



SCIENCE LITERACY PROFILE OF JUNIOR HIGH SCHOOL STUDENTS AS THE BASIS FOR DEVELOPING RESEARCH SKILLS IN SCIENCE LEARNING

Sri Wahyuni¹, Eko Hariyono², Beni Setiawan³

^{1,3}Department of Science Education, Faculty of Mathematics and Natural Sciences, State Surabaya University, Surabaya, Indonesia

²Department of Physics Education, Faculty of Mathematics and Natural Sciences, State Surabaya University, Surabaya, Indonesia

Article Info

Article history:

Received 26/03/2026

Accepted 09/05/2026

Published 19/05/2026

Keywords:

Research Skills;

Science Education;

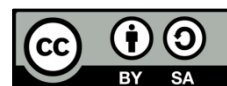
Scientific Literacy;

Student Profile.

ABSTRACT

Scientific literacy is recognized as a fundamental competency in science education; nevertheless, its connection with research skills has not been widely explored in classroom learning. This study aims to investigate the scientific literacy profile of junior high school students and identify its relationship with research skills within the research skill development (RSD) framework. A descriptive quantitative design was implemented involving 88 eighth-grade students selected through purposive sampling. Data collection was conducted using a multiple-choice instrument adapted from the programme for international student assessment (PISA) science framework developed by the OECD, complemented by limited interviews to strengthen data interpretation. The obtained data were processed through descriptive statistical analysis, including mean values, standard deviation, and score distribution, without applying inferential statistics. The results reveal that students generally demonstrate a moderate level of scientific literacy, with stronger achievement in explaining scientific phenomena (Mean = 63), whereas competencies related to evaluating investigations and applying scientific evidence remain relatively lower (Mean = 42 and 35, respectively). In addition, the findings indicate that students tend to perform more effectively in the early stages of research skills but still encounter challenges in more advanced stages, particularly data analysis and decision-making. These findings provide further insight into the relationship between scientific literacy and research skill development, emphasizing the importance of instructional approaches that promote inquiry and problem-solving activities to strengthen both scientific literacy and research skills.

This is an open-access article under the [CC BY-SA](#) license.



Corresponding Author:

Beni Setiawan

Department of Science Education, Faculty of Mathematics and Natural Sciences, State Surabaya University, Surabaya, Indonesia

Email: benisetiawan@unesa.ac.id

1. INTRODUCTION

Scientific literacy has become one of the crucial competencies required in 21st-century education because it equips students with the ability to critically respond to the rapid development

of science and technology (Irsan, 2021). Modern science education should not merely emphasize conceptual mastery, but also foster students' abilities to think critically, solve problems, and carry out inquiry activities in understanding scientific phenomena. These competencies are increasingly important as students encounter various global challenges, including environmental issues, technological progress, and health-related problems (Muhamad Dah et al., 2024). Through adequate scientific literacy, students are expected not only to comprehend information, but also to make rational and responsible decisions in everyday life (Sari et al., 2025; Ulfa & Kuswanto, 2025).

In formal education settings, particularly at the junior high school (SMP) level, science learning is intended to actively engage students in scientific practices, including observing phenomena, asking questions, conducting investigations, and formulating conclusions based on evidence (Husmar, 2025; Wasesa et al., 2024). Science should therefore be viewed not merely as a body of knowledge, but also as a systematic process for understanding natural phenomena through scientific inquiry (Rasyidi et al., 2022). Nevertheless, classroom practices in many schools continue to emphasize content delivery and memorization activities. As a result, students are often encouraged to recall concepts rather than develop investigative, analytical, and problem-solving skills connected to real-life situations (Afriani et al., 2025; Sholikhah & Subekti, 2025). This situation indicates a discrepancy between the intended goals of science education in the curriculum and the actual implementation of learning in classrooms. If such practices persist, achieving the objective of developing students with strong scientific literacy may become increasingly difficult.

Scientific literacy is commonly interpreted as an individual's ability to comprehend scientific concepts and processes and apply them to explain phenomena, make informed decisions, and address everyday problems (Wasis et al., 2020). This perspective is also reflected in international assessment frameworks, particularly the Programme for International Student Assessment (PISA) established by the OECD. Within educational contexts, scientific literacy is strongly associated with research skills because both involve systematic and evidence-based scientific reasoning. Learners with well-developed scientific literacy are generally more capable of identifying problems, constructing hypotheses, gathering and interpreting data, and drawing conclusions supported by evidence (Wati et al., 2025; Fauziyah et al., 2021). Conversely, limited scientific literacy may hinder students' ability to perform these scientific processes independently. Therefore, strengthening scientific literacy enables students not only to understand scientific concepts but also to apply them effectively in meaningful scientific inquiry activities.

Analyzing students' scientific literacy profiles can provide preliminary information regarding how learners understand and apply scientific concepts across different contexts (Tillah & Subekti, 2025). Without clear information about these initial abilities, learning improvement efforts tend to be general and not well-targeted. As a result, they may not align with students' actual needs. Furthermore, the results of the analysis can be used to develop more contextual and student-centered learning designs (Bull, 2025), such as STEM approaches, inquiry, and project-based learning. These three approaches basically emphasize the active involvement of students in the learning process through exploration, investigation, and real problem-solving (Sembiring, 2025; Hidayatullah & Widhyastuti, 2025). Thus, science literacy profile analysis not only serves as a mapping tool, but also becomes an important foundation in designing learning that is able to develop students' research skills more optimally.

Numerous earlier studies have investigated students' scientific literacy, especially in terms of measuring competency levels and identifying contributing factors (Fuadi et al., 2020; Tillah & Subekti, 2025; Syahrani et al., 2024; Yusmar & Fadilah, 2023). Nevertheless, most of these studies mainly emphasized literacy achievement and did not specifically relate it to the enhancement of students' research skills throughout the learning process. Although scientific literacy is widely acknowledged as an essential basis for advanced scientific thinking (Sriyani & Dewi, 2025), empirical studies examining how various literacy levels influence students' development at different stages of research skills remain limited. Skills such as explaining scientific phenomena, interpreting information, and applying scientific evidence may contribute differently to students' abilities in identifying problems, constructing hypotheses, and drawing conclusions.

To overcome this gap, the present study develops a systematic connection between scientific literacy competencies and research skill stages through the Research Skill Development (RSD) framework. Accordingly, the study seeks to investigate the scientific literacy profiles of junior high school students and explore their relationship with research skills in science education. Furthermore, this research combines scientific literacy, research competencies, and instructional design within an integrated conceptual framework. The RSD framework was adopted because it offers a clear and progressive description of research skill development, beginning with basic abilities such as identifying problems and extending to higher-level skills including data analysis and the communication of findings. In comparison with other inquiry-oriented approaches, the RSD framework provides more explicit operational stages that can be effectively connected to scientific literacy competencies assessed in the PISA framework. This integration supports a more comprehensive and systematic examination of how dimensions of scientific literacy, including explaining phenomena, interpreting data, and using evidence, are associated with students' research skills.

The alignment between the RSD framework and scientific literacy competencies allows for a more structured and in-depth analysis of the relationship between aspects of scientific literacy such as explaining scientific phenomena, interpreting information and data, and applying evidence-based reasoning, and the stages of research skill development. Within this perspective, scientific literacy serves as an essential foundation for evaluating students' preparedness to develop research competencies. Moreover, the findings of this study are anticipated to contribute as a reference for the development of more contextual and inquiry-oriented science learning designs, particularly those incorporating STEM approaches, in order to address the challenges and competencies required in 21st-century education.

2. METHOD

2.1. Types of Research

A descriptive quantitative design was employed to examine students' scientific literacy profiles based on the collected data. This approach was chosen because it is appropriate to identify the level of ability of students without providing special treatment (Niwangtika & Mu'alimah, 2025).

2.2. Research Subject

The participants consisted of eighth-grade students from a junior high school located in Surabaya consisting of classes VIII D, VIII E, and VIII F. Sample determination was carried out using purposive sampling techniques, taking into account the suitability of student characteristics with the research objectives (Memon et al., 2025). This technique was chosen by considering the subject's suitability for the research objectives (Campbell et al., 2020). The number of samples in this study is 88 which represents the entire population in the selected class. The selection of this subject is expected to provide a fairly representative picture of the science literacy profile of junior high school students. Furthermore, students' gender was considered as an additional variable in this study to explore potential differences in scientific literacy and its relation to research skills.

2.3. Research Instruments

The study employed a scientific literacy test in the form of multiple-choice questions developed by referring to the PISA 2025 science framework published by (OECD, 2023). The instrument was designed to assess three major competencies, including the ability to explain scientific phenomena, evaluate scientific investigations, and interpret scientific evidence for decision-making purposes. In addition, the assessment was linked to the Research Skill Development (RSD) framework proposed by Willison & O'Regan, (2007). The framework describes several stages of research skills, such as identifying problems, generating information, evaluating findings, organizing data, analyzing evidence, and communicating results.

The test consisted of 10 multiple-choice items with four response options in each question, adapted from the Programme for International Student Assessment (PISA) framework (OECD, 2023). Since the items were developed based on an established international framework, they reflect standardized constructs of scientific literacy. To ensure content validity and contextual suitability, the instrument was reviewed through expert judgment involving science education experts. The validation process focused on the alignment of the items with scientific literacy indicators, clarity of constructs, and appropriateness of language for junior high school students. However, this study did not conduct further statistical validation, such as construct validity or reliability testing, which is acknowledged as a limitation. The test was administered online with a working time of 30 minutes to maintain consistency in measurement conditions.

As supporting data, interviews were also conducted with several science students and teachers to obtain contextual information about learning practices in the classroom. Interview techniques are used to deepen the interpretation of quantitative results and reduce the potential for misinterpretation of numerical data (Romdona et al., 2025)

2.4. Data Analysis Techniques

The collected data were processed using descriptive statistical analysis to identify students' scientific literacy profiles. Students' scores were interpreted using the Benchmark Reference Assessment (PAP) criteria proposed by Widoyoko (2012), which classify achievement into five levels: very high, high, adequate, low, and very low. The analysis was also conducted for each scientific literacy indicator in order to identify students' strengths and weaknesses across different

competencies. Furthermore, the findings were interpreted to examine how scientific literacy relates to the development of research skills in science learning. To provide a broader understanding of students' literacy profiles, gender was additionally considered as a comparative variable. This analysis aimed to explore possible differences in scientific literacy performance based on student characteristics.

3. RESULTS AND DISCUSSION

The assessment of students' scientific literacy in this research was conducted using indicators adapted from the PISA science framework developed by the OECD. The assessment focused on students' abilities to explain scientific phenomena, evaluate scientific investigations, and interpret scientific evidence within relevant contexts. The obtained data were used to identify the initial profile of students' scientific literacy at the junior high school level. In addition, the findings were further analyzed to examine their potential relationship with students' research skills and their implications for science learning development. Further analysis was conducted on each scientific literacy competency to obtain a more detailed description of students' performance. The analysis revealed variations in achievement across the assessed aspects, ranging from high to low categories. Overall, the scientific literacy profile of eighth-grade students is presented in Figure 1.

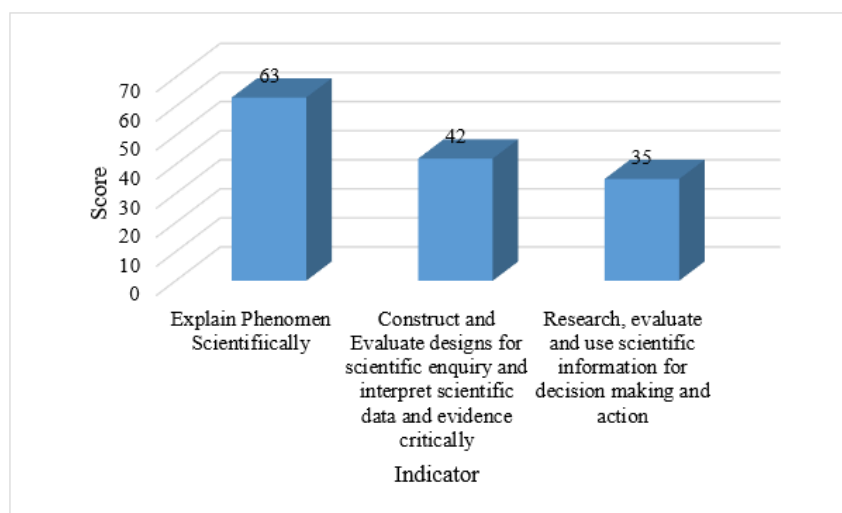


Figure 1. Students' Abilities in Each Aspect of Science Literacy Ability

Based on the analysis presented in Figure 1 and referring to the Benchmark Reference Assessment (PAP) proposed Widoyoko (2012), students' scientific literacy performance differed across indicators. The indicator related to explaining scientific phenomena achieved a mean score of 63, which falls within the high category. This finding indicates that students demonstrate relatively stronger abilities in understanding concepts and providing scientific explanations. From a cognitive standpoint, such performance reflects the predominance of basic cognitive processes, particularly comprehension and recall, which are closely associated with lower-order thinking skills in Bloom's taxonomy. Similar trends have also been identified in earlier studies, which reported that students generally show better achievement in conceptual comprehension than in higher-level scientific reasoning abilities (Rohmania & Suryanti, 2024; Yanthi et al., 2022). Nevertheless, students continue to encounter challenges in formulating investigations and

applying scientific evidence within authentic contexts, suggesting that higher-order thinking skills have not yet been fully developed (Musa et al., 2023; Tillah & Subekti, 2025).

To provide further support for these findings, additional descriptive statistical analyses were conducted, including the calculation of standard deviation, minimum and maximum scores, and score distribution. The analysis revealed that the standard deviation values for each indicator ranged from 6.87 to 8.52, reflecting a moderate degree of variation among students. These results imply that although the overall average achievement can be categorized as adequate to high, students' competencies remain unevenly distributed across individuals. Detailed information regarding the descriptive statistics of students' scientific literacy is presented in Table 1.

Table 1. Descriptive Statistics of Students' Scientific Literacy

Indicator	N	Mean	SD	Min	Max	Category
Explain phenomena scientifically	88	63	8.52	45	80	High
Compiling and evaluating designs for scientific inquiry and critically implementing scientific data and evidence	88	42	7.91	25	60	Adequate
Researching, evaluating, and using scientific information for decision-making and action	88	35	6.87	20	55	Low

Furthermore, the distribution of students' scientific literacy levels shows that the majority of students are in the adequate category (43.2%), followed by the high category (25.0%), and low category (20.5%). Only a small proportion of students fall into the very high and very low categories (5.7% each). This pattern suggests that most students have developed basic scientific literacy; however, their ability to engage in higher-order scientific reasoning remains limited. The limited number of students in the very high category also suggests that advanced scientific reasoning and evidence-based decision-making skills are still underdeveloped. The following is the distribution of students' scientific literacy levels in table 2.

Table 2. Distribution of Students' Scientific Literacy Levels

Category	Score Range	Frequency	Percentage
Very High	81–100	5	5.7%
High	61–80	22	25.0%
Adequate	41–60	38	43.2%
Low	21–40	18	20.5%
Very Low	0–20	5	5.7%
Total		88	100%

These findings reinforce the earlier analysis, showing that students demonstrate stronger performance in explaining scientific phenomena compared to higher-order competencies such as evaluating investigations and using scientific evidence. This indicates that students' scientific literacy is still predominantly oriented toward conceptual understanding, while competencies related to scientific reasoning and real-world application remain underdeveloped.

The observed pattern reflects that existing science instruction may still provide limited opportunities for developing higher-order thinking abilities and research skills. Therefore, there is

a need to design learning environments that place greater emphasis on inquiry-based and problem-solving activities, enabling students to engage more actively in scientific investigation and evidence-based reasoning. Such approaches are expected to support a more balanced development of students' scientific literacy. Furthermore, a more detailed analysis of students' scientific literacy across different classes is presented in Figure 2.

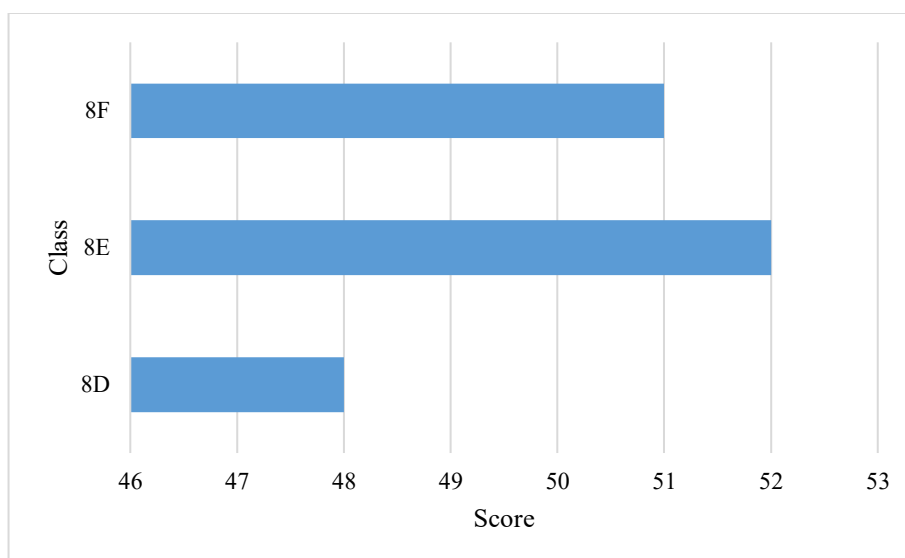


Figure 2. Analysis of science literacy skills for each class

Figure 2 illustrates that the mean scientific literacy scores across the three classes remain within the sufficient category. Among the classes, VIII E obtained the highest average score (52), followed by VIII F (51) and VIII D (48). Although slight differences are evident among classes, the gap is relatively limited, indicating that students' scientific literacy achievement tends to be distributed in a fairly comparable manner across the cohort. The overall performance level further suggests that students' scientific literacy competencies have not yet reached an optimal stage of development. The relatively narrow variation between classes also implies that differences in literacy achievement are not strongly determined by class grouping, but instead reflect a broader pattern of students' scientific literacy abilities.

The findings additionally indicate that students generally possess a foundational understanding of scientific concepts; however, they still encounter difficulties in developing deeper scientific reasoning skills, particularly in conducting investigations and applying scientific concepts within real-world situations. This observation supports previous studies reporting that students' competencies are commonly stronger in conceptual understanding than in procedural and application-oriented aspects of scientific literacy (Souza et al., 2026; Qiao et al., 2024; Faizin et al., 2024). Differences in achievement among classes may be influenced by several factors, including learning experiences, classroom engagement, and individual student characteristics (Alsayer, 2025; Rizky et al., 2024; Kaiser et al., 2013). Nevertheless, because all classes remain within the same achievement category, the results indicate that scientific literacy issues are not confined to a single class but instead represent a more general educational pattern. In addition, a gender-based analysis was conducted to identify potential differences in students' scientific literacy performance. The analysis revealed that gender-related differences were present; however,

these differences were not substantial, as the achievement level of both groups remained within the “adequate” category. Detailed results of the analysis are presented in Figure 3.

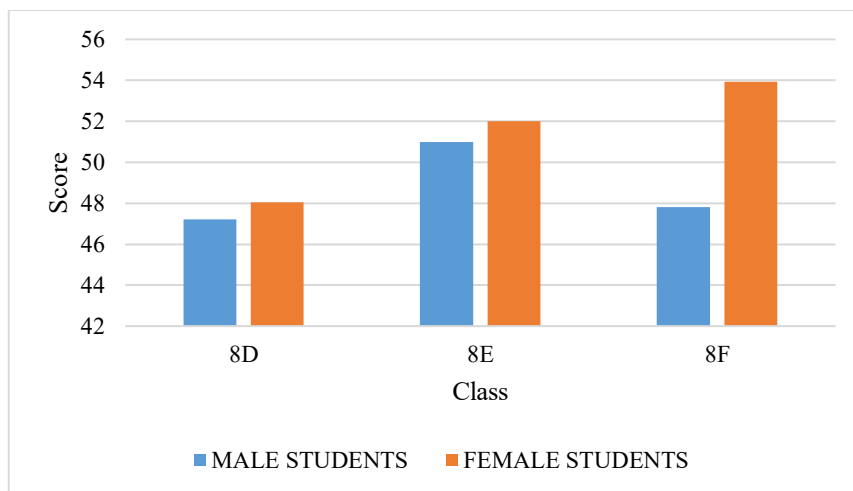


Figure 3. Gender science literacy analysis

The results indicate that there are observable differences in scientific literacy achievement between male and female students. Overall, female students tended to achieve slightly higher average scores compared to male students in each class. This difference is most noticeable in class VIII F, where the difference in grades between female and male students is quite significant compared to other classes.

GENDER

88 answers

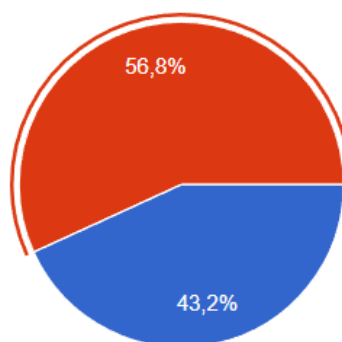


Figure 4. Comparison of the gender of women and men

From figure 4, it is known that the distribution of the number of students also shows that the number of female students (56.8%) is more than that of male students (43.2%). This condition can provide an idea that the participation and involvement of female students in learning tends to be more dominant, which has the potential to affect the achievement of learning outcomes, including in science literacy (Paul, 2026).

In general, these results indicate that female students have a better tendency to understand and work on science literacy questions. This can be caused by several factors, such as accuracy in

reading questions, the ability to understand context, and the tendency to be more thorough in analyzing information (OECD, 2019; OECD, 2025). However, this difference does not necessarily indicate that one group is absolutely superior, but rather that it is more of a variation in characteristics in the learning process. If associated with research skills, this difference shows that female students are potentially more prepared in carrying out the stages of research, especially in the aspect of understanding problems and analyzing information. However, both male and female students still need strengthening, especially in the aspects of using scientific evidence and decision-making that were previously identified as still low. The relationship between scientific literacy competencies and research skill stages is further illustrated in Table 3.

Table 3. The relationship between science literacy competencies and research skills

No	RSD Stages (Research Skills)	Science Literacy Competency (PISA)	Question No.	Average Score	Category
1	Embarq & Clarify	Explaining scientific phenomena	1, 8	63	High
2	Find & Generate	Using scientific information	10A	35	Low
3	Evaluate & Reflect	Design investigations	2, 5	42	Adequate
4	Organize & Manage	Integration of mathematics in science	9	42	Adequate
5	Analyze & Synthesize	Interpretation of data and evidence	3,4,6,7	42	Adequate
6	Communicate & Apply	Decision-making	10B	35	Low

Each question item in this study not only measures students' scientific literacy but is also aligned with stages of research skills based on the Research Skill Development (RSD) framework. This alignment provides a basis for mapping scientific literacy competencies to different stages of research skills in science learning. As shown in Table 1, students achieved the highest average score in explaining scientific phenomena (Mean = 63), which corresponds to the initial stage (Embarq & Clarify). This indicates that students are relatively capable of understanding and identifying scientific problems. Furthermore, in the Find & Generate stage and the Communicate & Apply stage, which involve the use of scientific evidence for decision-making, students obtained lower average scores (Mean = 35). This suggests that students experience difficulties when required to apply scientific knowledge in more complex contexts, particularly in formulating hypotheses and drawing evidence-based conclusions. Meanwhile, competencies related to designing investigations, organizing data, and interpreting evidence (Evaluate & Reflect, Organize & Manage, and Analyze & Synthesize) show moderate performance (Mean = 42), indicating that students have begun to develop scientific process skills, although these are not yet optimal. These findings suggest a pattern in which students perform better in the early stages of research processes but face increasing challenges as the complexity of the stages increases. Therefore, this mapping indicates that students' scientific literacy abilities are associated with their progression across research skill stages, although the relationship observed remains indicative rather than implying a causal relationship.

Overall, the results show that students' abilities are still dominated by the aspect of explaining phenomena, while aspects related to data analysis and decision-making remain relatively weak. This condition implies that students' research skills have not yet developed optimally, particularly in higher-order stages such as analysis and communication of results. Thus, scientific literacy can be positioned as a foundational element in developing students' research skills. Previous studies also support that higher levels of scientific literacy are associated with better scientific reasoning and inquiry abilities (Danianty & Sari, 2022; Jannah et al., 2024). Therefore, science learning needs to be designed in a more integrated manner by incorporating research skill stages, so that it not only improves conceptual understanding but also enhances students' ability to conduct systematic scientific investigations (Liila et al., 2021; Kang, 2022; Sari et al., 2025; Firdausi et al., 2025; Zulaekah et al., 2023) . A diagram of the relationship between science literacy and research ability can be seen in figure 5.

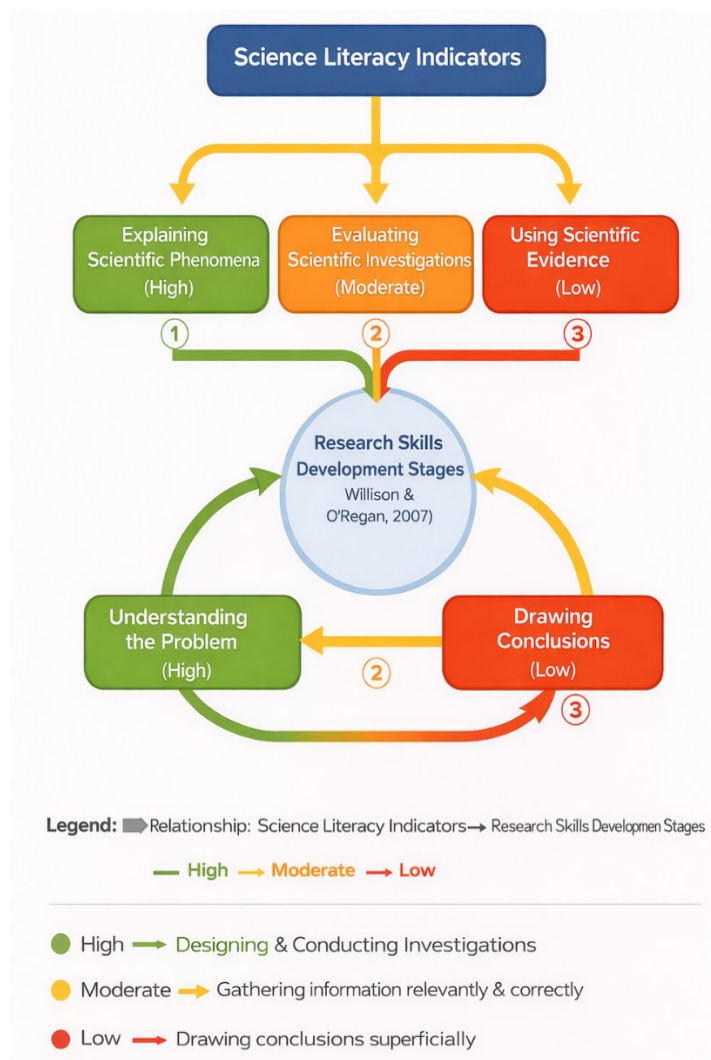


Figure 5. The relationship between science literacy and research ability

The picture clarifies the relationship between science literacy indicators and the stages of research skills. The ability to explain scientific phenomena in the high category supports the initial stage of research, namely understanding the problem. However, in the indicators of evaluating scientific investigations (medium) and using scientific evidence (low), there was a decrease in the

ability to design investigations to draw conclusions. Overall, the more complex the research stages, the lower the student achievement. This shows that science literacy is an important foundation, but it is not strong enough to support comprehensive research skills, especially in the aspects of analysis and decision-making.

This condition shows that science learning needs to be directed to an approach that emphasizes inquiry activities, such as inquiry-based and project-based learning, so that students can develop research skills more optimally. These approaches are considered relevant as they provide students with opportunities to actively engage in the scientific process, including formulating problems, developing hypotheses, conducting investigations, analyzing data, and drawing evidence-based conclusions. In addition, the integration of STEM approaches is also important to relate science concepts to real context through interdisciplinary problem-solving (Ling et al., 2024; Portillo-Blanco et al., 2024), so as to encourage critical thinking skills and the use of scientific evidence in decision-making.

4. CONCLUSION

This study reveals that the scientific literacy of junior high school students remains within the adequate category, with stronger performance in explaining scientific phenomena compared to evaluating investigations and using scientific evidence. This pattern is consistent across grades and genders. The findings also show that students perform better at the initial stages of research skills but face difficulties in more advanced stages such as designing investigations, analyzing data, and drawing conclusions. These results suggest that while scientific literacy provides a foundation for research skills, it has not yet fully supported higher-order research processes. Therefore, science learning should be directed toward strengthening students' abilities in designing investigations, interpreting data, and making evidence-based decisions through structured inquiry and problem-based activities. Further research is needed to examine the effectiveness of these instructional strategies in improving students' competencies.

REFERENCES

- Afriani, N., Lestari, T., & Oktafrida, L. (2025). Penerapan model problem based learning untuk meningkatkan pemahaman konsep di smp negeri 2 lubuk basung. *Jurnal pendidikan dan pembelajaran khatulistiwa*, 14(7), 1298–1305. <https://doi.org/https://doi.org/10.26418/jppk.v14i7.97934>
- Alsayer, A. (2025). Factors Affecting Students' Achievement: *International Journal of Web-Based Learning and Teaching Technologies*, 20(1). <https://doi.org/https://doi.org/10.4018/IJWLTT.371405>
- Bull, D. A. (2025). Impact of Curriculum Misalignment and Assessment Practices on Student Learning Outcomes in Higher Education: A PRISMA Guided Qualitative Content Synthesis. *International Journal of Interdisciplinary Research and Innovations*, 13(3), 65–87. <https://doi.org/https://doi.org/10.5281/zenodo.16262451>
- Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing: JRN*, 25(8), 652–661.

<https://doi.org/10.1177/1744987120927206>

- Danianty, N., & Sari, P. M. (2022). Hubungan Literasi Sains dengan Keterampilan Proses Sains pada Peserta Didik Kelas V di Sekolah Dasar. *Ideas: Jurnal Pendidikan, Sosial, Dan Budaya*, 8(3), 1007–1012. <https://doi.org/10.32884/ideas.v8i3.894>
- Faizin, A., Susantini, E., & Raharjo. (2024). Application of A Guided Inquiry Learning Model to Improve Students' Scientific Literacy Skills. *IJORER : International Journal of Recent Educational Research*, 5(2), 490–503. <https://doi.org/10.46245/ijorer.v5i2.573>
- Fauziyah, A., Prasetyaningsih, & Biru3, L. T. (2021). Analysis of scientific literacy skills in solving question science on food security themes in serang city. *Jurnal Penelitian Pendidikan IPA*, 6(2), 56–63. <https://doi.org/https://doi.org/10.26740/jppipa.v6n2.p56-63>
- Firdausi, N., Sugiharto, B., & Karyanto, P. (2025). A Systematic Literature Review: Project-Based Learning to Empower Students' Science Process Skills. *Jurnal PAJAR (Pendidikan Dan Pengajaran)*, 9(3), 315–325. <https://doi.org/https://doi.org/10.33578/pjr.v9i3.112>
- 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>
- Hidayatullah, M. I., & Widhyastuti, K. L. (2025). Tinjauan Literatur: Efektifitas Penggunaan Model Pembelajaran Inquiry dalam Pembelajaran IPA di Sekolah Dasar. *IJoEd: Indonesian Journal on Education*, 1(3), 228–234. <https://doi.org/https://doi.org/10.70437/ijoed.v1i3.112>
- Husmar, N. A. (2025). Menumbuhkan Rasa Ingin Tahu Siswa Melalui Pembelajaran Ipa Berbasis Eksperimen Di Sekolah Dasar. *Jurnal Ilmiah Multidisiplin Mahasiswa Dan Akademisi*, 1(3), 12–21. <https://doi.org/https://doi.org/10.64690/intelektual.v1i3.123>
- Irsan. (2021). Implementasi Literasi Sains dalam Pembelajaran IPA di Sekolah Dasar. *JURNAL BASICEDU*, 5(6), 5631–5639. <https://doi.org/https://doi.org/10.31004/basicedu.v5i6.1682>
- Jannah, M., Sudiby, E., & Mursyidah, R. W. (2024). Analisis keterampilan literasi sains siswa melalui implementasi model pembelajaran guided inquiry. *Pensa e-jurnal : pendidikan sains*, 12(3), 88–92. <https://doi.org/https://doi.org/10.26740/pensa.v12i3.62670>
- Kaiser, J., Retelsdorf, J., Südkamp, A., & Möller, J. (2013). Achievement and engagement: How student characteristics influence teacher judgments. *Learning and Instruction*, 28, 73–84. <https://doi.org/https://doi.org/10.1016/j.learninstruc.2013.06.001>
- Kang, J. (2022). Interrelationship Between Inquiry-Based Learning and Instructional Quality in Predicting Science Literacy. *Research in Science Education*, 52(1), 339–355. <https://doi.org/10.1007/s11165-020-09946-6>
- Liila, A., Siswanto, J., & Roshayanti, F. (2021). Analisis pembelajaran ipa terpadu ditinjau dari kemampuan science inquiry siswa kelas viii smp PGRI 01 Semarang. *Edukatif*, 7(2), 84–90. <https://doi.org/https://doi.org/10.37567/jie.v7i2.941>
- Ling, Y., Zhou, L., Zhang, B., & Ren, H. (2024). Developing middle school students' problem-solving ability through interdisciplinary project-based learning. *Education for Chemical Engineers*, 46, 43–53. <https://doi.org/https://doi.org/10.1016/j.ece.2023.11.001>
- Memon, M. A., Thuramy, R., Ting, H., & Cheah, J.-H. (2025). Purposive sampling: a review and guidelines for quantitative research. *Journal of Applied Structural Equation Modeling*, 9(1), 1–23. [https://doi.org/10.47263/JASEM.9\(1\)01](https://doi.org/10.47263/JASEM.9(1)01)
- Muhamad Dah, N., Mat Noor, M. S. A., Kamarudin, M. Z., & Syed Abdul Azziz, S. S. (2024). The impacts of open inquiry on students' learning in science: A systematic literature review.

- Educational Research Review*, 43, 100601.
<https://doi.org/https://doi.org/10.1016/j.edurev.2024.100601>
- Musa, W. J. A., Zainudin, F., Isa, I., Kilo, J. La, & Kilo, A. K. (2023). Analisis Kemampuan Literasi Sains Ditinjau dari Aspek Kompetensi Sains Siswa pada Materi Global Warming. *Jambura Journal of Educational Chemistry*, 5(2), 142–149.
<https://doi.org/https://doi.org/10.34312/jjec.v5i2.12705>
- Niwangtika, W., & Mu'alimah, I. K. (2025). Analisis Profil Literasi Sains Siswa Sekolah Dasar di Daerah Pesisir Pantai Tulungagung. *Patria Educational Journal*, 5(4), 208–215.
<https://doi.org/https://doi.org/10.28926/pej.v5i4.2588>
- OECD. (2019). *PISA 2018 Results (Volume II): Where All Students Can Succeed: Vol. II*. OECD Publishing. <https://doi.org/https://doi.org/10.1787/b5fd1b8f-en>.
- OECD. (2023). *Pisa 2025 Science Framework. May 2023*, 1–93.
- OECD. (2025). *Gender Differences in Education, Skills and STEM Careers in Latin America and the Caribbean: Insights from PISA and PIAAC*. OECD Publishing. <https://doi.org/https://doi.org/10.1787/4ea07281-en>.
- Paul, B. (2026). Unveiling Gender Dynamics in Introductory Physics Labs. *Physics Education*, 61(1), 015035.
- Portillo-Blanco, A., Deprez, H., De Cock, M., Guisasola, J., & Zuza, K. (2024). A Systematic Literature Review of Integrated STEM Education: Uncovering Consensus and Diversity in Principles and Characteristics. In *Education Sciences* (Vol. 14, Issue 9, p. 1028). <https://doi.org/10.3390/educsci14091028>
- Qiao, C., Chen, Y., Guo, Q., & Yu, Y. (2024). Understanding science data literacy: a conceptual framework and assessment tool for college students majoring in STEM. *International Journal of STEM Education*, 11(1), 25. <https://doi.org/10.1186/s40594-024-00484-5>
- Rasyidi, M., Sarjan, M., Muliadi, A., Azizi, A., Hamidi, H., Fauzi, I., Yamin, M., Rahmatiah, R., Sudirman, S., & Khery, Y. (2022). Pendidikan ipa bervisi sets dalam filsafat multidimensi. *Al YAZIDIY: Ilmu Sosial, Humaniora, Dan Pendidikan*, 4(2), 30–36.
<https://doi.org/https://doi.org/10.55606/ay.v4i2.32>
- Rizky, M., Sayidina, P., Kinanthi, M., Aziz, R. R., Ramdhaniyya, & Rahmi, Y. (2024). Efek Latar Lingkungan Belajar terhadap Capaian Akademik Matematika Siswa Sekolah Dasar. *Jurnal Flourishing*, 4(12), 580–590. <https://doi.org/10.17977/10.17977/um070v4i122024p580-590>
- Rohmania, M., & Suryanti. (2024). Analisis kemampuan literasi sains pada domain pengetahuan dan kompetensi materi suhu dan kalor kelas 5 sdn sumput. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, 12(8), 1592–1602. <https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/62417/47540>
- Romdona, S., Junista, S. S., & Gunawan, A. (2025). Teknik Pengumpulan Data: Observasi, Wawancara, dan Kuesioner. *JISOSEPOL: JURNAL ILMU SOSIAL EKONOMI DAN POLITIK*, 3(1), 39–47. <https://doi.org/10.61787/taceee75>
- Sari, S. W., Yokhebed, & Tenriawaru, B. (2025). Analisis Kemampuan Literasi Sains pada Materi Virus Kelas X di SMA Negeri 1 Rasau Jaya. *Jurnal Pendidikan MIPA*, 15(3), 1222–1231. <https://doi.org/https://doi.org/10.37630/jpm.v15i3.3201>
- Sari, Y. L., Harianto, R., Amilatus, N., Zahra, N. A. E., & Evito, G. A. Z. (2025). Literature analysis on improving science literacy through an inquiry-based learning approach for students. *Islamic Journal of Integrated Science Education (IJISE)*, 4(3), 158–174.

- <https://doi.org/https://doi.org/10.30762/ijise.v4i3.6635>
- Sembiring, R. S. (2025). Pembelajaran IPA Berbasis STEM–PjBL: Tinjauan Kritis Implementasi dan Integrasi Teknologi Deep Learning untuk Meningkatkan Keterampilan Berpikir Kritis dan Kreatif Siswa. *Ibtida'i: Jurnal Kependidikan Dasar*, 12(2), 233–248. <https://doi.org/https://doi.org/10.32678/ibtidai.v12i2.11783>
- Sholikhah, N., & Subekti, H. (2025). Peningkatan keterampilan proses sains siswa smp melalui penerapan model creative problem solving. *Science : Jurnal Inovasi Pendidikan Matematika Dan IPA*, 5(2), 702–711. <https://doi.org/https://doi.org/10.51878/science.v5i2.5358>
- Souza, P. V. S., Silva, L. V., Dutra, R. de S., & Monteiro, F. F. (2026). Scientific literacy through an inquiry-based multimodal teaching: outcomes from a classroom study. *Front. Educ.*, 11, 1–8. <https://doi.org/10.3389/educ.2026.1726851>
- Sriyani, & Dewi, R. F. (2025). Hubungan keterampilan literasi sains dengan kemampuan berpikir ilmiah siswa pada materi ekosistem kelas x mipa. *JURNAL MEDIA AKADEMIK (JMA)*, 3(12), 1–15. <https://doi.org/https://doi.org/10.62281/5v516338>
- Syahriani, S., Irfan, M., & Syawaluddin, A. (2024). Analisis Rendahnya Kemampuan Literasi Sains Siswa Kelas Tinggi Di SD Inpres Paku Kecamatan Pallangga Kabupaten Gowa. *Jurnal Lempu*, 1(3), 340–347. <https://doi.org/https://doi.org/10.70713/lempu.v1i3.3758>
- Tillah, N. F., & Subekti, H. (2025). Analisis kemampuan literasi sains siswa smp berdasarkan indikator dan level literasi sains. *Edusaintek: Jurnal Pendidikan, Sains Dan Teknologi*, 12(1), 137–154. <https://doi.org/https://doi.org/10.47668/edusaintek.v12i1.1271>
- Ulfa, S. M., & Kuswanto, H. (2025). Analysis of Scientific Literacy in Science Learning: A Systematic Literature Review. *International Journal of Multicultural and Multireligious Understanding*, 12(8), 440–450. <https://doi.org/2i8.6935>
- Wasesa, G., Wardani, N. K., & Pamelasari, S. D. (2024). Peningkatan Keterampilan Proses Sains Peserta Didik Kelas IXB SMPN 17 Semarang Melalui Model Pembelajaran Discovery Learning. *Peningkatan Kualitas Pembelajaran Melalui Penelitian Tindakan Kelas Dan Publikasi Ilmiah*, 675–679. <https://proceeding.unnes.ac.id/snpptk/article/view/3194/2659>
- Wasis, Rahayu, Y. S., Sunarti, T., & Indana, S. (2020). *HoTs dan Literasi Sains: Konsep, Pembelajaran, dan Penilaiannya* (1st ed.). Kun Fayakun.
- Wati, S. I., Kumala, F. N., & Yasa, A. D. (2025). Analisis literasi sains terhadap kemampuan berpikir kritis peserta didik kelas iv sekolah dasar. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, 10(4), 601–622. <https://doi.org/https://doi.org/10.23969/jp.v10i4.33695>
- Widoyoko, E. P. (2012). *Teknik penyusunan instrumen penelitian*. Yogyakarta: Pustaka Pelajar.
- Willison, J., & O'Regan, K. (2007). Commonly known, commonly not known, totally unknown: a framework for students becoming researchers. *Higher Education Research & Development*, 26(4), 37–41. <https://doi.org/10.1080/07294360701658609>
- Yanthi, M. D., Sinaga, P., & Siahaan, P. (2022). Using Non-Traditional Writing Task Strategy to Improve Cognitive Concept Mastery in Learning Science and Identify Self- Regulated Learning Ability. *Jurnal Pendidikan MIPA*, 23(4), 1561–1571. <https://doi.org/10.23960/jpmipa/v23i4.pp1561-1571>
- Yusmar, F., & Fadilah, R. E. (2023). Analisis rendahnya literasi sains peserta didik indonesia: hasil pisa dan faktor penyebab. *Lensa (Lentera Sains): Jurnal Pendidikan IPA*, 13(1), 11–19. <https://doi.org/10.24929/lensa.v13i1.283>
- Zulaekah, Djafri, N., Santosa, T. A., Rahman, A., & Yustitia, V. (2023). The Effect of The Project

Based Learning Model on Students' Science Process Skills. : A Meta-Analysis. *Edumaspul: Jurnal Pendidikan*, 7(2), 2148–2158.
<https://doi.org/https://doi.org/10.33487/edumaspul.v7i2.6550>