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Systematic Literature Review: Technology-Based and Contextual Science Literacy in Elementary School Science Education

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Abstract

Low science literacy is one of the challenges in education in Indonesia. Various learning innovations are one of the efforts to increase students' interest and science literacy. This study aims to systematically review trends, approaches, and innovations in technology-based and contextual science learning in improving students' science literacy. The method used was a systematic literature review of 26 selected articles from various databases, which were selected using specific inclusion and exclusion criteria. The results of the analysis show that the trend of publications has been increasing since 2023 with various innovations in science literacy learning. The most widely used learning approaches include technology-based learning, outdoor learning, science experiments, social science issues, and local culture or ethnoscience. The learning innovations that have been developed include science curricula, VR media, interactive video media, E-LKPD, and so on. The conclusion of this study confirms that science literacy can be improved through various learning innovations to increase students' interest and motivation in learning science. Technology-based and contextual science learning has proven to be a strategic response to the challenge of low science literacy.

Keywords:

Science literacy, science education, technology, ethnoscience, contextual science

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1. INTRODUCTION

Science literacy is one of the crucial skills needed in this era of scientific and technological advancement (Utami, 2024). Through science literacy, students will be able to think critically, solve problems, and develop a scientific attitude (Parisau et al., 2025). Science literacy has components of the scientific process, which include recognizing scientific questions, identifying evidence, drawing and evaluating conclusions, communicating valid conclusions, and demonstrating understanding (Pratama, 2025). The low level of science literacy can be seen from the 2018 PISA results, which show that Indonesia ranks 70th out of 78 countries, with an average science literacy score of 396. In the 2022 PISA results, Indonesia's ranking rose by 6 positions compared to the previous year, but its science literacy score decreased by 13 points (Pusmendik, 2024). This is influenced by many factors, both internal and external, related to the decline in science literacy.

Internal factors that can influence science literacy include the quality of classroom learning, such as a lack of variety in teaching methods (Hutabarat et al., 2025). In addition, it is also influenced by the lack of practical learning or experiments and the failure to integrate technology into learning, as well as teachers not linking science to real life in the learning process. Other factors include limited resources, students finding science difficult to understand, and a lack of interest and motivation to learn science (Indriyani, 2025). External factors include the lack of utilization of open spaces, the unavailability of science laboratories, the lack of teaching aids and supporting facilities in classrooms, and the unsupportive conditions of libraries (Syahriani et al., 2024). The application of innovative strategies is identified as the key to improving the

quality of learning in the classroom, which in turn will encourage children's independence in the future (Chrismanto et al., 2024). These various factors require alternative solutions for innovative learning development through the integration of science with contextual learning and technology.

Technology can be integrated into the development of interactive science learning media. Learning media should support students' critical thinking skills so that it not only presents information, but also challenges students to analyze, evaluate, and conclude information independently (Purnawati & Yakin, 2025). Examples include the development of virtual laboratories (Labster) and educational assessments using Quizizz (Atmojo & Wardana, 2025). In addition, teachers can also develop simple experiments, educational games, and interactive demonstrations packaged in science fun day themed activities (Sariyyah et al., 2025). Another use of technology is through interactive Augmented Reality-based science learning media (Lestari, 2025). Technology-based science learning can also be integrated with contextual approaches such as local culture.

The integration of local cultural elements into science education not only makes learning more contextual but can also shape students' positive character (Laili et al., 2025). The results of research by Hidayah & Suryanti, (2025) show that the development of ethnoscience-based e-comis has proven effective in improving elementary school science literacy. Not only that, the development of ethnoscience-based LKPD also helps students to think critically, thereby improving science literacy (Sari et al., 2024). Through ethnoscience, teachers can integrate local cultural elements into science learning, so that the material presented is closer to the daily lives of students (Zumaro et al., 2024).

As research and development in science literacy increases, studies on the use of technology and contextual learning are becoming increasingly important. Systematic studies are needed to identify trends, approaches, and innovations in science literacy learning. Therefore, it is important to conduct systematic studies to collect, evaluate, and synthesize the results of research related to technology-based and culturally contextual science literacy learning. The results of this study are expected to provide a comprehensive overview of the most relevant and effective dimensions of science literacy in supporting science learning in the digital age. In addition, the results of this SLR will also contribute to the development of science curricula, science literacy measurement tools, and interactive science learning media or models. This research aims to synthesize the findings of studies that analyze the development of technology-based and locally contextual science literacy learning.

2. LITERATURE REVIEW

Science literacy is an important competency that students must possess from elementary school onwards because it is related to the ability to understand scientific concepts, solve problems, and make decisions based on scientific evidence. According to the OECD through the Programme for International Student Assessment (PISA) framework, science literacy includes the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically (OECD, 2022). At the elementary school level, the development of science literacy must be tailored to the cognitive development characteristics of students who are still in the concrete operational stage, so that learning needs to connect scientific concepts with real experiences in everyday life.

With the development of digital technology, the use of technology in science education has been proven to improve students' science literacy (Missouri et al., 2025). Various studies show that technology-based learning media such as animated videos, interactive simulations, augmented reality, and digital learning platforms can improve students' conceptual understanding, motivation to learn, and critical thinking skills. Technology allows abstract phenomena to be visualized in a more concrete and understandable way for elementary school students. In addition, the integration of technology also supports more interactive, collaborative, and student-centered learning, thereby encouraging active engagement in the science learning process.

The contextual approach also plays an important role in improving science literacy because it links learning materials to the social, cultural, and real-life environments of students. Contextual learning helps students understand the relevance of science in everyday life and develop scientific thinking skills through direct experience. In the context of basic education in Indonesia, integrating local wisdom and culture into science learning can enrich students' understanding and enhance the meaning of learning (Septina et al., 2025). Therefore, combining a technology-based approach with contextual learning is an effective strategy for improving the science literacy of elementary school students, as it connects scientific concepts with real-life experiences while utilizing technological advances as an innovative learning tool.

3. RESEARCH METHOD

The research design used was descriptive narrative with the Systematic Literature Review (SLR) method, which used literature study techniques from published secondary data. The evaluation method used was PRISMA (Preferred Reporting Items for Systematic Review and Meta Analyses) to select the quality of articles to be reviewed (Hartini et al., 2025). The main data sources in this study came from the Google Scholar, Scopus, Since Direct, and Pubmed databases by entering search queries using Boolean operators. The search query in this study was (“scientific literacy” OR “science literacy”) AND (“technology-based learning” OR “digital learning” OR “e-learning”) AND (“contextual learning” OR ‘ethnoscience’) AND (“elementary school” OR “primary school”). The data obtained from the database search was identified by removing duplicate data, and the remaining data was sorted alphabetically by title. The screening and eligibility process was carried out by selecting data that was relevant, high quality, and in line with the focus of the study. The inclusion criteria applied to eliminate data that did not meet the requirements are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria using the PICOS Format

Component	Inclusion Criteria	Exclusion Criteria
P (<i>Population</i>)	Elementary school students (grades 1–6) focus on science or integrated science and technology subjects and discuss science literacy among elementary school students.	Participants from junior high school, high school, or college levels, with a focus not on science literacy
I (<i>Intervention</i>)	Technology-based learning (e.g., interactive videos, applications, simulations, e-learning, digital media, etc.). Contextual learning (e.g., real-world problems, local culture, ethnoscience, or the surrounding environment).	Non-technological and non-contextual approaches (e.g., traditional lectures without technological integration or cultural context)
C (<i>Comparison</i>)	Conventional/traditional learning as a comparison	Research that does not provide any comparison at all (e.g., purely descriptive without intervention)
O (<i>Outcome</i>)	Improvement of science literacy (knowledge, skills, and scientific attitudes).	Learning outcomes not related to science literacy (e.g., numeracy, character, etc.)
S (<i>Study Design</i>)	<ul style="list-style-type: none"> - Empirical research (experimental, quasi-experimental, R&D, mixed-method, or quantitative survey) - Published between 2020 and 2025 - Published in accredited national or reputable international journals 	<ul style="list-style-type: none"> - Non-empirical articles (opinions, editorials, theories without data) - Full text not available - Published before 2020

An overview of the article selection steps is presented in the PRISMA flow diagram. This flow diagram shows how, from 426 initial documents, a rigorous selection process successfully filtered down to 26 relevant documents that were suitable for analysis in a systematic literature review study on technology-based and contextual science literacy research. The PRISMA flow diagram visualization ensures transparency in the selection process and enhances the reliability of the study results obtained. The entire process is systematically visualized in Figure 1.

4. RESULT AND DISCUSSION

The results of the study of all articles obtained through various scientific databases such as Google Scholar, Scopus, and ScienceDirect were analyzed using bibliometric mapping techniques with the help of VOSviewer software. The analysis was conducted based on keywords that appeared in publications to identify the interrelationships between topics in science literacy research, particularly those focusing on the use of technology and contextual learning in primary education. This process involved metadata extraction, filtering of relevant keywords, and grouping of terms based on frequency of occurrence and strength of relationships between keywords.

The resulting visualization shows the network of connections between keywords in the form of a bibliometric map divided into several thematic clusters. Each cluster represents a group of research topics that are conceptually related, such as the use of digital technology in science education, the development of student science literacy, real-life context-based learning, and the integration of interactive media in the learning process. The size of the nodes on the map indicates the frequency of keyword occurrence, while the connecting lines illustrate the strength of the relationship between topics in the analyzed literature.

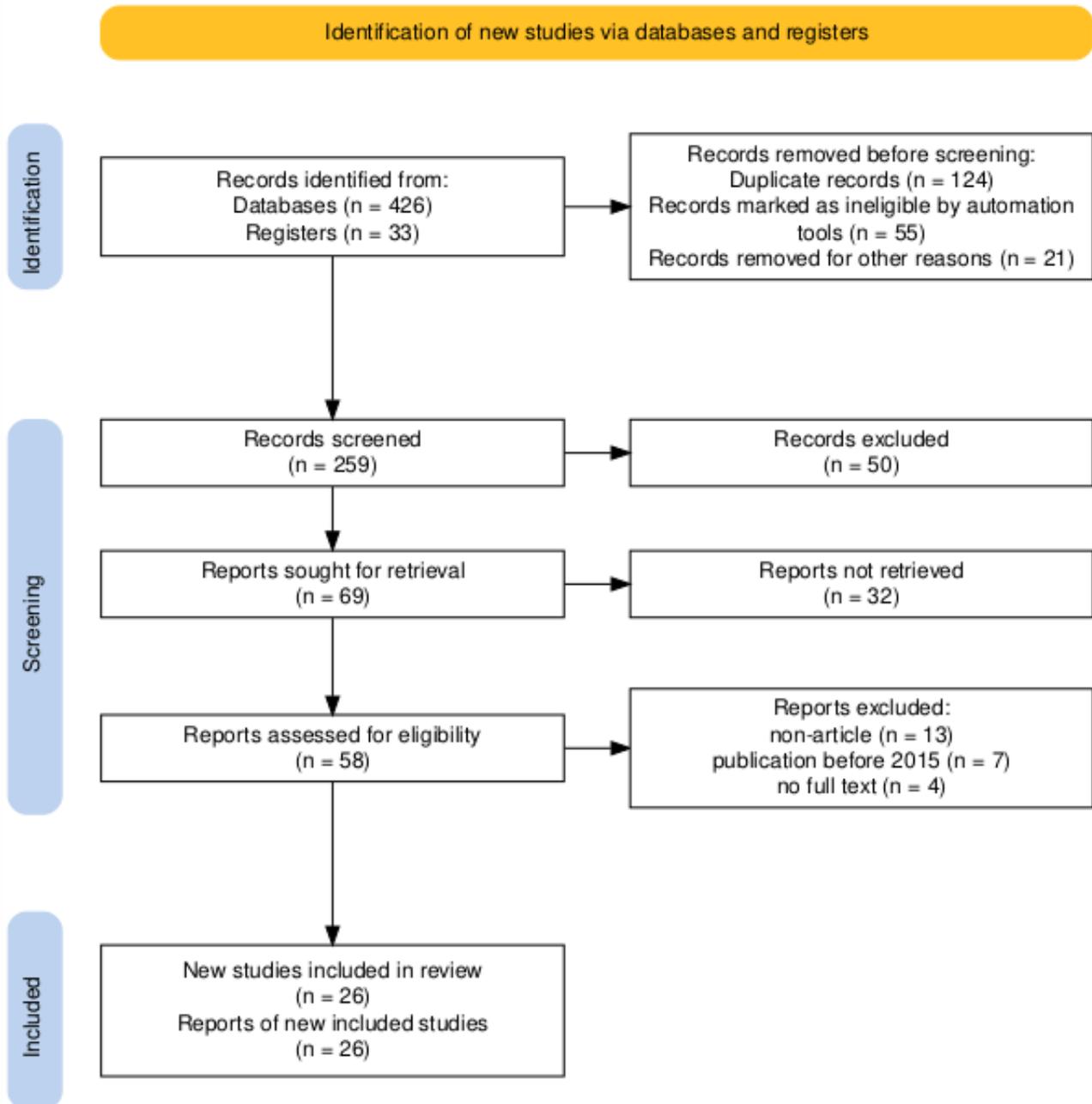


Figure 1. PRISMA Flow Chart

Through this mapping, key research trends and directions for the development of technology-based and contextual science literacy studies can be identified. In addition to highlighting themes that have been extensively researched, cluster analysis also helps to reveal areas of research that are still limited and have the potential for further development. Thus, the results of this analysis not only provide a comprehensive overview of existing research focuses, but also serve as a basis for determining opportunities for innovation and research development in the future. The keyword map and research clusters generated from this VOSviewer analysis are presented in Figure 2 as a visual representation of the relationships between research themes.

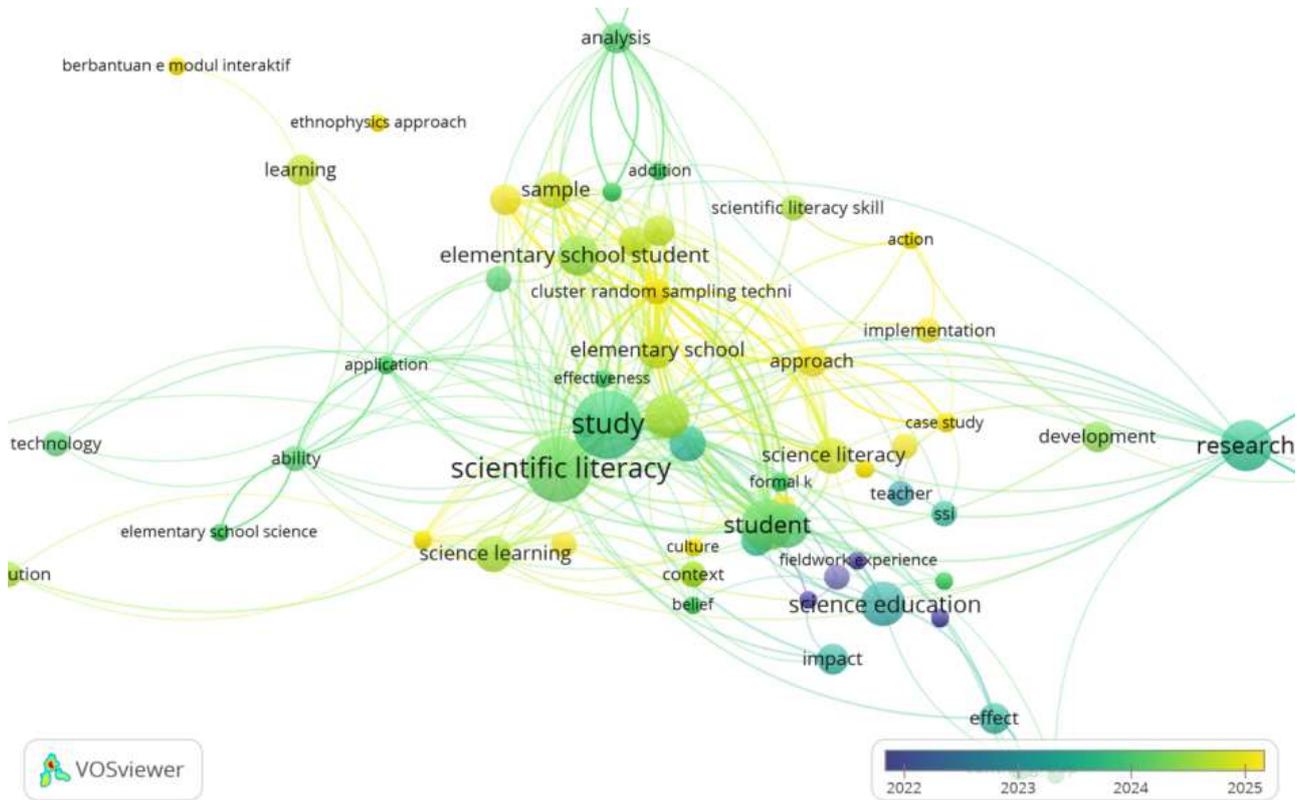


Figure 2. Keyword Visualization Using VOSviewer

The image above shows the results of bibliometric analysis using VOSviewer, which depicts a map of keyword co-occurrence related to the topic of scientific literacy, particularly in the context of primary education and science learning. It can be seen that the most dominant keywords at the center of the map are scientific literacy, study, elementary school student, and student. The data shows that research on science literacy focuses heavily on elementary school students as the main subject. The dense connections around the keyword scientific literacy indicate that this topic is the main axis connecting various themes such as science education, science learning, analysis, application, and research.

Green dominates this map, indicating that most publications related to science literacy were published in the period 2023–2024. Yellow indicates the latest research trends in 2025, such as interactive e-modules, implementation, case studies, culture, and the ethnophysics approach. This signifies an increased focus on practical implementation and innovation in contextual and culture-based science learning approaches. The emergence of the terms interactive e-modules and technology indicates a research trend toward developing digital teaching materials and technology-based learning media to increase student engagement. The theme of ethnophysics approach is interesting because it leads to the integration of local culture in science learning, which is in line with efforts to contextualize science literacy to be closer to students' daily lives. This is important in building science literacy that is not only cognitive but also socially and culturally relevant. On the other hand, keywords such as teacher, context, and culture indicate that the research does not only focus on students but also considers the role of teachers and socio-cultural backgrounds.

This map also displays the word “research” on the right side in large letters, indicating that this field continues to grow and produce many new studies. The interconnectedness of the keywords “development,” “effectiveness,” “impact,” and “approach” indicates that the research is not only descriptive but also oriented toward developing learning models, evaluating impact, and testing program effectiveness. The color trend moving from blue to yellow indicates a shift in research focus from theoretical and conceptual studies (2022) towards the implementation and development of learning interventions (2024–2025). Thus, the results of VOSviewer can be concluded that science literacy research at the elementary school level is developing in a more applicative, technology-based direction that pays attention to the socio-cultural context of students. These findings open up opportunities for the development of innovative curricula, learning methods, and teaching materials to improve students' science literacy skills so that they are ready to face the challenges of the 21st century.

4.1. Technology-Based and Contextual Science Literacy Learning

The results of the systematic analysis of the articles provide an overview of how science literacy learning is applied in various technological and cultural contexts. Science literacy learning has been a research trend over the past five years, resulting in a variety of research outcomes. Based on 26 relevant articles from the PRISMA flow, the six best articles were selected and analyzed in Table 2.

Table 2. Results of Article Findings Analysis

No	Author	Topic	Method	Novelty
1	(Suryanti <i>et al.</i> , 2024)	STEAM-Project-Based Learning: A Catalyst for Elementary School Students' Scientific Literacy Skills	Quasi-experimental methodology	The STEAM-PjBL model significantly improves students' science literacy skills.
2	(Uslan <i>et al.</i> , 2024)	The Effectiveness Of The Local Knowledge-Based Module (LKBM) To Improve Students' Scientific Literacy And Thinking Skills	Experimental method	Local knowledge-based modules effectively improve students' science literacy and thinking skills
3	(Prasetyo <i>et al.</i> , 2024)	Integration indigenous science in merdeka curriculum to strengthen scientific literacy and environmental care in elementary schools	Qualitative approach with case study design.	Multimodal indigenous science from Javanese culture can be specified according to the needs of elementary school science.
4	(Sariyyah <i>et al.</i> , 2025)	Enhancing Science Literacy Of Elementary School Students Through An Interactive Learning Approach Based On Educational Videos And Real Life Contexts	Experiential learning approach	A creative, enjoyable, and real-world experience-based approach to science learning can be an alternative solution in fostering science literacy from an early age.
5	(Fan <i>et al.</i> , 2024)	Effects of Outdoor Education on Elementary School Students' Perception of Scientific Literacy and Learning Motivation	Experimental method	Outdoor learning has a positive effect on increasing awareness and developing science literacy and motivation.
6	(Herayanti <i>et al.</i> , 2025)	Development of Ethnoscience-Based Teaching Materials to Improve Students' Scientific Literacy	Development methods (R&D).	Ethnoscience-based learning significantly improves science literacy.

Based on a systematic review of the six articles listed in Table 2, it can be concluded that the trend in science literacy research at the elementary school level shows a significant shift towards the integration of technological and contextual approaches. The first study by Suryanti *et al.*, (2024) highlights the application of the STEAM Project-Based Learning (PjBL) model as a catalyst for improving the science literacy skills of elementary school students. Through a quasi-experimental methodology, this study found that the integration of Science, Technology, Engineering, Arts, and Mathematics elements in elementary school science literacy skills can be used as a catalyst for improving students' science literacy skills. -Based Learning (PjBL) model as a catalyst for improving the science literacy skills of elementary school students. Through a quasi-experimental methodology, this study found that the collaborative integration of Science, Technology, Engineering, Arts, and Mathematics elements can encourage students to think critically, creatively, and reflectively about the scientific phenomena around them (Khoiriya *et al.*, 2023). The STEAM approach not only fosters conceptual abilities, but also improves practical skills relevant to real life (Atiaturrahmaniah *et al.*, 2022). This model shows that when science learning is linked to technology and contextual problem-based

projects, students are better able to understand the relationship between theory and application, which ultimately strengthens their functional science literacy (Putri et al., 2023). The results of research by Novita et al., (2025) also show that the use of STEAM combined with the Discovery Learning model can improve concept verification, increase science literacy and learning outcomes, and involve students in contextual learning activities. STEAM can also be combined with the Problem-Based Learning (PBL) model, which can improve science literacy through real-life problems (Firawaty et al., 2025).

Further research by Uslan et al., (2024) reinforces this view by developing a Local Knowledge-Based Module (LKBM) that emphasizes the integration of local knowledge in the learning process. Through experimental methods, the results of the study show that modules based on local wisdom are not only effective in improving science literacy but also enrich students' thinking skills comprehensively. This indicates that contextual aspects in science learning are able to connect scientific concepts with students' social and cultural experiences (Muizz et al., 2023). When students understand that scientific concepts are rooted in phenomena they encounter in their daily environment, the learning process becomes more meaningful and builds inclusive scientific awareness. Ethnoscience learning is not only capable of improving science literacy but can also have a positive effect on regional cultural appreciation (Siagian & Tamba, 2023). Thus, LKBM innovation can be categorized as a form of contextual science learning that is relevant to the principles of science literacy, namely making science a tool for thinking to understand the surrounding world scientifically.

The results of the study by Prasetyo et al., (2024) deepen the dimension of contextualization by exploring indigenous science in the Merdeka curriculum. This qualitative study with a case study design shows that the integration of traditional Javanese science, such as agricultural practices and environmental management, can strengthen science literacy while fostering ecological awareness. This approach not only builds a bridge between modern science and local wisdom, but also fosters a sense of cultural identity in students (Nugroho et al., 2024). In the context of the Merdeka Curriculum, this model is relevant to the principles of differentiated and contextual learning that place local experiences as authentic learning resources. The results of this study confirm that the integration of indigenous knowledge can broaden students' scientific literacy horizons because they learn to understand science as a socio-cultural product, not just a collection of facts and theories. Science learning based on indigenous science can facilitate active student interaction with concrete objects through the surrounding environmental culture as a source of learning. Science learning with the integration of local wisdom can make the science concepts studied more applicable, solution-oriented, and relevant to the surrounding environment (Muyassaroh et al., 2024).

Further research by Sariyyah et al., (2025) highlights technological aspects through an experiential learning approach based on educational videos and real-life contexts. This study emphasizes the importance of using interactive media that can stimulate students' curiosity about scientific phenomena around them. Creative and enjoyable learning approaches using interactive media play an important role in building meaningful learning experiences (Zulqadri & Nurgiyantoro, 2023). By watching educational videos linked to simple experiments or environmental observations, students can learn multisensorily (hearing, seeing, and feeling), which has been proven to improve conceptual understanding and scientific thinking skills (Najib et al., 2023). In addition, the use of technology in real contexts makes learning more adaptive to the digital age, where science literacy skills need to be in line with digital literacy so that students can navigate scientific information critically and wisely (Hafis & Ngazizah, 2022). Animated video media also helps students visualize science material, thereby improving their understanding of scientific concepts, which has a positive effect on increasing science literacy (Purniasih et al., 2024).

In a study conducted by Fan et al., (2024), outdoor learning was identified as an effective strategy for improving elementary school students' perception of science literacy and motivation to learn. Through experimental methods, it was found that learning activities in the open air provided opportunities for students to observe scientific phenomena directly and relate them to theoretical concepts in the classroom. Interaction with the natural environment encourages curiosity, ecological responsibility, and contextual scientific thinking skills. Thus, outdoor learning is not merely a recreational activity, but serves as an integrative vehicle for fostering scientific awareness and environmental awareness (Halizah et al., 2025). The results of this study also emphasize the importance of experiential learning that integrates digital technology for documentation, reflection, and presentation of student observations. The results of the study show that effective outdoor learning can provide real experiences that enrich learning and have a positive impact on students' science literacy (Parisu et al., 2025).

Further research by Herayanti et al., (2025) confirms the importance of developing ethnoscience-based teaching materials to improve science literacy. Using the Research and Development (R&D) method, this study produced learning tools that integrate local cultural values with modern scientific concepts. Ethnoscience-based learning has been proven to not only enrich students' conceptual understanding but also

increase their awareness of the relationship between science and community life (Ndoya et al., 2024). In addition to improving conceptual understanding, the ethnoscience approach also contributes to strengthening cultural identity and an appreciative attitude towards local wisdom. Students become more aware that traditions passed down from generation to generation contain scientific values and practical logic that are relevant to modern life. This can foster a sense of pride in local culture while building a critical and reflective scientific attitude in interpreting the phenomena around them. By utilizing the cultural context, students can learn to recognize scientific practices in local traditions such as natural material processing, traditional ceremonies, or traditional agricultural practices. This reinforces the argument that science literacy at the elementary school level needs to be developed through a contextual and socio-culturally relevant approach (Mukti et al., 2022).

Overall, these six studies indicate the direction of science literacy studies, which are becoming increasingly integrative between technology, local wisdom, and the context of everyday life. The application of learning models such as STEAM-PjBL, LKBM, indigenous science, and ethnoscience shows that science literacy does not only focus on understanding concepts but also on scientific thinking skills, cultural awareness, and ecological responsibility. Thus, IPAS learning in elementary schools should no longer be viewed as merely the transfer of scientific knowledge, but as a process of forming scientific character rooted in the local socio-cultural and ecological context. This systematic study provides a theoretical contribution to the development of technology-based and contextual science literacy learning models that are in line with the vision of the Merdeka Curriculum, namely to nurture empowered, adaptive, and scientific-minded students in facing the challenges of the 21st century.

Based on a review of a number of research articles from 2020–2025, it appears that the direction of science literacy research at the elementary school level is moving towards the integration of digital technology and local wisdom as innovative and contextual learning strategies. The results of research by Suryanti et al., (2024) show that the application of STEAM-PjBL can improve science literacy skills. The contextual learning process through project creation related to problems, searching for potential solutions, project design and implementation, data collection and analysis, and drawing conclusions can improve science literacy skills. The results of research by Fan et al., (2024) also support that outdoor learning can increase motivation and science literacy in three dimensions, namely awareness, skills, and affection. Science learning with a scientific approach will help students develop scientific process skills and build scientific attitudes (Siregar et al., 2020). Contextual, interactive, and enjoyable science learning will have a positive effect on improving science literacy (Sariyyah et al., 2025). Science learning with approaches such as direct experiments, interactive simulations, and educational games can increase motivation to learn science (Sun & Chan, 2025). Science literacy skills will help students solve problems based on their scientific knowledge (Nasir et al., 2024).

Science literacy can also be improved through a cultural approach. Utilizing the culture and environment surrounding students can make science learning more meaningful and relevant (Osborne & Allchin, 2024). The results of research by Chamdani et al., (2025) show that ethnoscience has a significant influence on improving science literacy. The use of local culture-based knowledge will help develop scientific concepts, thereby deepening the understanding of scientific concepts (Uslan et al., 2024). One example is Javanese culture, which can be used as a source of indigenous science integration in terms of content, process, and learning products (Prasetyo et al., 2024). Research by Rifa'i et al., (2025) also shows that traditional foods can be used as a source of science learning for elementary school students. Ethnoscience, which combines elements of science and culture, can be an alternative solution to improve students' science literacy. Ethnoscience teaching materials help students explore science through their own culture, thereby increasing their depth of understanding (Herayanti et al., 2025). Ethnoscience is able to attract students' interest in science and technology material, thereby increasing their science literacy (Minsih et al., 2025).

The use of technology in science education in elementary schools is one of the key strategies for improving students' science literacy in the digital age. Science literacy encompasses not only the ability to understand scientific concepts, but also critical thinking skills, problem solving, and the application of science in everyday life. The use of technology can also be a solution for improving science literacy. Research by Atmojo & Wardana, (2025) states that technology-based science learning using virtual laboratories (Labster) and educational applications (Quizizz) in elementary schools is effective. Digital technologies such as encyclopedias, interactive simulations, animations, and educational videos provide a more contextual, visual, and engaging learning experience that can improve science literacy (Aviarizki et al., 2024). Technology can also be integrated with socio-scientific issues to make science learning more interesting and contextual (Badeo & Duque, 2022). The application of socio-science can be implemented in the curriculum to improve science literacy (Pessoa et al., 2025).

The use of media innovation can also have an impact on improving science literacy. Research conducted by Annetta et al., (2024) shows that the use of Mixed Reality (MR) can enhance the science

learning experience through audio-visual integration and three-dimensional interactions that are attractive to students. Similar findings were also reported by Septarini et al., (2024), who developed STEAM-based e-LKPD and reported a significant increase in students' science literacy and learning motivation. In addition, Zumaroh et al., (2024) and Hidayah & Suryanti,(2025) found that the application of interactive e-modules and e-comics can strengthen the connection between scientific concepts and local culture. Science literacy will be more meaningful when linked to technology, socio-culture, and the environment in which students grow up (Syofyan et al., 2025).

The practical implications of this review highlight the importance of synergy between technological innovation, ethnoscience approaches, and strengthening teacher competencies in improving science literacy in elementary schools. Teachers need to be trained not only in technological aspects, but also in integrating local culture as a source of learning. On the policy side, these research results emphasize the need to develop national science literacy standards based on local wisdom and sustainable teacher training programs so that they are able to implement contextual and project-based learning. Thus, the development of science literacy in Indonesia can move towards a more holistic, inclusive learning model that is rooted in the character of the nation. The role of teachers is a key factor in the successful implementation of this approach. Teachers not only need to master the use of learning technology, but also have the pedagogical skills to integrate local wisdom as a meaningful learning resource. Continuous professional training needs to be designed to improve teachers' digital literacy, their ability to design contextual learning, and their skills in developing teaching materials based on local culture. In addition, teachers need to be encouraged to develop project-based and inquiry-based learning that allows students to explore scientific phenomena through cultural practices and the surrounding environment.

At the policy level, the findings of this study indicate the need for systemic support from the government and education stakeholders. The development of national science literacy standards that accommodate local wisdom can serve as a foundation for designing a curriculum that is relevant to Indonesia's cultural diversity. In addition, structured and sustainable teacher training programs need to be integrated into education policy so that teachers are able to effectively implement technology-based and contextual learning. Digital infrastructure support, the provision of locally-based learning resources, and partnerships with cultural communities are also important factors in supporting the implementation of these policies. Furthermore, strengthening science literacy through this holistic approach has the potential to shape a generation that is not only academically competent, but also has a strong cultural identity and critical thinking skills in facing global challenges. An inclusive learning model rooted in national character can help students understand the relationship between science, culture, and environmental sustainability. Thus, the development of science literacy in Indonesia can move towards a more relevant, adaptive, and future-oriented education system, while maintaining cultural values as the foundation for shaping students' character.

The implementation of technology-based science literacy and ethnoscience also opens up opportunities for collaboration between schools, communities, and local cultural institutions. The involvement of community leaders, cultural practitioners, and parents in the learning process can enrich learning resources and provide authentic experiences for students. Activities such as field trips, documentation of traditional practices, environmental exploration projects, and culture-based exhibitions can strengthen the connection between schools and communities. This collaboration not only supports contextual learning but also fosters a sense of social responsibility and concern among students for the preservation of culture and the environment around them. With the support of a collaborative educational ecosystem, science literacy can develop as a relevant, applicable, and sustainable competency.

5. CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that technology-based science literacy learning and contextual culture is the most effective approach to fostering science literacy among elementary school students. The integration of interactive digital media such as e-modules, e-LKPD, and mixed reality with local wisdom values can create meaningful, relevant, and real-life learning experiences for students. This approach not only improves cognitive learning outcomes but also strengthens the affective and social dimensions through cultural, traditional, and social context engagement around students. Therefore, technology-based and contextually-based science literacy should be the foundation for curriculum development, learning innovation, and teacher training so that science education in Indonesia can be more adaptive to the times without losing its cultural roots. A technology-based and culturally contextual approach not only improves cognitive achievement but also strengthens the affective and social dimensions of students. The involvement of cultural elements, traditions, and the social context surrounding students fosters an appreciative attitude towards local wisdom, increases concern for the environment, and develops collaboration and communication skills. Therefore, technology-based and culturally contextual science literacy needs to be

used as a foundation in curriculum development, learning innovation, and teacher training programs. Through the application of this approach, science education in Indonesia is expected to become more adaptive to the times while remaining rooted in the cultural values of the nation.

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