, which allows them to be strongly involved in developing their students' scientific literacy (Fakhriyah et al., 2019; Sargioti & Emvalotis, 2020; Stylos et al., 2022). Teachers must continue to develop and improve their abilities to increase students' scientific literacy in the future (Wahab et al., 2023).

Preparing prospective science teachers who are well-literate is the main task of higher education so that graduates can later create innovative learning that supports the development of students' scientific literacy. With this argument, assessing the extent of the scientific literacy achievements of prospective science teacher students is very important. Several studies on the profile of scientific literacy of prospective teacher students in various regions of Indonesia have been conducted, which overall show that

their literacy skills are still low. The scientific literacy achievements of prospective physics teachers in Lampung are still low and need to be improved (Pahrudin et al., 2019); the average scientific literacy of prospective biology teachers in Palembang is 39.67 in the very poor category (Antika & Marpaung, 2023); and the achievements the scientific literacy of prospective elementary education teacher students in the city of Malang is 45.28% in the very low category (Muslihasari et al., 2023).

The quality of science teaching has a significant impact on student performance, including their achievements in scientific literacy. Empirical studies of previous research show that students' low scientific literacy achievements are caused by science learning not being linked to real-life contexts and not starting from problems that exist in students' daily lives (Adnan et al., 2021). There are still many Biology teacher candidates who do not understand scientific concepts in depth (Antika & Marpaung, 2023). Meanwhile, AlAli & Wardat (2024) found that students already have sufficient theoretical skills and scientific concepts but still experience problems in explaining phenomena or problems well. The constructivism paradigm needs to be applied to increase students' scientific literacy (Adnan et al., 2021). Pahrudin et al. (2019) suggests getting students used to solving scientific literacy-based questions to develop the scientific literacy of prospective Physics teachers.

There has not been much research regarding the profile of scientific literacy among prospective science teacher students. Based on this explanation, this research aims to analyze the scientific literacy profile of prospective science teacher students. This research is very important to carry out as a basis for determining strategies for improving the quality of the learning process to increase the scientific literacy of prospective science teacher students. The results of this research contribute to providing valuable information regarding the literacy achievements of prospective science teacher students as a basis for consideration and contribution of thought to decision makers in an effort to improve the scientific literacy of prospective science teacher students.

RESEARCH METHOD

This research is quantitative descriptive research, namely a form of research that aims to explain or describe a condition as it is without manipulating or changing the independent variables. This research aims to describe the scientific literacy achievements of prospective science teacher students. The research is also preliminary research which aims to find the information needed to study problems properly (Wahab et al., 2023), especially those related to increasing the scientific literacy of prospective science teacher students. The research was carried out in the even semester of the 2022/2023 academic year at the Bachelor of Science Education Study Program, Ganesha Education University. The sampling technique used was purposive sampling to obtain a sample of 65 prospective science teacher students. The research flowchart is shown in Figure 1.

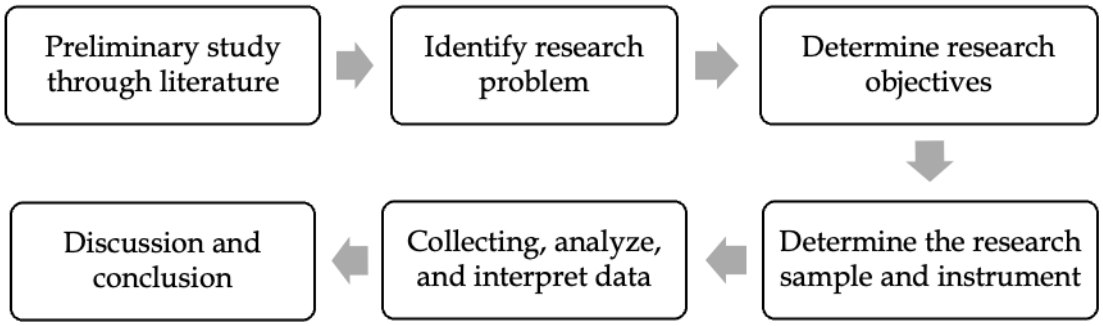

Figure 1. The research flowchart.

The instrument used to obtain student scientific literacy data is the Test of Scientific Literacy Skills (TOSLS), developed by Gormally et al. (2012), which consists of 28 multiple-choice questions. The results of the TOSLS trial conducted by Gormally et al. (2012) shows that TOSLS is valid and reliable as a scientific literacy diagnostic test. There are several considerations for using TOSLS as an appropriate instrument in this research, including TOSLS is easier to administer with coverage of literacy aspects that are considered broad, so it is suitable for use in various fields of science, and the results are more relevant to science education (Shaffer et al., 2019). TOSLS is also very adequate because its aim is not to assess the science content in a science course but rather to emphasize the application of scientific information and methods to solve the problems we face every day, so this test is very relevant to our understanding of scientific literacy (Čipková et al., 2020). The assessment of scientific literacy focuses more on two indicators: understanding inquiry methods that lead to scientific knowledge, which consists of four sub-indicators; and organizing, analyzing, and interpreting quantitative data and scientific information, which consists of five sub-indicators (Gormally et al., 2012). The indicators, sub-indicators, and question numbers used to measure each sub-indicator are shown in Table 1.

Table 1. Indicators and sub-indicators of the TOSLS Instrument (Gormally et al., 2012).

Indicator	Sub-Indicators	Question Number
A. Understand inquiry methods that lead to scientific knowledge	1. Identify valid scientific arguments.	1, 8, 11
	2. Evaluate the validity of the source.	10, 12, 17, 22, 26
	3. Evaluate the use and misuse of scientific information.	5, 9, 27
	4. Understand the elements of research design and how they influence scientific findings and conclusions.	4, 13, 14
B. Organize, analyze, and interpret quantitative data and scientific information	5. Create graphs as data representations.	15
	6. Read and interpret graphically represented data correctly.	2, 6, 7, 18
	7. Solve problems using quantitative skills, including probability and statistics.	16, 20, 23
	8. Understand and interpret basic statistics.	3, 19, 24
	9. Justify inferences, predictions, and conclusions based on quantitative data.	21, 25, 28

The test is carried out for 45 minutes in a classroom and is closely guarded. Students are not allowed to use any tools while taking the test. Students get a score of 1 if the

answer is correct and 0 if the answer is wrong or they do not answer. The scientific literacy scores obtained by students were then analyzed descriptively in a score range of 1–100 based on the following formula:

$$\text{Student's Scientific Literacy} = \frac{\text{Correct Answer Score}}{\text{Maximum Score}} \times 100$$

Students' scientific literacy achievements are grouped into several categories based on Arikunto's (2021) score interpretation criteria, namely very high (80–100), high (66–79), fair (56–65), low (40–55), and very low (30–39).

RESULTS AND DISCUSSION

Results

The scientific literacy achievements of prospective science teacher students were measured using the scientific literacy instrument developed by Gormally et al. (2012), which consists of 28 questions in multiple-choice form. The scientific literacy indicators measured are understanding inquiry methods that lead to scientific knowledge and interpreting quantitative data and scientific information. Each indicator consists of four sub-indicators and five sub-indicators. The scientific literacy achievements of prospective science teacher students for each indicator and sub-indicator are shown in Table 2.

Table 2. Recapitulation of scientific literacy achievements of science teacher prospective students.

Indicator	Sub-Indicator	Average Score For Each Sub-Indicator	Category
A. Understand inquiry methods that lead to scientific knowledge	1. Identify valid scientific arguments.	35.38	Very Low
	2. Evaluate the validity of the source.	30.15	Very Low
	3. Evaluate the use and misuse of scientific information.	47.18	Low
	4. Understand the elements of research design and how they influence scientific findings and conclusions.	38.46	Very Low
Average Indicator A		**37.79**	**Very Low**
B. Organize, analyze, and interpret quantitative data and scientific information	5. Create graphs as data representations.	43.08	Low
	6. Read and interpret graphically represented data correctly.	35.38	Very Low
	7. Solve problems using quantitative skills, including probability and statistics.	33.33	Very Low
	8. Understand and interpret basic statistics.	24.62	Very Low
	9. Justify inferences, predictions, and conclusions based on	26.15	Very Low

Indicator	Sub-Indicator	Average Score For Each Sub-Indicator	Category
	quantitative data.		
Average Indicator B		**32.51**	**Very Low**
Average Score		**34.40**	**Very Low**

Overall, the scientific literacy achievements of prospective science teacher students are in the very low category, with an average score of 34.40. Students' scientific literacy achievement in the indicator of understanding inquiry methods that lead to scientific knowledge was 37.79 in the very low category, and organizing, analyzing, and interpreting quantitative data and scientific information was 32.51 in the very low category. Students' scientific literacy achievements for each sub-indicator are shown in Figure 2.

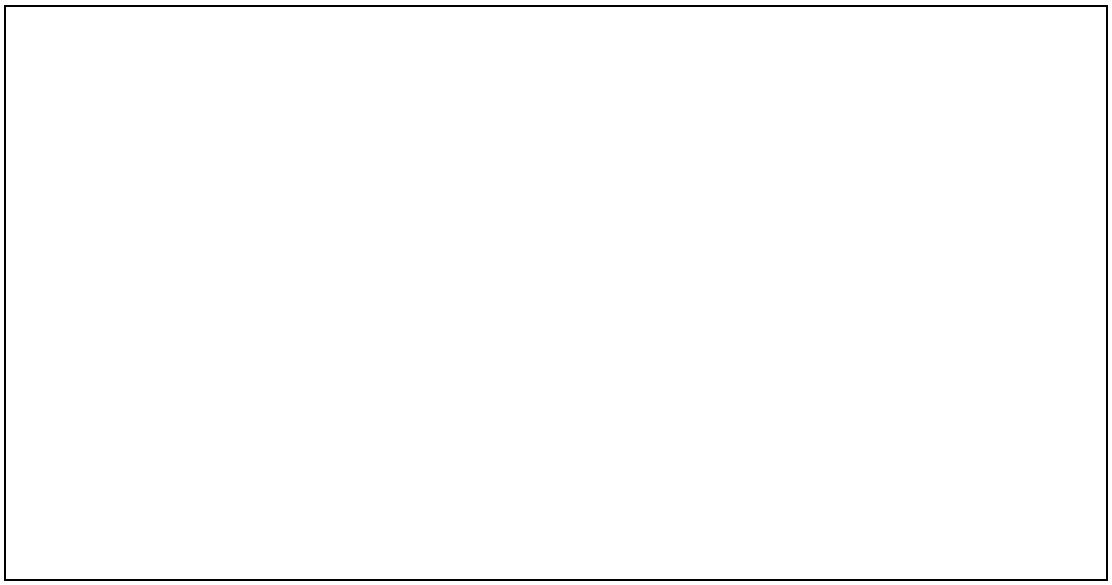

Figure 2. Scientific literacy profile of prospective science teacher students.

From Figure 1, it can be seen that the average score of students' scientific literacy achievement in all sub-indicators is below a score of 48 in the low and very low categories. Of the nine sub-indicators, only sub-indicator 3 (evaluating the use and misuse of scientific information) and sub-indicator 5 (making graphs to represent data) are in the low category, while the other seven sub-indicators are in the very low category or below a score of 40. Achievement of student scientific literacy The lowest science teacher candidate occurred in sub-indicator 8 (understanding and interpreting basic statistics) at 24.62 in the very low category, and the highest scientific literacy achievement occurred in sub-indicator 3 (evaluating the use and misuse of scientific information) at 47.18 in the low category.

Discussion

The scientific literacy achievements of prospective science teacher students were measured using the TOSLS instrument developed by Gormally et al. (2012), which focused on two aspects (indicators), namely understanding inquiry methods that lead to scientific knowledge and organizing, analyzing, and interpreting quantitative data

and scientific information. There are nine components (sub-indicators) assessed in this instrument, as listed in Table 1.

The results of the descriptive data analysis show that the scientific literacy achievements of prospective science teacher students at Ganesha University of Education are still very low, with an average score of 34.40. This finding is in line with the findings of previous research, including that the average scientific literacy of prospective biology teacher students in Palembang is 38.67 in the very poor category (Antika & Marpaung, 2023) and the scientific literacy of prospective elementary education teacher students in Malang is still low with an average of 45.28% (Muslihasari et al., 2023). The scientific literacy abilities of prospective elementary education teacher students in Tuban are in a low category with scientific literacy achievements of less than 50% on all indicators. The results of this research are also supported by research conducted by Firdaus et al. (2023), which states that the scientific literacy abilities of prospective biology teacher students in Mataram are generally still low, and the scientific literacy achievements of prospective physics teacher students in Lampung are still not satisfactory and therefore need to be improved (Pahrudin et al., 2019).

The scientific literacy achievements of prospective science teacher students on the indicator of understanding inquiry methods that lead to scientific knowledge are still very low. This indicator is closely related to students' ability to carry out scientific criticism of experiments, data, and results to make decisions about unstructured problems that are common in science or the ability to analyze the strength of arguments based on evidence (Gormally et al., 2012) and basic skills that are necessary for a comprehensive understanding of scientific inquiry techniques and their application (Lu-ong, 2023). The low literacy achievement of students in understanding inquiry methods that lead to scientific knowledge shows that students are still unable to identify valid scientific arguments (very low), are still weak in evaluating the validity of sources (very low), are still unable to evaluate the use and misuse of scientific information (low), and do not understand the elements of research design and how they influence scientific findings and conclusions (very low). The low achievement of students' scientific literacy on the indicator of understanding inquiry methods that lead to scientific knowledge is supported by findings from Muslihasari et al. (2023), Antika & Marpaung (2023), and Adnan et al. (2021).

Students' scientific literacy achievements in the indicators of organizing, analyzing, and interpreting quantitative data and scientific information are also still in the very low category. The low achievement of students' scientific literacy on this indicator shows that students are not yet skilled in making graphs as data representations (low), are not skilled at reading and interpreting graphically represented data correctly (very low), are not yet able to solve problems using quantitative skills, including probability and statistics (very low), are still weak in understanding and interpreting basic statistics (very low), and are still having difficulty justifying inferences, predictions, and conclusions based on quantitative data (very low). These findings are in line with the results of research from Firdaus et al. (2023), namely that students are weak in the aspects of creating tables or graphs, justifying conclusions, predictions, and conclusions based on quantitative data, and solving problems using quantitative skills (including probability and statistics). This finding was confirmed by Muslihasari et al. (2023) and Antika & Marpaung (2023), who found that literacy achievement in the aspects (sub-indicators) assessed in the indicator of organizing, analyzing, and interpreting

quantitative data and scientific information was limited to the low and very low categories. Of the nine sub-indicators, the lowest scientific literacy achievement for prospective science teacher students occurred in the sub-indicator of understanding and interpreting basic statistics, with an average score of 24.63 (very low).

The low scientific literacy achievements of prospective science teacher students are closely related to the ongoing learning process, which has not supported the development of aspects of scientific literacy. Science learning that is only oriented toward the general context listed in textbooks or is only content-based (Sholahuddin et al., 2021; Zulirfan et al., 2023) and is not linked to real-life contexts (Adnan et al., 2021) causes students' weak understanding of inquiry methods and students' low ability to organize, analyze, and interpret quantitative data and scientific information. Due to the demands of exams that are only based on curriculum standards, lecturers tend to focus more on instilling scientific knowledge and rote learning (Wang et al., 2024). The absence of a clear connection between the material studied in class and real problems developing in society, including community culture, has an impact on students' low scientific literacy achievements (Chen & Liu, 2018; Ratini et al., 2018). The disconnection of material with environmental phenomena also causes students to have difficulty solving complex problems because complex problems cannot be separated from critical thinking and problem-solving skills (Fakhriyah et al., 2019).

The use of inappropriate learning models also has an impact on students' low scientific literacy achievements. As stated by Sholahuddin et al. (2023) the use of inappropriate learning strategies results in students' scientific literacy not being properly trained. The learning model applied so far has only focused on developing cognitive (textual) abilities (Sholahuddin et al., 2021). Teaching methods are still teacher-centered, so science learning becomes less meaningful (Nasor et al., 2023). The learning process begins with a material presentation and continues with class discussion. The lecturers presented several examples of problems in society related to science, but students were not encouraged to investigate until they found solutions to these problems (Sholahuddin et al., 2021).

Students are also not yet trained to solve problems based on scientific literacy. Students' ability to solve problems based on scientific literacy is very dependent on the ability of lecturers to facilitate learning in class (Adnan et al., 2021), namely by training students to solve problems based on scientific literacy (Wahab et al., 2023). Unfortunately, most of the problems given by lecturers so far have not been based on scientific literacy, so students are not used to solving problems based on scientific literacy (Fuadi et al., 2020). To increase students' scientific literacy, constructivist learning principles must be applied in the classroom (Adnan et al., 2021; Lu-ong, 2023). Scientific inquiry has become a fundamental aspect of science education reform worldwide (Teig, 2024). The inquiry-based learning model is a student-centered learning model that is widely applied to increase students' scientific literacy (Suwono et al., 2022). The inquiry-based learning model can create a dynamic learning environment that can increase students' understanding of scientific principles (Alqawasmi et al., 2024) and students are actively involved in authentic research cycles (Meulenbroeks et al., 2024). Adnan et al. (2021) emphasize that inquiry methods supported by innovative media and learning resources can increase students' scientific literacy. With inquiry-

based learning, students become more skeptical because they build new knowledge actively through group discussion activities (Wiyarsi et al., 2021). Several empirical studies have proven the effectiveness of inquiry-based learning to increase scientific literacy at various levels of education (Aditomo & Klieme, 2020; Adnan et al., 2021; Romero-Ariza et al., 2020; Suwono et al., 2022; Wang et al., 2022).

Contextual learning is a learning method that can develop students' scientific literacy by highlighting various scientific contexts and issues in the surrounding environment (Wahab et al., 2023). Learning scientific concepts in local culture and environment provides a more relevant and meaningful learning experience for students (Verawati & Wahyudi, 2024). Science learning in a popular context that is close to students' lives can increase scientific literacy (Zulirfan et al., 2023). One way is to learn science in a local cultural context. The cultural background of students or the community where the school is located greatly influences the learning process in the classroom (Lasmana, 2024). Integrating locally based knowledge in science learning allows students to interact with scientific inquiry (Uslan et al., 2024). Optimal use of local cultural traditions in the context of science teaching will make it easier for students to connect the science they learn in the classroom with what they see in everyday life (Chen & Liu, 2018), and science learning will become very interesting and personally relevant for students (Zidny & Eilks, 2022). Various empirical studies have shown that culture-based science learning has a positive impact on the development of students' scientific literacy (Dewi et al., 2019; Dewi et al., 2021; Heliawati et al., 2022; Yuliana et al., 2021; Zidny & Eilks, 2022). Thus, an inquiry-based learning model that utilizes local culture as a context for science learning will be more effective in increasing students' scientific literacy.

CONCLUSION

Fundamental Finding : The research results show that the literacy achievement of prospective science teacher students is very low, with scientific literacy achievement in the aspect of identifying and assessing inquiry methods that contribute to scientific knowledge of very low and the aspect of compiling, analyzing, and understanding quantitative data and scientific information of very low. Efforts to increase the scientific literacy of prospective science teacher students are very important. **Implication :** The low scientific literacy achievements of prospective science teacher students are caused by several factors, including the implementation of inappropriate learning models so that they do not facilitate the development of students' scientific literacy; local culture has not been utilized as a context for science learning, so that science learning has become less contextual; and there has been no training in problem-solving based on scientific literacy. **Limitation :** This research is limited to describing and analyzing the scientific literacy achievements of prospective science teacher students based on the TOSLS scientific literacy test with two scientific literacy indicators, namely understanding inquiry methods that lead to scientific knowledge and organizing, analyzing, and interpreting quantitative data and scientific information. **Future Research :** The research findings are useful for other researchers in determining interventions that should be implemented to train various aspects of scientific literacy and can be used as a basis for developing an innovative science learning model that can improve students' scientific literacy as a whole.

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REFERENCES

Aditomo, A., & Klieme, E. (2020). Forms of inquiry-based science instruction and their relations with learning outcomes: evidence from high and low-performing education systems. *International Journal of Science Education*, *42*(4), 1-10. https://doi.org/10.1080/09500693.2020.1716093

Adnan, Mulbar, U., Sugiarti, & Bahri, A. (2021). Scientific literacy skills of students: Problem of biology teaching in junior high school in south sulawesi, indonesia. *International Journal of Instruction*, *14*(3), 847–860. https://doi.org/10.29333/iji.2021.14349a

Al Sultan, A., Henson, H., & Lickteig, D. (2021). Assessing preservice elementary teachers' conceptual understanding of scientific literacy. *Teaching and Teacher Education*, *102*, 1-23. https://doi.org/10.1016/j.tate.2021.103327

AlAli, R., & Wardat, Y. (2024). Low PISA performance students: Factors, perceptions, and improvement strategies. *International Journal of Religion*, *5*(9), 334–348. https://doi.org/10.61707/nve8gj33

Alqawasmi, A., Alsalhi, N. R., & Al Qatawneh, S. S. (2024). The influence of utilizing inquiry-based learninstrategy on science accomplishment of primary students' stage. *International Journal of Interactive Mobile Technologies*, *18*(5), 62–76. https://doi.org/10.3991/ijim.v18i05.47011

Antika, R. N., & Marpaung, R. R. T. (2023). Profil literasi sains dan literasi digital mahasiswa universitas muhammadiyah palembang. *Oryza (Jurnal Pendidikan Biologi)*, *12*(1), 59–68. https://doi.org/10.33627/oz.v12i1.1051

Arikunto, S. (2021). *Dasar-dasar evaluasi pendidikan edisi 3*. Bumi aksara.

Baltikian, M., Kärkkäinen, S., & Kukkonen, J. (2024). Assessment of scientific literacy levels among secondary school students in Lebanon: Exploring gender-based differences. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(3), 23-37. https://doi.org/10.29333/ejmste/14279

Cansiz, M., & Cansiz, N. (2019). Reconceptualizing and field testing the scientific literacy framework by exploring the aspect of scientific literacy in Turkish science curriculum. *Journal of Baltic Science Education*, *18*(5), 681–691. https://doi.org/10.33225/jbse/19.18.681

Chang, T. C., Lyu, Y. M., Wu, H. C., & Min, K. W. (2024). Introduction of taiwanese literacy-oriented science curriculum and development of an aligned scientific literacy assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(1), 111-129. https://doi.org/10.29333/ejmste/13930

Chen, S. Y., & Liu, S. Y. (2018). Reinforcement of scientific literacy through effective argumentation on an energy-related environmental issue. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(12), 1-10. https://doi.org/10.29333/ejmste/95171

Čipková, E., Karolčík, Š., & Scholzová, L. (2020). Are secondary school graduates prepared for the studies of natural sciences?–evaluation and analysis of the result of scientific literacy levels achieved by secondary school graduates. *Research in Science and Technological Education*, *38*(2), 146–167. https://doi.org/10.1080/02635143.2019.1599846

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 279–287. https://doi.org/10.15294/jpii.v8i2.19261

Dewi, C. A., Erna, M., Martini, M., Haris, I., & Kundera, I. N. (2021). Effect of contextual collaborative learning based ethnoscience to increase student's scientific literacy ability. *Journal of Turkish Science Education*, *18*(3), 525–541. https://doi.org/10.36681/tused.2021.88

Fakhriyah, F., Masfuah, S., & Mardapi, D. (2019). Developing scientific literacy-based teaching materials to improve students' computational thinking skills. *Jurnal Pendidikan IPA Indonesia*, *8*(4), 482–491. https://doi.org/10.15294/jpii.v8i4.19259

Firdaus, L., Ibrohim, I., Lestari, S. R., Masiah, M., Primawati, S. N., & Hunaepi, H. (2023). Quantitative study on the scientific literacy skills of prospective biology teachers. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 80–86. https://doi.org/10.29303/jppipa.v9i1.1891

Forbes, C. T., Neumann, K., & Schiepe-Tiska, A. (2020). Patterns of inquiry-based science instruction and student science achievement in PISA 2015. *International Journal of Science Education*, *42*(5), 1-10. https://doi.org/10.1080/09500693.2020.1730017

Fuadi, H., Robbia, A. Z., Jamaluddin, J., & Jufri, A. W. (2020). Analisis faktor penyebab rendahnya kemampuan literasi sains peserta didik. *Jurnal Ilmiah Profesi Pendidikan*, *5*(2), 108–116. https://doi.org/10.29303/jipp.v5i2.122

Gormally, C., Brickman, P., & Lut, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. *CBE Life Sciences Education*, *11*(4), 364–377. https://doi.org/10.1187/cbe.12-03-0026

Hanifha, S., Erna, M., Noer, A. M., & Talib, C. A. (2023). Socioscientific issue-based undergraduate student worksheets on scientific literacy and environmental awareness. *Jurnal Pendidikan IPA Indonesia*, *12*(4), 504–513. https://doi.org/10.15294/jpii.v12i4.45817

Heliawati, L., Lidiawati, L., Adriansyah, P. N. A., & Herlina, E. (2022). Ethnochemistry-based adobe flash learning media using indigenous knowledge to improve students' scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 271–281. https://doi.org/10.15294/jpii.v11i2.34859

Husamah, H., Suwono, H., Nur, H., & Dharmawan, A. (2022). The development and validation of environmental literacy instrument based on spirituality for prospective science teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(12), 260-280. https://doi.org/10.29333/EJMSTE/12732

Kahar, M. S., Susilo, Abdullah, D., & Oktaviany, V. (2022). The effectiveness of the integrated inquiry guided model stem on students scientific literacy abilities. *International Journal of Nonlinear Analysis and Applications*, *13*(1), 1667–1672. https://doi.org/10.22075/IJNAA.2022.5782

Kelp, N. C., McCartney, M., Sarvary, M. A., Shaffer, J. F., & Wolyniak, M. J. (2023). Developing science literacy in students and society: Theory, research, and practice. *Journal of Microbiology & Biology Education*, *24*(2), 1–14. https://doi.org/10.1128/jmbe.00058-23

Kembara, M. D., Hanny, R., Gantina, N., & Kusumawati, I. (2020). Scientific literacy profile of student teachers on science for all context. *Solid State Technology*, *63*(6), 1–14.

Lasmana, O. (2024). Exploring local wisdom through project-based learning: A case study of the application of ethnoscience models. *Chelonian Conservation And Biology*, *19*(1), 1–8.

Lu-ong, A. L. (2023). Evaluating the scientific literacy skills of undergraduate biology students. *Psych Educ*, *15*(7), 712–720. https://doi.org/10.5281/zenodo.10371373

Mahardika, A. I., Arifuddin, M., Alkaf, N., Saputra, B., Hayati, M., & Nicosia, N. (2022). The effectiveness of wetland environment static fluid e-module to train learners' science literacy. *Cypriot Journal of Educational, 17*(12), 4556–4569. http://dx.doi.org/10.18844/cjes.v17i12.8190

Meulenbroeks, R., van Rijn, R., & Reijerkerk, M. (2024). Fostering secondary school science students' intrinsic motivation by inquiry-based learning. *Research in Science Education*, *54*(3), 339–358. https://doi.org/10.1007/s11165-023-10139-0

Muslihasari, A., Susilo, H., Ibrohim, & Lukiati, B. (2023). *The scientific literacy's profile of primary education's teacher candidates*. Atlantis Press SARL. https://doi.org/10.2991/978-2-38476-072-5_41

Nasor, A., Lutfi, A. L., & Prahani, B. K. (2023). Science literacy profile of junior high school students on context, competencies, and knowledge. *IJORER : International Journal of Recent Educational Research*, *4*(6), 847–861. https://doi.org/10.46245/ijorer.v4i6.436

Nuangchalerm, P., El Islami, R. A. Z., & Prasertsang, P. (2022). Science Attitude on environmental conservation of thai and indonesian novice science teacher students. *International Journal of STEM Education for Sustainability*, *2*(2), 148–155. https://doi.org/10.53889/ijses.v2i2.62

OECD. (2019). *PISA 2018 assessment and analytical framework*. OECD Publishing.

OECD. (2023). *Equity in education in PISA 2022*. OECD Publishing.

Pahrudin, A., Irwandani, Triyana, E., Oktarisa, Y., & Anwar, C. (2019). The analysis of pre-service physics teachers in scientific literacy: Focus on the competence and knowledge aspects. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 52–62. https://doi.org/10.15294/jpii.v8i1.15728

Ploj Virtič, M. (2022). Teaching science & technology: Components of scientific literacy and insight into the steps of research. *International Journal of Science Education*, *44*(12), 1916–1931. https://doi.org/10.1080/09500693.2022.2105414

Ratini, Muchtar, H., Suparman, M. A., Tamuri, A. H., & Susanto, E. (2018). The influence of learning models and learning reliance on students' scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 458–466. https://doi.org/10.15294/jpii.v7i4.12489

Romero-Ariza, M., Quesada, A., Abril, A. M., Sorensen, P., & Oliver, M. C. (2020). Highly recommended and poorly used: English and spanish science teachers' views of inquiry-based learning (IBL) and its enactment. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(1), 1–16. https://doi.org/10.29333/ejmste/109658

Rusmansyah, R., Leny, L., & Sofia, H. N. (2023). Improving students' scientific literacy and cognitive learning outcomes through ethnoscience-based PjBL Model. *Journal of Innovation in Educational and Cultural Research*, *4*(1), 1–9. https://doi.org/10.46843/jiecr.v4i1.382

Sargioti, A., & Emvalotis, A. (2020). Attitudes towards science and the impact of epistemic beliefs on pre- service primary teachers ' scientific literacy. *Educational*

Journal of the University of Patras UNESCO Chair, *7*(1), 174–189. http://dx.doi.org/10.26220/une.3239

Shaffer, J. F., Ferguson, J., & Denaro, K. (2019). Use of the test of scientific literacy skills reveals that fundamental literacy is an important contributor to scientific literacy. *CBE Life Sciences Education*, *18*(3), 60-69. https://doi.org/10.1187/cbe.18-12-0238

Sholahuddin, A., Anjuni, N., & Faikhamta, C. (2023). Project-based and flipped learning in the classroom: A strategy for enhancing students' scientific literacy. *European Journal of Educational Research*, *12*(1), 239-251. http://dx.doi.org/10.12973/eu-jer.12.1.239

Sholahuddin, A., Susilowati, E., Prahani, B. K., & Erman, E. (2021). Using a cognitive style-based learning strategy to improve students' environmental knowledge and scientific literacy. *International Journal of Instruction*, *14*(4), 791–808. https://doi.org/10.29333/iji.2021.14445a

Stylos, G., Siarka, O., & Kotsis, K. T. (2022). Assessing greek pre-service primary teachers' scientific literacy. *European Journal of Science and Mathematics Education*, *11*(2), 271–282. https://doi.org/10.30935/scimath/12637

Suwono, H., Maulidia, L., Saefi, M., Kusairi, S., & Yuenyong, C. (2022). The development and validation of an instrument of prospective science teachers' perceptions of scientific literacy. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(1), 211-231. https://doi.org/10.29333/EJMSTE/11505

Teig, N. (2024). Uncovering student strategies for solving scientific inquiry tasks: Insights from student process data in PISA. *Research in Science Education*, *54*(2), 205–224. https://doi.org/10.1007/s11165-023-10134-5

Uslan, Abdullah, N., Imami, M. K. W., & Aiman, U. (2024). The effectiveness of the local knowledge-based module (LKBM) to improve students' scientific literacy and thinking skills. *Jurnal Pendidikan IPA Indonesia*, *13*(1), 147–161. https://doi.org/10.15294/jpii.v13i1.47561

Verawati, N. N. S. P., & Wahyudi, W. (2024). Raising the issue of local wisdom in science learning and its impact on increasing students' scientific literacy. *International Journal of Ethnoscience and Technology in Education*, *1*(1), 42-55. https://doi.org/10.33394/ijete.v1i1.10881

Wahab, M. N. N. D., Wasis, W., & Yuliani, Y. (2023). Profile of junior high school students' scientific literacy. *IJORER: International Journal of Recent Educational Research*, *4*(2), 176–187. https://doi.org/10.46245/ijorer.v4i2.292

Wang, H. H., Hong, Z. R., She, H. C., Smith, T. J., Fielding, J., & Lin, H. shyang. (2022). The role of structured inquiry, open inquiry, and epistemological beliefs in developing secondary students' scientific and mathematical literacies. *International Journal of STEM Education*, *9*(1), 1-11. https://doi.org/10.1186/s40594-022-00329-z

Wang, L., Yuan, Y., & Wang, G. (2024). The construction of civil scientific literacy in china from the perspective of science education. *Science and Education*, *33*(1), 249–269. https://doi.org/10.1007/s11191-022-00367-7

Wiyarsi, A., Prodjosantoso, A. K., & Nugraheni, A. R. E. (2021). Promoting students' scientific habits of mind and chemical literacy using the context of socio-scientific issues on the inquiry learning. *Frontiers in Education*, *6*, 1–12. https://doi.org/10.3389/feduc.2021.660495

Yuliana, I., Cahyono, M. E., Widodo, W., & Irwanto, I. (2021). The effect of ethnoscience-themed picture books embedded within contextbased learning on students'

scientific literacy. *Eurasian Journal of Educational Research*, 317–334. https://doi.org/10.14689/ejer.2021.92.16

Zidny, R., & Eilks, I. (2022). Learning about pesticide use adapted from ethnoscience as a contribution to green and sustainable chemistry education. *Education Sciences*, *12*(4), 1-12. https://doi.org/10.3390/educsci12040227

Zulirfan, Z., Yennita, Y., Maaruf, Z., & Sahal, M. (2023). Ethnoscientific literacy in Pacu Jalur tradition: Can students connect science with their local culture? *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(1), 1-11. https://doi.org/10.29333/ejmste/12773

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