An analysis of primary school students' scientific literacy

Nur Indah Ririn Fitriani Nasir[1], Endang Purwaningsih[1,*], Ratna Ekawati[1], Tomás de Aquino Caluyua Yambi[2]

[1]Universitas Negeri Malang, Indonesia
[2]Institute of Higher Educational Sciences of Huíla, Angola

Abstract: The study aims to analyze the scientific literacy skills of elementary school students. In addition, differences in scientific literacy based on gender were also examined in this study. The study is quantitative and measures students' scientific literacy. Researchers investigated the literacy profile of sixth-grade students in one of the primary schools in Malang City. The target population was 107 sixth-grade students. The sampling technique was saturated, and the population was included in the sample. Data were collected using ten multiple-choice tests. The findings were analyzed by calculating the results of the validity and reliability tests, percentages, mean, and the Mann-Whitney test to calculate the differences in scientific literacy of boys and girls. The results showed that ten items were valid (sig. <0.05), and the reliability was 0.72. The results of the study showed that the less category dominated students' scientific literacy, while only 2.80% achieved excellence. The average total scientific literacy of students was less (45.51). There is no difference in the scientific literacy of girls and boys. It can be concluded from this study that the scientific literacy skills of sixth-grade primary school students are lacking but do not show significant differences between boys and girls. The results of this research are the basis for developing students' scientific literacy in the future by creating appropriate learning.

Keywords: Appropriate learning, conclusion, interpreting, our earth

Abstrak: Penelitian ini bertujuan untuk menganalisis kemampuan literasi sains siswa sekolah dasar. Selain itu, perbedaan literasi sains berdasarkan gender juga diperiksa dalam penelitian ini. Penelitian ini bersifat kuantitatif dan mengukur literasi sains siswa. Peneliti menyelidiki profil literasi siswa kelas enam di salah satu sekolah dasar di Kota Malang. Populasi sasaran adalah 107 siswa kelas enam. Teknik pengambilan sampel jenuh, dan populasi dimasukkan ke dalam sampel. Data dikumpulkan dengan menggunakan sepuluh tes pilihan ganda. Temuan dianalisis dengan menghitung hasil uji validitas dan reliabilitas, persentase, rata-rata, dan uji Mann-Whitney untuk menghitung perbedaan literasi sains anak laki-laki dan perempuan. Hasil penelitian menunjukkan bahwa kategori kurang mendominasi literasi sains siswa, sementara hanya 2.80% yang mencapai sangat baik. Rata-rata total literasi sains siswa adalah kurang (45,51). Tidak ada perbedaan literasi sains anak perempuan dan laki-laki. Dari penelitian ini dapat disimpulkan bahwa keterampilan literasi sains siswa sekolah dasar kelas VI masih kurang namun tidak menunjukkan perbedaan yang signifikan antara siswa laki-laki dan perempuan. Hasil penelitian ini menjadi dasar untuk mengembangkan literasi sains siswa di masa mendatang dengan menciptakan pembelajaran yang tepat.

Kata kunci: Pembelajaran yang tepat, kesimpulan, penafsiran, bumi kita

INTRODUCTION

Scientific literacy is a critical skill that students must possess in order to effectively apply science (Suryani et al., 2017). These skills are a primary need for students in the 21st century (Deming et al., 2012). Scientific literacy is applied to define phenomena scientifically (Afriana et al., 2016). It pertains to how students apply their knowledge to generate a novel concept or idea for a problem in a scientific way (Wulandari & Sholihin,

2016). Scientific literacy enables students to create procedures based on their conducted investigations (Irmita & Atun, 2018). The application of scientific literacy in primary schools aims to equip students with 21st-century competencies, enabling them to solve problems and develop competitive, innovative, creative, collaborative, and character-based personalities (Martiasari et al., 2022). Based on the opinions of these researchers, scientific literacy is critical for students to apply science effectively, define phenomena, and create new ideas. It prepares students for 21st-century competencies, encouraging competitive, innovative, and creative problem-solving.

Scientific literacy is one of several forms of literacy, including written, numerical, and digital literacy (Adolphus et al., 2012). It is essential to master because it can direct individuals in personal decision-making and participation in society, interpersonal relations, culture, economic productivity, and civil affairs. Scientific literacy in science learning should be trained so that students utilize scientific knowledge in real situations. Students' inadequate scientific literacy abilities may result from traditional science instructional practices that overlook the significance of scientific understanding as an essential competency for students. Students are habituated to just completing tables supplied by the instructor, restricting their capacity to analyze graphs and tables (Martiasari et al., 2022). Factors contributing to diminished scientific literacy in students include textbook selection, misunderstandings, students' reading proficiency, and non-contextual learning (Fuadi et al., 2020).

Scientific literacy is closely related to students' understanding of the environment, nature, and surroundings (Chasanah et al., 2022). It is crucial in determining a country's education quality (Fu'adah et al., 2017). According to data from the Trends in International Mathematics and Science Study (TIMSS), the science literacy scores of Indonesian students in 1999, 2003, 2007, 2011, and 2015 were 492, 510, 471, 426, and 397, respectively. Scientific literacy is one of the most important 21st-century skills. Therefore, it is the main focus of 21st-century learning (Rusilowati, 2018) revealed that science instructors still do not seem to have a comprehensive knowledge of the science learning processes that foster students' scientific literacy. The educational methods and assessment instruments remain traditional and focused on conceptual understanding, resulting in students lacking proficiency in scientific literacy skills.

Scientific literacy is a critical 21st-century skill for learners to apply science effectively (Astuti et al., 2012). It is necessary for students to compete in the modern era. In addition, it prepares students to face the development of the era with the life skills they have. Learning allows for the training and developing scientific literacy skills (Almiasih et al., 2022). It is how individuals have to understand a scientific phenomenon and identify issues in order to acquire new knowledge to explain it, make conclusions based on scientific evidence, and have sensitivity to themselves and their environment (Rahmadani et al., 2018).

Science learning in primary schools will be meaningful if it implements learning that can develop knowledge and abilities to apply knowledge to face problems in life (Almiasih et al., 2022). One of the science materials taught to primary school students is Let's Get to Know Our Earth. This material teaches students about the structure of the earth and the phenomena that result from changes in this structure, including earthquakes, volcanic eruptions, the water cycle, and landslides. The Let's Get to Know Our Earth material

introduces students to the various forms of the earth, enabling them to explain how rain occurs (Kamila & Sukartono, 2023). However, there is still a need to enhance scientific literacy concerning earthquakes (Fadilah et al., 2020). Explaining phenomena due to changes in the earth's structure requires scientific literacy skills.

Science is a subject that has been taught since primary school, which introduces everything that happens in the universe through various methods, namely observing, observing, and conveying the results of observations that have been made (Darmayanti et al., 2022). Learning science involves acquiring knowledge and focusing on processes, cultivating scientific attitudes, and enhancing scientific literacy skills (Almiasih et al., 2022). The goal of teaching scientific literacy in primary school is to give students the knowledge and understanding of scientific ideas and processes they need to be active members of society in the digital age. Students are required to recognize and resolve any challenges faced in their daily learning experiences (Martiasari et al., 2022).

The development of students' scientific literacy skills is impacted by how these skills are taught in science classes (Chang et al., 2024; Iddy et al., 2024; Lestari et al., 2023). A study conducted in Lebanon showed that students' scientific literacy was low (Baltikian et al., 2024). In their research, Iddy et al. (2024) explained that the scientific literacy gap in Tanzania can be improved with teaching practices that train scientific literacy. Another study by Archer-Bradshaw (2017) found that traditional science teaching practices have led to a decline in students' scientific literacy skills in Barbados. Based on PISA 2022 data, Indonesian students' scientific literacy score is 383 (OECD, 2023), down 13 points from 396 in 2018. Meanwhile, the target of the RPJMN (National Medium-Term Development Plan-*Rencana Pembangunan Jangka Menengah Nasional*) is 402 (Napitupulu, 2023). Research by Ristanto et al. (2017) shows that the scientific literacy skills of Indonesian students in the domains of content, context, and competence are still inadequate. These skills in PISA decreased because students had difficulty reading and understanding the contents of the material more accurately and precisely (Fitriani et al., 2018).

Gender factors also influence students' low scientific literacy (Archer-Bradshaw, 2017; Tsoumanis et al., 2024). Other researchers have shown that gender differences contribute to differences and similarities in scientific literacy skills. For example, Mukti et al. (2019) explained that girls are more dominant in scientific literacy than boys. However, Hardinata et al. (2019) found no difference between the two genders regarding scientific literacy. Kristyasari et al. (2018) elucidated that boys primarily dominate the scientific literacy indicator associated with making conclusions, whereas girls outnumber them in other indicators. Stahl et al. (2023) explained that gender inequality persists in the fields of science and literacy education, so in the future, it is necessary to study scientific literacy related to gender.

Based on the explanation that has been presented, it is revealed that the scientific literacy of primary school students still needs to be investigated. Investigation of the scientific literacy abilities of primary school students is important because it is the basis for teachers to create appropriate solutions. Thus, this research aims to assess the scientific literacy abilities of primary school students. This study also examined differences in scientific literacy based on gender.

METHOD

The research is a quantitative type through the process of measuring students' scientific literacy. The researcher conducted an investigation to find the literacy profile of primary school students in one of the cities in Malang. The target population is 107 sixth-grade students. They are students who have learned about "let's get to know our earth". The research sample was determined using saturated sampling. The technique is used because students in the population are all samples. Table 1 is the sample distribution in this research.

Table 1. Gender profile of sampels

Gender	Girls	64	59.81
	Boys	43	40.19
Total		107	100

The research was conducted through several stages, namely:

First, questions were compiled to measure students' scientific literacy. Ten questions were compiled. The indicators of scientific literacy are based on the OECD (2023), namely: describing, explaining, and predicting scientific phenomena (SL-1) with as many as four questions; understanding scientific investigations (SL-2) with as many as two questions; and interpreting scientific evidence and conclusions (SL-3) as many as four questions. Figure 1 is an example of the questions used.

The following image shows the structure of a volcano.
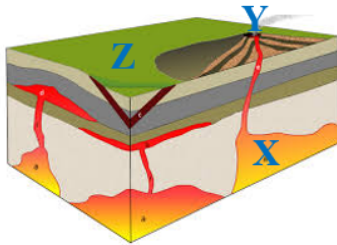
Based on the image above, predict the natural phenomena that will occur at the volcano above if the area marked X occurs when the earth's plates collide!

a. If there is a collision of earth plates in area **X**, then a magma intrusion will occur, where the magma will move to reach the earth's surface (Area **Y**) and a volcanic eruption will occur.

b. If there is a collision of earth plates in area **X**, magma extrusion will occur, where the magma will move on the surface of the earth (Area **X**) and a volcanic eruption will occur.

c. If there is a collision of earth plates in area **X**, magma extrusion will occur, where the magma will move to reach the earth's surface (Area **Y**) and a volcanic eruption will occur.

d. If there is a collision of earth plates in area **X**, then magma intrusion will occur, where the magma will move on the surface of the earth (Area **X**) and a volcanic eruption will occur.

Fig. 1. Examples of scientific literacy questions

The questions that have been created are validated by 1 expert and 1 practitioner. The results of the expert assessment show that the questions are valid, while the practitioner assessment shows that they are very good. The decision is that the prepared test can be continued to the trial to calculate empirical validity and reliability. The trial was conducted on 77 students.

The analysis of the instrument trial used product-moment correlation (using SPPS 20 for Windows) and KR21 (using Microsoft Excel). The validity and reliability analysis of the instrument are summarized in Table 2. The scientific literacy measurement results were analyzed by calculating the scores of each student. In addition, a percentage calculation was carried out for each score based on the student's achievement category (Nasir et al., 2024), mean, and standard deviation. Differences in scientific literacy between boys and girls students using the Mann-Whitney test. Shapiro-Wilk test is used for data normality calculation.

Table 2. Result of validity and reliability calculated

Item (I)	Item Validity			Reliability	
	r	Sig.	Annotation	KR 21	Annotation
I-1	0.641	0.000	I-V		
I-2	0.622	0.000	I-V		
I-3	0.482	0.000	I-V		
I-4	0.366	0.001	I-V		
I-5	0.566	0.000	I-V	0.72	High reliability
I-6	0.489	0.000	I-V		
I-7	0.513	0.000	I-V		
I-8	0.448	0.000	I-V		
I-9	0.613	0.000	I-V		
I-10	0.736	0.000	I-V		

Note: I-V= Item Valid

Based on the data presentation in Table 2, the researcher's ten questions created, as presented in Table 2, meet the valid criteria with a significance level of less than 0.5. The results of the reliability test indicate that the questions are reliable. The analysis findings show that the test is useful for assessing students' scientific literacy abilities. Questions that are empirically valid and reliable can be used to measure students' abilities that will be investigated (Atta et al., 2020; Nasir et al., 2023).

RESULTS AND DISCUSSION

Our research has investigated the profile of primary school students' scientific literacy. It is important to measure as a basis for teachers in determining the learning that will be used. Teachers may assess students' scientific literacy levels and create empowering learning experiences. The results of student literacy achievement based on categories is presented in Figure 2, and the scores for each scientific literacy indicator are presented in Figure 3.
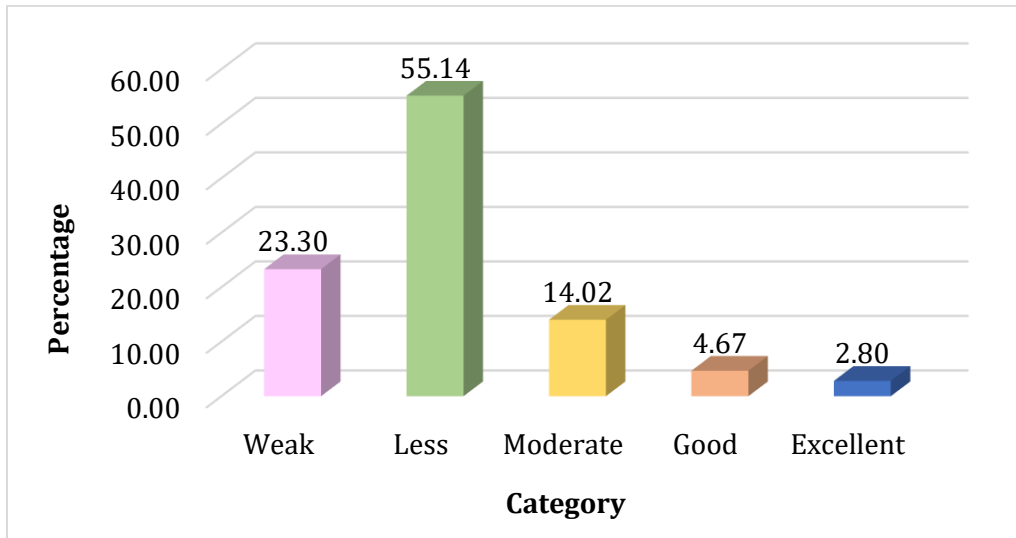
Fig. 2. Categories of students' scientific literacy

The data in Figure 2 indicates that students' scientific literacy is dominated by the less category. More than 50% of students reach the less category. It was found that only 2.80% students reached the excellent category, even the good category only reached 4.67%. This finding reveals that the scientific literacy skills of sixth grade primary school students are still underdeveloped.

Scientific literacy is necessary for primary school students to be empowered well. This is based on our research findings, which show that students' scientific literacy skills are dominated at the lower level. Initial measurements related to scientific literacy make students accustomed to problems related to it (Rusilowati et al., 2016). The low scientific literacy obtained from our research measurements indicates that school learning has not empowered scientific literacy. Students are not yet accustomed to learning, which develops their abilities related to scientific literacy. This is what causes the scientific literacy of primary school students to be low. Factors influencing students' low scientific literacy are non-contextual learning and inappropriate teaching materials (Suparya et al., 2022).
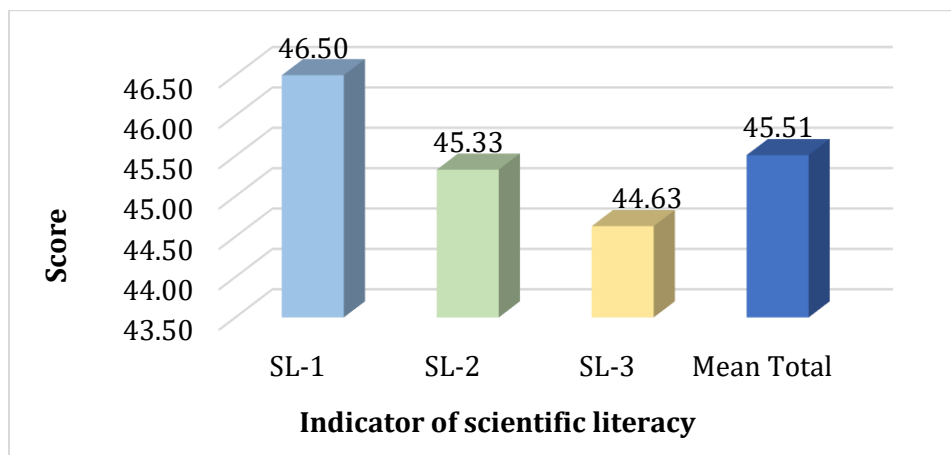

Fig. 3. Mean total and based on each indicator of scientific literacy

The data in Figure 3 reveals that the three indicators of scientific literacy only reach the less category. One indicator, namely interpreting scientific evidence and conclusions (SL-3), shows a low achievement of the other two indicators. Meanwhile, the total mean shows the same data, reaching a mean of 45.51, which indicates that students' scientific literacy is less.

In learning, students must be able to explain and predict a natural phenomenon studied in science. However, our measurement results show that students lack this ability. This research is in line with that conducted by Sari et al. (2017). They found that students were not yet able to make and justify accurate predictions, as well as explain scientific phenomena, because teachers did not use appropriate learning to develop scientific literacy. Students' ability to explain a scientific phenomenon indicates their conceptual understanding has occurred (Ogundeji et al., 2019). Thus, the low scientific literacy of students in the indicator of explaining and predicting scientific phenomena proves that students' understanding of the science learning delivered is not formed. Students cannot explain and predict because they do not understand the material their teacher has taught.

Another indicator of scientific literacy that received the least category was understanding scientific investigations. The findings revealed that primary school students could not yet understand scientific investigations. According to Pambudi et al. (2022), students can understand scientific investigations if they have been involved in learning. Discussion, observation, and explanation activities in scientific investigations support science learning (Moeed, 2013). The low understanding of students regarding scientific investigations reveals that their teachers rarely apply learning that leads to scientific investigations. Students who are accustomed to scientific investigation activities can understand activities related to scientific investigations.

The scientific literacy indicator related to interpreting and concluding obtained a score of 44.63, indicating that students' abilities in this indicator are less. However, Astria et al. (2022) found that primary school students obtained a moderate score in this indicator. This indicates that differences in schools affect differences in scientific literacy achievements. In science teaching, students must be able to interpret the results of experiments and formulate a conclusion. The experiments carried out by students must be interpreted in the form of data interpretation, and finally, they can formulate a conclusion for the results of their experiments (Nasir et al., 2020). The low ability to interpret evidence and draw conclusions indicates that students have never been accustomed to doing so. Habits related to interpretation and conclusion can be made through learning sets for scientific investigation (Kang, 2022) or learning experiences (Vieira & Tenreiro-Vieira, 2016).

Table 3. Result for analyzing differences in scientific literacy by gender

Gender	Mean Score	Standard Deviation	Shapiro-Wilk		Mann-Whitney	
			df	Sig.	Z	Sig.
Boys	43.49	12.13	43	0.008	-	0.151
Girls	46.87	15.21	64	0.010	1.435	

Based on Table 3, the mean scores for boys and girls are not normal (Sig < 0.05). Further testing uses non-parametric analysis. Although the mean boys and girls showed a

difference of 3.38 points, the results of the Mann-Whitney test showed an insignificant difference (Sig. > 0.05) between the scientific literacy skills of boys and girls students.

Our research found that the mean scores of boys and girls showed differences, but they were insignificant. Boys and girls in the primary schools we studied had the same scientific literacy skills. Research Baltikian et al. (2024) also showed the same results: no difference in students' scientific literacy based on gender. However, the findings of Herianingtyas et al. (2023) showed that boys in primary schools had higher scientific literacy than girls. Learning does not have to cause significant differences between boys and girls (Nunaki et al., 2019). Both genders must obtain the same results as the output of learning carried out by their teachers. The cause of differences in scientific literacy between genders is due to the use of learning (Ismail et al., 2016), although some do not cause differences (Srikandi et al., 2017). Unfortunately, the results of the analysis showed that boys and girls both had less scientific literacy.

Students, particularly those in primary school, must enhance their scientific literacy through education. The utilization of conventional learning methods is the cause of students' inadequate scientific literacy. Conventional learning causes students' scientific literacy skills to be low (Winarni et al., 2020). Students should be more involved in classes that are set to empower their scientific literacy. Learning activities must support changes in students' scientific literacy for the better. Science learning must familiarize students with activities based on scientific literacy empowerment (Güçlüer & Kesercioğlu, 2012). Activities must be adjusted to scientific literacy indicators, such as explaining phenomena, predicting phenomena, understanding scientific investigations, and interpreting and formulating conclusions. Students ' scientific literacy remains low when activities are not related to this. This is following our findings that the scientific literacy of primary school students is less.

CONCLUSION

This research concludes that primary school students have a lower level of scientific literacy. Based on the three indicators of scientific literacy measured, the ability to interpret and draw scientific conclusions is lower than the other two indicators. The less category dominates students' scientific literacy. Boys and girls do not indicate any significant differences in scientific literacy. Education must address students' lack of scientific literacy in primary schools. Education can create teaching activities that empower students' scientific literacy.

REFERENCES

Adolphus, A., Telima, T., & Arokoyu, A. A. (2012). Improving Scientific Literacy among Secondary School Students throughIntegration of Information and Communication Technology. *ARPN Journal of Science and Technology*, *2*(5), 444–448.

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 202–212. https://doi.org/10.21831/jipi.v2i2.8561

Almiasih, S., Winarto, W., & Kristyaningrum, D. H. (2022). Efektivitas model pembelajaran PJBL berbasis STEM-NOS terhadap literasi sains siswa kelas V SD Negeri Kalierang

01. *DIALEKTIKA Jurnal Pemikiran Dan Penelitian Pendidikan Dasar*, *12*(2), 1021–1021. https://doi.org/10.58436/jdpgsd.v12i2.1229

Archer-Bradshaw, R. E. (2017). Teaching for scientific literacy? An examination of instructional practices in secondary schools in Barbados. *Research in Science Education*, *47*, 67–93. https://doi.org/10.1007/s11165-015-9490-x

Astria, F. P., Wardani, K. S. K., Nurwahidah, N., & Hasnawati, H. (2022). Analisis Kemampuan Literasi Sains (KLS) Siswa Sekolah Dasar pada Pembelajaran Sains. *Jurnal Ilmiah Profesi Pendidikan*, *7*(4b), 2744–2752. https://doi.org/10.29303/jipp.v7i4b.1064

Astuti, W. P., Prasetyo, A. P. B., & Rahayu, E. S. (2012). Pengembangan instrumen asesmen autentik berbasis literasi sains pada materi sistem ekskresi. *Lembaran Ilmu Kependidikan*, *41*(1). 39–43. https://doi.org/10.15294/lik.v41i1.2228

Atta, H. B., Vlorensius, V., Aras, I., & Ikhsanudin, I. (2020). Developing an instrument for students scientific literacy. *Journal of Physics: Conference Series*, *1422*(1), 012019. https://doi.org/10.1088/1742-6596/1422/1/012019

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), em2407. https://doi.org/10.29333/ejmste/14279

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), em2380. https://doi.org/10.29333/ejmste/13930

Chasanah, N., Widodo, W., & Suprapto, N. (2022). Pengembangan Instrumen Asesmen Literasi Sains Untuk Mendeskripsikan Profil Peserta Didik. *PENDIPA Journal of Science Education*, *6*(2), 474–483. https://doi.org/10.33369/pendipa.6.2.474-483

Darmayanti, N. W. S., Saputri, N. K. T., & Prabayanthi, G. D. (2022). Analisis Pelaksanaan Pembelajaran IPA Kelas V Di SD N 1 Cempaga. *Jurnal Pendidikan Dasar Rare Pustaka*, *4*(2), 20–30. https://doi.org/10.59789/rarepustaka.v4i2.127

Deming, J. C., O'Donnell, J. R., & Malone, C. J. (2012). Scientific literacy: Resurrecting the phoenix with thinking skills. *Science Educator*, *21*(2), 10–17. https://course1.winona.edu/cmalone/promotion/Publications/Scientific%20Literacy%20with%20Deming.pdf

Fadilah, M., Permanasari, A., Riandi, R., & Maryani, E. (2020). Analisis Karakteristik Kemampuan Literasi Sains Konteks Bencana Gempa Bumi Mahasiswa Pendidikan IPA pada Domain Pengetahuan Prosedural dan Epistemik. *Jurnal IPA & Pembelajaran IPA*, *4*(1), 103–119. https://doi.org/10.24815/jipi.v4i1.16651

Fitriani, F., Harahap, F., & Manurung, B. (2018). Biology scientific literacy of Indonesian students: Case study in Aceh. *International Journal of Research and Review*, *5*(3), 63–72. https://www.ijrrjournal.com/IJRR_Vol.5_Issue.3_March2018/Abstract_IJRR007.html

Fu'adah, H., Rusilowati, A., & Hartono, H. (2017). Pengembangan Alat Evaluasi Literasi Sains untuk Mengukur Kemampuan Literasi Sains Siswa Bertema Perpindahan Kalor dalam Kehidupan. *Lembaran Ilmu Kependidikan*, *46*(2), 51–59. https://doi.org/10.15294/lik.v46i2.11350

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

Güçlüer, E., & Kesercioğlu, T. (2012). The Effect Of Using Activities Improving Scientific Literacy on Students' Achievement In Science and Technology Lesson. *International Online Journal of Primary Education*, *1*(1), 8–13. https://dergipark.org.tr/en/pub/iojpe/issue/69839/1114008

Hardinata, A., Putri, R. E., & Permanasari, A. (2019). Gender difference and scientific literacy level of secondary student: A study on global warming theme. *Journal of Physics: Conference Series*, *1157*, 022016. https://doi.org/10.1088/1742-6596/1157/2/022016

Herianingtyas, N. L. R., Edwita, E., & Yarmi, G. (2023). Analisis Literasi Sains Siswa Sekolah Dasar Menggunakan Rasch Analysis Model (RAM). *JPGMI (Jurnal Pendidikan Guru Madrasah Ibtidaiyah Al-Multazam)*, *9*(2), 293–300. https://doi.org/10.54892/jpgmi.v9i2.236

Iddy, H., Fussy, D. S., Mkimbili, S. T., & Amani, J. (2024). Supporting the Development of Students' Scientific Literacy. *Journal of Science Teacher Education*, 1–18. https://doi.org/10.1080/1046560X.2023.2287790

Irmita, L., & Atun, S. (2018). The ınfluence of technological pedagogical and content knowledge (TPACK) approach on science literacy and social skills. *Journal of Turkish Science Education*, *15*(3), 27–40. https://www.tused.org/index.php/tused/article/view/244

Ismail, I., Permanasari, A., & Setiawan, W. (2016). Efektivitas virtual lab berbasis STEM dalam meningkatkan literasi sains siswa dengan perbedaan gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 190. https://doi.org/10.21831/jipi.v2i2.8570

Kamila, U. S., & Sukartono, S. (2023). Penerapan Media Pop Up Book Pada Pembelajaran IPAS Materi Ayo Berkenalan Dengan Bumi Kita Pada Siswa Kelas 5 SD Negeri 2 Kalirejo. *Jurnal Elementaria Edukasia*, *6*(4), 1872–1882. https://doi.org/10.31949/jee.v6i4.7610

Kang, J. (2022). Interrelationship between inquiry-based learning and instructional quality in predicting science literacy. *Research in Science Education*, *52*(1), 339–355. 10.1007/s11165-020-09946-6

Kristyasari, M. L., Yamtinah, S., Utomo, S. B., Ashadi, & Indriyanti, N. Y. (2018). Gender Differences in Students' Science Literacy towards Learning on Integrated Science Subject. *Journal of Physics: Conference Series*, *1097*, 012002. https://doi.org/10.1088/1742-6596/1097/1/012002

Lestari, D. P., Supahar, S., Paidi, P., Suwarjo, S., & Herianto, H. (2023). Effect of science virtual laboratory combination with demonstration methods on lower-secondary school students' scientific literacy ability in a science course. *Education and Information Technologies*, *28*(12), 16153–16175. https://doi.org/10.1007/s10639-023-11857-8

Martiasari, E., Rodiyana, R., & Susilo, S. V. (2022). Kandungan Literasi Sains Pada Buku Tematik Terpadu Siswa Kelas V SD/MI Kurikulum 2013. *Prosiding Seminar Nasional Pendidikan*, *4*, 105–110. https://prosiding.unma.ac.id/index.php/semnasfkip/article/view/786

Moeed, A. (2013). Science investigation that best supports student learning: Teachers' understanding of science investigation. *International Journal of Environmental and Science Education*, *8*(4), 537–559. http://www.ijese.net/makale/1292.html

Mukti, W. R., Yuliskurniawati, I. D., Noviyanti, N. I., Mahanal, S., & Zubaidah, S. (2019). A Survey of High School Students' Scientific Literacy Skills in Different Gender. *Journal of Physics: Conference Series*, *1241*(1), 012043. https://doi.org/10.1088/1742-6596/1241/1/012043

Napitupulu, E. L. (2023, Desember). Penurunan Skor PISA Indikasikan Darurat Pendidikan Dasar. *Kompas*. https://www.kompas.id/baca/humaniora/2023/12/07/penurunan-skor-pisa-indikasikan-darurat-pendidikan-dasar?open_from=Section_Artikel_Terkait

Nasir, N. I. R. F., Arifin, S., & Damopolii, I. (2023). The analysis of primary school student's motivation toward science learning. *Journal of Research in Instructional*, *3*(2), 258–270. https://doi.org/10.30862/jri.v3i2.281

Nasir, N. I. R. F., Damopolii, I., & Nunaki, J. H. (2020). Pengaruh pembelajaran inkuiri terhadap level berpikir siswa SMA. *Bioilmi: Jurnal Pendidikan*, *6*(2), 112–119. https://doi.org/10.19109/bioilmi.v6i2.6948

Nasir, N. I. R. F., Mahanal, S., Ekawati, R., Damopolii, I., Supriyono, S., & Rahayuningsih, S. (2024). Primary school students' knowledge about animal life cycle material: The survey study. *Journal of Research in Instructional*, *4*(1), 253–262. https://doi.org/10.30862/jri.v4i1.320

Nunaki, J. H., Damopolii, I., Kandowangko, N. Y., & Nusantari, E. (2019). The Effectiveness of Inquiry-based Learning to Train the Students' Metacognitive Skills Based on Gender Differences. *International Journal of Instruction*, *12*(2), 505–516. https://doi.org/10.29333/iji.2019.12232a

OECD. (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*. OECD Publishing. https://www.oecd.org/en/publications/pisa-2022-results-volume-i_53f23881-en.html

Ogundeji, O. M., Madu, B. C., & Onuya, C. C. (2019). Scientific Explanation of Phenomena and Concept Formation as Correlates of Students' Understanding of Physics Concepts. *European Journal of Physics Education*, *10*(3), 10–19.

Pambudi, G. D., Winangsih, F., Nunaki, J. H., Nusantari, E., & Damopolii, I. (2022). Encouraging students' metacognitive skills through inquiry learning. *Inornatus: Biology Education Journal*, *2*(1), 43–52. https://journalfkipunipa.org/index.php/ibej/article/view/272

Rahmadani, Y., Fitakurahmah, N., Fungky, N., Prihatin, R., Majid, Q., & Prayitno, B. A. (2018). Profil Keterampilan Literasi Sains Siswa di Salah Satu Sekolah Swasta di Karanganyar. *Jurnal Pendidikan Biologi*, *7*(3), 183–190. https://doi.org/10.24114/jpb.v7i3.10123

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2017). Scientific Literacy of Students Learned Through Guided Inquiry. *International Journal of Research and Review*, *4*(5), 23–30. https://www.ijrrjournal.com/IJRR_Vol.4_Issue.5_May2017/Abstract_IJRR004.html

Rusilowati, A. (2018). Asesmen literasi sains: Analisis Karakteristik instrumen dan kemampuan siswa menggunakan teori tes modern rasch model. *Prosiding Seminar*

Nasional Fisika Universitas Riau ke-3. 2–15. https://snf.fmipa.unri.ac.id/wp-content/uploads/2019/03/0.-300B-2-15NI.pdf

Rusilowati, A., Kurniawati, L., & Widiyatmoko, S. E. N. & A. (2016). Developing an Instrument of Scientific Literacy Asessment on the Cycle Theme. *International Journal of Environmental and Science Education*, *11*(12), 5718–5727. http://www.ijese.net/makale/736.html

Sari, D. N. A., Rusilowati, A., & Nuswowati, M. (2017). Pengaruh pembelajaran berbasis proyek terhadap kemampuan literasi sains siswa. *PSEJ (Pancasakti Science Education Journal)*, *2*(2), 114–124. https://www.scienceedujournal.org/index.php/PSEJ/article/download/85/55

Srikandi, M. M., Sujana, A., & Aeni, A. N. (2017). Pengaruh Pembelajaran Kontekstual Terhadap Kemampuan Literasi Sains Berbasis Gender Pada Materi Sistem Pencernaan. *Jurnal Pena Ilmiah*, *2*(1), 661–670. https://doi.org/10.17509/jpi.v2i1.10105

Stahl, G., Scholes, L., McDonald, S., Mills, R., & Comber, B. (2023). Boys, science and literacy: Place-based masculinities, reading practices and the 'science literate boy.' *Research Papers in Education*, *38*(3), 328–356. https://doi.org/10.1080/02671522.2021.1964097

Suparya, I. K., Suastra, I. W., & Arnyana, I. B. P. (2022). Rendahnya Literasi Sains: Faktor Penyebab Dan Alternatif Solusinya. *Jurnal Ilmiah Pendidikan Citra Bakti*, *9*(1), 153–166. https://doi.org/10.38048/jipcb.v9i1.580

Suryani, A. I., A.W, J., & Setiadi, D. (2017). Pengaruh model pembelajaran 5E terintegrasi pendekatan saintifik terhadap kemampuan literasi sains siswa SMPN 1 Kuripan Tahun Ajaran 2016/2017. *Jurnal Pijar Mipa*, *12*(1). 39–43. https://doi.org/10.29303/jpm.v12i1.339

Tsoumanis, K. G., Stylos, G., & Kotsis, K. T. (2024). An investigation of primary school students' scientific literacy. *European Journal of Education Studies*, *11*(2). 107–133 https://doi.org/10.46827/ejes.v11i2.5195

Vieira, R. M., & Tenreiro-Vieira, C. (2016). Fostering Scientific Literacy and Critical Thinking in Elementary Science Education. *International Journal of Science and Mathematics Education*, *14*(4), 659–680. https://doi.org/10.1007/s10763-014-9605-2

Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of Language and Scientific Literacy Skills for 4th Grade Elementary School Students through Discovery Learning and ICT Media. *International Journal of Instruction*, *13*(2), 213–222. https://doi.org/10.29333/iji.2020.13215a

Windyariani, S., Setiono, S., & Sutisnawati, A. (2017). Pengembangan model asesmen literasi sains berbasis konteks bagi siswa sekolah dasar. *Prosiding Seminar Nasional Pendidikan Berkemajuan Dan Menggembirakan*, 613–622. https://publikasiilmiah.ums.ac.id/xmlui/handle/11617/9565

Wulandari, N., & Sholihin, H. (2016). Analisis kemampuan literasi sains pada aspek pengetahuan dan kompetensi sains siswa SMP pada materi kalor. *EDUSAINS*, *8*(1), 66–73. https://doi.org/10.15408/es.v8i1.1762