



Digital Literacy, Self-Regulated Learning, and Science Literacy: Examining Their Relationships among Fifth-Grade Elementary Students

Adella Latifa Fauziah*, Diki Rukmana

Primary School Teacher Education Department, Faculty of Teacher Training and Education,
Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia.

*Corresponding Author. Email: adellalatifa62@gmail.com

Abstract: This study aims to analyze the relationship between digital literacy, self-regulated learning, and science literacy among elementary school students. The study employed a quantitative approach with a correlational design involving 184 fifth-grade students from three public elementary schools. Data were collected using Likert-scale questionnaires to measure digital literacy and self-regulated learning, as well as an essay test to assess science literacy. The data were analyzed using descriptive statistics, assumption testing, and multiple linear regression with IBM SPSS Statistics. The results indicate that digital literacy and self-regulated learning are positively and significantly associated with science literacy, both individually and jointly. Self-regulated learning makes a greater contribution to students' science literacy than digital literacy. These findings suggest that improving science literacy requires the integration of digital technology with the development of students' self-regulated learning skills in the classroom. The findings provide a foundation for teachers and curriculum developers to integrate these two competencies into environment-based science instruction in elementary schools.

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Introduction

Science literacy is an essential competency that enables students to understand scientific concepts, evaluate evidence, explain natural phenomena, and make informed decisions concerning science-related issues (Fitria & Setiyawati, 2024). It is not limited to the acquisition of scientific knowledge but also involves the ability to apply such knowledge when addressing problems encountered in everyday life (Efendi et al., 2021). Organisation for Economic Co-operation and Development (OECD) defines science literacy as the capacity to engage with science-related issues reflectively, including explaining phenomena scientifically, evaluating scientific enquiry, and interpreting data and evidence (Pratama, 2025). These competencies are particularly relevant to environmental issues because students are increasingly required to understand the causes, consequences, and possible solutions to problems such as pollution, waste accumulation, ecosystem degradation, and climate-related changes.

At the elementary school level, science literacy provides a foundation for developing critical thinking, environmental awareness, and evidence-based decision-making. *Ilmu Pengetahuan Alam dan Sosial (IPAS)*, under the Merdeka Curriculum. *IPAS* learning is expected to connect scientific concepts with social and environmental conditions encountered by students in their surroundings. Environmental topics are therefore not merely theoretical content; they provide contextual learning opportunities through which students can identify



problems, examine causal relationships, interpret information, and propose practical solutions. Previous studies have emphasized that contextual science instruction can help elementary school students understand environmental phenomena and develop greater responsibility for their surrounding (Safrizal et al., 2020, 2021; Suparya et al., 2022). The proposal underlying this study similarly positions environmental issues as a relevant context for examining science literacy among fifth-grade students.

Advances in digital technology have transformed the way elementary school students access scientific information. Today, students can use educational videos, e-books, interactive simulations, websites, and social media to learn about science and environmental issues. However, the use of technology does not always lead to meaningful learning. Students need to be able to search for relevant information, assess the accuracy of digital sources, identify misinformation, and use technology responsibly. Therefore, digital literacy is not only about technical skills but also encompasses the ability to think critically, evaluate information, create knowledge, and use technology ethically (Nurdin et al., 2025). These skills are closely related to science literacy because scientific information is now largely obtained and disseminated through digital media.

Digital literacy can support science literacy by helping students access various scientific sources and compare information from different sources. Students with strong digital literacy will find it easier to locate relevant information, assess its reliability, and use it to understand environmental phenomena. Muchsin and Akbar (2023) reported that digital literacy has a positive and significant relationship with the science literacy of fifth-grade elementary school students, with a correlation coefficient of 0.691. This indicates that the ability to access, understand, and evaluate digital information is related to students' ability to understand scientific concepts.

However, the benefits of digital learning resources are also influenced by students' ability to manage their own learning process. Self-regulated learning refers to students' ability to initiate learning, take responsibility, develop strategies, and evaluate their learning outcomes. Students with self-regulated learning tend to actively seek additional information, strive to complete challenging tasks, and connect knowledge to real-world problems. This ability is crucial for science literacy because understanding scientific and environmental issues requires exploration, reflection, and the use of evidence. Zainudin et al. (2024) found that self-regulated learning is significantly associated with students' science literacy, although their study was conducted with middle school students and included curiosity as a variable.

Digital literacy and self-regulated learning also mutually reinforce each other in improving students' science literacy. Wahyuni et al. (2021) demonstrated that digital literacy significantly predicts self-regulated learning among elementary school students. These findings suggest that the ability to search for and utilize digital information can reduce students' reliance on direct explanations from teachers. However, the study only examined the relationship between digital literacy and self-regulated learning without including science literacy as an outcome variable.

Existing studies therefore provide partial evidence regarding the relationships among the three constructs. Muchsin and Akbar (2023) investigated digital literacy and science literacy, Zainudin et al. (2024) examined self-regulated learning and science literacy at the secondary-school level, and Wahyuni et al. (2021) analyzed digital literacy and self-regulated learning. Previous studies have generally examined only two variables, been conducted at different educational levels, or failed to link science literacy to the context of environmental



learning. Therefore, evidence regarding the relationship between digital literacy and self-regulated learning, both separately and in conjunction with science literacy among elementary school students, remains limited. This limitation is important to note because environmental learning requires students to be able to access digital information, learn independently, critically evaluate evidence, and propose solutions based on sound reasoning. This study addresses this gap by examining the relationship among all three variables simultaneously.

The scientific novelty of this study lies in its integrated examination of digital literacy and self-regulated learning as simultaneous correlates of science literacy among fifth-grade elementary school students in the context of environmental issues. This approach provides a more comprehensive picture than previous studies, which examined only one or two variables. Based on this framework, the study proposed three hypotheses: (H₁) digital literacy is positively and significantly related to students' science literacy; (H₂) self-regulated learning is positively and significantly related to students' science literacy; and (H₃) digital literacy and self-regulated learning are simultaneously and significantly related to students' science literacy. Accordingly, this study aimed to examine the individual and simultaneous relationships of digital literacy and self-regulated learning with the science literacy of fifth-grade elementary school students in the context of environmental issues.

Research Method

This study employed a quantitative associative approach with a cross-sectional correlational survey design. The design was selected to examine the direction, strength, and statistical significance of the relationships among variables without manipulating the participants' learning conditions. Digital literacy (X₁) and self-regulated learning (X₂) were treated as predictor variables, while science literacy (Y) was treated as the criterion variable. The relationships were examined both individually and simultaneously within the context of environmental issues in fifth-grade Integrated Natural and Social Sciences learning. The study was conducted during the 2025/2026 academic year at three elementary schools: SDN Baru 01 Pagi, SDN Pekayon 03 Pagi, SDN Pejaten Barat 01 Pagi.

The study population consisted of all fifth-grade students from the three elementary schools participating in the study, SDN Pekayon 03 Pagi, SDN Kalisari 05 Pagi, and SDN Pejaten Barat 01 Pagi, for a total of 184 students. These three schools were selected because fifth-grade students had already studied material on environmental issues in their Natural and Social Sciences courses, making them relevant to the study's objectives. This study used total sampling, so that all members of the population were included as the research sample (Sugiono, 2022). The eligibility criteria for respondents included students enrolled as fifth-graders at one of the participating schools who completed all research instruments, namely the questionnaires on digital literacy, self-regulated learning, and science literacy.

A total of 184 questionnaires were distributed to all students and all were successfully returned, resulting in a gross response rate of 100%. Next, a data screening process was conducted to check the completeness and consistency of the responses. The results of the screening showed that all questionnaires were fully completed, with no duplicate or invalid data, so no data were excluded. Thus, the clean sample used in the analysis consisted of 184 respondents (N = 184).

Data were collected using three structured questionnaires designed to measure digital literacy, self-regulated learning, and science literacy. Each instrument consisted of nine statements rated on a five-point Likert scale: strongly agree, agree, undecided, disagree, and



strongly disagree. Positively worded statements were scored from 5 to 1, whereas negatively worded statements were reverse-scored from 1 to 5. A higher total score represented a higher level of the measured construct. The instrument framework is presented in Table 1.

Table 1. Framework of the research instruments

Variable	Main dimensions	Number of items	Measurement scale
Digital literacy (X ₁)	Access, analysis, creation, and digital ethics	9	Five-point Likert scale
Self-regulated learning (X ₂)	Initiative, discipline, responsibility, self-confidence, and persistence	9	Five-point Likert scale
Science literacy (Y)	Cognitive science literacy, science media literacy, and contextual or civic science literacy	9	Essay Test (0-5 scoring rubric)

The digital literacy instrument was developed with reference to four competencies: accessing digital resources, analyzing digital information, creating digital learning products, and using technology ethically. Its indicators included operating digital devices for learning, locating online information, understanding and assessing digital content, producing digitally supported assignments, protecting privacy, respecting copyright, and using technology responsibly.

The self-regulated learning instrument measured students' initiative to learn without continuous instruction, ability to manage study time, responsibility for completing assignments, confidence in their learning ability, and persistence when encountering difficulties. These indicators were adapted from the self-regulated learning framework used by Saleh et al. (2024).

The science literacy instrument consisted of nine open-ended essay questions focusing on environmental issues encountered in elementary science learning. Students' responses were evaluated using a five-point analytic scoring rubric. Cognitive science literacy assessed students' understanding of environmental concepts and cause-and-effect relationships. Science media literacy measured their ability to interpret and evaluate scientific information obtained from learning media or digital sources. Contextual or civic science literacy assessed students' ability to apply scientific concepts to environmental problems and make evidence-based decisions in everyday life. The dimensions were adapted from the multidimensional science literacy framework proposed by Mede et al. (2025).

Before field administration, instrument quality was evaluated through item validity and internal consistency testing. Item validity was examined using Pearson's product-moment correlation at a significance level of 0.05. Items meeting the predetermined validity criterion were retained for analysis. Reliability was assessed using Cronbach's alpha, with a coefficient of at least 0.70 indicating acceptable internal consistency. Following coordination with the participating schools, students completed the digital literacy questionnaire, the self-regulated learning questionnaire, and the science literacy essay test. Responses to the essay test were scored using a five-point analytic scoring rubric, whereas questionnaire responses were scored using a five-point Likert scale. All data were checked for completeness, coded, scored, and entered into the statistical database. Only complete responses were included in the final analysis.

The data were analyzed using IBM SPSS Statistics. The analysis included descriptive statistics (mean, median, standard deviation, minimum score, maximum score, skewness, and kurtosis), assumption tests, and multiple linear regression. Data normality was tested using



the Kolmogorov–Smirnov and Shapiro–Wilk tests, while the linearity of the relationship between variables was tested using the Linearity and Deviation from Linearity tests. A relationship was considered linear if the significance value for Linearity was < 0.05 and that for Deviation from Linearity was > 0.05 (Field, 2024).

Multiple linear regression was used to analyze the partial and simultaneous relationships between digital literacy (X_1) and self-regulated learning (X_2) with science literacy (Y). The analysis included the multiple correlation coefficient (R), the coefficient of determination (R^2), the F-test, partial t-tests, and standardized beta coefficients. All tests were conducted at a significance level of 0.05. Additionally, multicollinearity tests were performed using the Tolerance and Variance Inflation Factor (VIF) values, while heteroscedasticity tests were conducted to ensure there were no violations of regression assumptions.

Results and Discussion

Descriptive Profile and Statistical Assumptions

The descriptive statistics for digital literacy, self-regulated learning, and science literacy are presented in Table 2. The mean scores of all three variables exceeded the theoretical midpoint of the measurement scale, indicating that the students generally demonstrated relatively adequate levels of the measured competencies. Self-regulated learning obtained the highest mean score ($M = 35.84$), followed by science literacy ($M = 35.77$) and digital literacy ($M = 35.10$).

Table 2. Descriptive statistics of the research variables

Variable	Mean	Median	SD	Minimum	Maximum	Range	Skewness	Kurtosis
Digital literacy	35.10	35.00	4.71	21	45	24	-0.262	-0.151
Self-regulated learning	35.84	36.00	3.77	26	45	19	0.077	-0.153
Science literacy	35.77	36.00	5.14	23	45	22	-0.314	-0.428

The relatively similar mean and median scores indicate that the distribution of scores for each variable tends to be balanced. Self-regulated learning showed the highest mean and the smallest standard deviation, indicating that most students have a relatively uniform level of self-regulated learning. This finding can be attributed to the implementation of the Merdeka Curriculum, which positions students as active participants in learning through exploration, discussion, reflection, and the completion of contextual projects in the IPAS subject (Izzah et al., 2026). Learning that consistently provides students with opportunities to set goals, seek information, and reflect on their learning outcomes has the potential to foster relatively independent learning habits among students (Sakinah et al., 2026).

In contrast, science literacy showed the largest standard deviation, indicating greater variation in ability among students. This pattern is consistent with various international studies, including the results of the PISA, which show that even though students follow the same curriculum, their abilities to apply scientific concepts, evaluate evidence, and use scientific knowledge in real-life contexts remain highly diverse (Fitria & Setiyawati, 2024). Science literacy is a multidimensional competency that depends not only on conceptual mastery but also on the ability to reason, evaluate information, and make evidence-based decisions (Purnawati & Yakin, 2025). Therefore, differences in science literacy abilities among students tend to be greater than those in self-regulated learning skills, which have been developed through daily learning activities. This finding is also consistent with the multidimensional science literacy framework proposed by Mede et al. (2025), which positions science literacy as a combination of conceptual understanding, information



evaluation, and the application of evidence in both social and environmental contexts. Conversely, science literacy exhibits the largest standard deviation, indicating a higher degree of variation in ability among students. This pattern is consistent with various international studies, including the results of the PISA, which show that even though students follow the same curriculum, their abilities.

Table 3. Results of normality and linearity testing

Statistical test	Variable or relationship	Statistic	P-value	Interpretation
Kolmogorov–Smirnov	Digital literacy	0.073	0.018	Significant departure from normality
Kolmogorov–Smirnov	Self-regulated learning	0.087	0.002	Significant departure from normality
Kolmogorov–Smirnov	Science literacy	0.099	<0.001	Significant departure from normality
Shapiro–Wilk	Digital literacy	0.989	0.148	No significant departure from normality
Shapiro–Wilk	Self-regulated learning	0.989	0.179	No significant departure from normality
Shapiro–Wilk	Science literacy	0.975	0.002	Significant departure from normality
Linearity	Digital literacy–science literacy	113.317	<0.001	Significant linear relationship
Deviation from linearity	Digital literacy–science literacy	1.399	0.126	No significant deviation
Linearity	Self-regulated learning–science literacy	109.019	<0.001	Significant linear relationship
Deviation from linearity	Self-regulated learning–science literacy	1.032	0.427	No significant deviation

The non-significant values of the Deviation from Linearity statistic for digital literacy ($p = 0.126$) and self-regulated learning ($p = 0.427$) indicate that both relationships are linear. Given the sample size of 184 students, the relatively small values of the slope and kurtosis coefficients, and the confirmed linearity of the relationships, multiple linear regression was still used for hypothesis testing.

Table 4. Results of Regression Assumption Tests

Test	Variable	Statistic	Interpretation
Multicollinearity	Digital Literacy	Tolerance = 0.687; VIF = 1.456	No multicollinearity
	Self-Regulated Learning	Tolerance = 0.687; VIF = 1.456	No multicollinearity
Heteroscedasticity	Digital Literacy	Sig. = 0.770	No heteroscedasticity
	Self-Regulated Learning	Sig. = 0.180	No heteroscedasticity

The results of the multicollinearity test showed a Tolerance value of 0.687 (> 0.10) and a VIF value of 1.456 (< 10), while the heteroscedasticity test showed significance values of 0.770 for the digital literacy variable and 0.180 for the self-regulated learning variable (both > 0.05). These results indicate that the regression model meets the assumptions and is suitable for testing the research hypotheses.



Simultaneous Relationship of Digital Literacy and Self-regulated Learning with Science Literacy

The multiple regression analysis showed that digital literacy and self-regulated learning were jointly and significantly associated with students' science literacy. The model summary and simultaneous test results are presented in Table 4.

Table 5. Multiple regression model summary and simultaneous test

R	R ²	Adjusted R ²	Standard error of the estimate	F	p-value
0.692	0.479	0.473	3.73183	83.212	<0.001

The multiple correlation coefficient of 0.692 indicates that digital literacy and self-regulated learning are strongly associated with science literacy. This model proved to be statistically significant ($F = 83.212$, $p < 0.001$), thus supporting the third hypothesis. This means that digital literacy and self-regulated learning can be used to explain differences in students' science literacy abilities. The coefficient of determination indicates that the two predictor variables together account for 47.9% of the variation in science literacy. After adjusting for the number of predictors and sample size, the model was still able to explain 47.3% of that variation. The small difference between R^2 and Adjusted R^2 indicates that the model has stable explanatory power and does not experience an excessive increase due to the addition of predictors.

The main findings of this study indicate that science literacy develops through the interplay between information management skills and the ability to regulate the learning process. Digital literacy helps students access scientific information and evaluate its relevance, accuracy, and credibility (Mede et al., 2025). Meanwhile, self-regulated learning determines how students use that information purposefully, persevere when facing learning difficulties, and reflect on their understanding (Zulaiha et al., 2023). These two skills complement each other in supporting the development of students' science literacy.

This relationship is important in environmental education because information about pollution, waste management, deforestation, climate change, and ecosystem degradation is often presented through videos, websites, digital illustrations, and social media (Nasikhah et al., 2022). Students need digital literacy to distinguish scientific information from information that lacks an evidence base (S. F. Wijayanti et al., 2025). However, the ability to access and evaluate information alone is not enough without the self-regulated to seek solutions, compare various explanations, complete tasks responsibly, and refine their understanding (Patras et al., 2021). Therefore, the contribution of these two variables indicates an integrated learning process, in which digital literacy provides sources of information and self-regulated learning helps students process that information into scientific understanding.

These findings reinforce previous research, which generally examined the relationships between variables separately. Muchsin and Akbar (2023) found that digital literacy has a positive relationship with science literacy among elementary school students, while Zainudin et al. (2024) demonstrated that self-regulated learning is positively associated with science literacy. Furthermore Wahyuni et al. (2021) found that digital literacy can support self-regulated learning among elementary school students. This study combines these relationships into a single model and demonstrates that both digital literacy and self-regulated learning remain significantly influential when analyzed together.

Nevertheless, 52.1% of the variation in science literacy remains unexplained by this research model. This suggests that science literacy is influenced not only by digital literacy and self-regulated learning but also by other factors such as prior knowledge, reading ability,



curiosity, critical thinking skills, learning motivation, the quality of instruction, teacher support, the family environment, and the availability of learning resources. Thus, while this research model has fairly good explanatory power, it does not yet fully account for all factors influencing students' science literacy development.

Relationship between Digital Literacy and Science Literacy

The partial regression results are displayed in Table 5. Digital literacy had a positive and statistically significant relationship with science literacy after self-regulated learning was statistically controlled, $B = 0.427$, $\beta = 0.391$, $t = 6.044$, $p < 0.001$. Accordingly, the first hypothesis was supported.

Table 6. Partial regression coefficients predicting science literacy

Predictor	B	Standardized β	t	p-value	Decision
Constant	1.559	-	0.570	0.569	Not significant
Digital literacy	0.427	0.391	6.044	<0.001	H1 supported
Self-regulated Learning	0.536	0.393	6.065	<0.001	H2 supported

The estimated regression equation was:

$$\hat{Y} = 1.559 + 0.427X_1 + 0.536X_2$$

Holding self-regulated learning constant, a one-point increase in digital literacy was associated with an estimated increase of 0.427 points in science literacy. This positive relationship can be explained by the connection between digital literacy and modern science literacy. In this study, digital literacy encompasses the ability to access information, analyze content, create digital products, and use technology ethically (Nurdin et al., 2025). Meanwhile, science literacy includes the ability to understand scientific concepts, evaluate scientific information from various media, and connect evidence to environmental decision-making (Purnawati & Yakin, 2025). Students who are able to identify appropriate search keywords, compare various sources, recognize invalid information, and understand visual information will find it easier to construct accurate scientific explanations (S. F. Wijayanti et al., 2025).

Digital environments may also make abstract environmental phenomena more observable. Processes such as water pollution, ecosystem imbalance, climate change, or the decomposition of waste may be difficult to observe directly during ordinary classroom instruction. Digital videos, simulations, animations, and interactive texts can present these processes dynamically (Paling & Suparyono, 2024). When students have adequate digital literacy, the digital information they access helps them understand the relationships between causes, processes, and environmental impacts that were previously abstract.

The result supports Muchsin and Akbar (2023) finding that elementary students' ability to use digital information was positively related to their understanding of science concepts. It is also consistent with research indicating that digital learning resources can strengthen students' abilities to identify scientific information, interpret evidence, and formulate conclusions. Furthermore, Wijayanti et al. (2025) reported that a guided inquiry-based flipped classroom enhanced both digital literacy and science understanding among elementary school students. Their finding suggests that digital competence becomes particularly valuable when digital resources are incorporated into inquiry-oriented learning rather than used only for passive content consumption.

Thus, the research findings indicate that the benefits of technology for science literacy depend on the quality of its use. Students benefit when they use digital media to investigate scientific problems, evaluate information, and construct evidence-based explanations



(Wahyuni et al., 2021). Therefore, digital literacy needs to be developed as the ability to use technology critically and responsibly.

Relationship between Self-regulated Learning and Science Literacy

Self-regulated learning also had a positive and statistically significant relationship with science literacy after digital literacy was controlled, $B = 0.536$, $\beta = 0.393$, $t = 6.065$, $p < 0.001$. This result supported the second hypothesis. Holding digital literacy constant, a one-point increase in self-regulated learning was associated with an estimated increase of 0.536 points in science literacy.

These findings indicate that science literacy depends not only on the availability of scientific information, but also on students' ability to regulate their own learning process. Through metacognitive regulation, students are able to plan, monitor, and evaluate their understanding, thereby becoming better able to connect scientific evidence to environmental issues. The result is consistent with Zainudin et al. (2024) who found that self-regulated learning was positively related to students' science literacy. Their study explained that students who independently evaluated their mistakes and improved their learning strategies demonstrated stronger scientific understanding. The finding also aligns with research on self-regulated science learning, which indicates that students who actively organize and monitor their learning demonstrate greater engagement and deeper conceptual understanding.

The standardized coefficient for self-regulated learning ($\beta = 0.393$) was only slightly higher than that for digital literacy ($\beta = 0.391$). The difference of 0.002 is too small to indicate meaningful practical dominance. Therefore, the more appropriate interpretation is that both predictors made nearly equivalent relative contributions to science literacy. Self-regulated learning may have been marginally stronger because digital information produces educational value only when students are sufficiently motivated and self-directed to use it for learning. However, the almost identical beta coefficients confirm that neither competency should be developed in isolation.

Integrated Scientific and Educational Implications

Research findings indicate that digital literacy and self-regulated learning are two complementary factors that support science literacy. Digital literacy helps students critically acquire and evaluate scientific information, while self-regulated learning supports their ability to manage and reflect on the learning process. The combination of the two helps students not only receive information but also analyze evidence to understand environmental issues.

These findings also indicate that the use of technology in learning does not always result in the same level of science literacy among all students. These differences are influenced by students' ability to evaluate digital information and manage their learning process. Therefore, variations in science literacy among students likely reflect differences in digital literacy and self-regulated learning.

In science education at the elementary school level, teachers need to integrate the use of digital learning resources with the promotion of self-regulated learning. Students can be guided to search for and evaluate information, compare various sources, draw conclusions based on evidence, and reflect on their learning process. In this way, technology is utilized as a tool to support meaningful science learning.

This study shows that digital literacy and self-regulated learning each have a positive relationship with science literacy and, together, contribute to variations in students' science literacy. However, because it employs a correlational design, the results of this study only indicate associations and predictive contributions, not a cause-and-effect relationship. Therefore, future research is recommended to use a longitudinal or experimental design



involving a more diverse sample and examining other factors that influence the development of science literacy.

Conclusion

This study shows that digital literacy and self-regulated learning have a positive and significant relationship with the science literacy of fifth-grade elementary school students in environmental education. Self-regulated learning contributes slightly more than digital literacy. These findings indicate that improvements in science literacy depend not only on the ability to use technology but also on students' ability to manage their own learning process. Therefore, IPAS instruction needs to integrate the use of digital learning resources with the development of self-regulated learning. The results of this study support all hypotheses and show that both competencies play an important role in the learning of Natural and Social Sciences. Therefore, teachers and curriculum developers need to integrate digital literacy and self-regulated into environment-based learning to strengthen students' science literacy.

Recommendation

Based on the results of the statistical analysis, digital literacy and self-regulated learning have a positive and significant relationship with elementary school students' science literacy. However, self-regulated learning shows a slightly greater contribution than digital literacy. This indicates that students' ability to manage their own learning process, such as setting goals, choosing strategies, monitoring progress, and reflecting, plays a crucial role in improving science literacy. Therefore, the development of digital literacy must be accompanied by efforts to strengthen students' self-regulated learning (Sari, 2022).

Teachers are encouraged to design lessons that integrate digital learning resources with strategies that promote independent learning through reflection, setting learning goals, and evaluating the learning process. This strategy can help students manage their learning process while using digital information more effectively (Nafsi & Abdussakir, 2025). In these activities, teachers play a role in guiding students to set goals, search for information, monitor their understanding, and reflect on their learning outcomes (Sakinah et al., 2026).

Future research is recommended to use a longitudinal or experimental design to examine the effects of digital literacy and self-regulated learning on the development of science literacy. In addition, future research could involve schools with more diverse characteristics, use performance-based science literacy assessments, and consider other factors, such as cognitive abilities, motivation, and the learning environment.

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