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Science Literacy and Foundational Critical-Thinking Behaviors in Early Childhood: Kindergarten Teachers' Perceptions and Practices

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ABSTRACT

Science literacy plays a crucial role in stimulating critical thinking skills in early childhood through various activities that provide children with opportunities to observe, explore, investigate, and explain phenomena encountered in daily life. This study describes kindergarten teachers' perceptions and reported science-literacy practices, examines teacher-reported child behaviors that are consistent with foundational processes related to critical thinking, and identifies implementation barriers. A convergent mixed-methods design was used. The raw Google Forms export contained 111 submissions; screening by unique respondent identifier identified 15 repeat submissions, leaving 96 unique respondents. Among valid quantitative responses, all 96 teachers reported having introduced science activities; 77 of 96 (80.21%) rated science literacy at the highest importance category; and 80 of 96 (83.33%) reported science activities at least three times per month. Qualitative analysis showed that teachers commonly reported children's enthusiasm and curiosity, questioning, attentive observation, willingness to try or repeat experiments, and simple explanations or predictions. These behaviors were interpreted as learning dispositions, science-process skills, and emerging reasoning behaviors rather than as direct evidence of validated critical-thinking performance. Barriers included limited tools and materials, time constraints, classroom-management demands, and uneven teacher knowledge and institutional support. Integration of the two data strands suggests that science activities are perceived as important and are implemented regularly, but the quality and depth of implementation vary according to available support.

Keywords: critical thinking, early childhood education, kindergarten teachers, science literacy

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INTRODUCTION

Early childhood education is a crucial foundation for the development of all aspects of a child's growth- cognitive, social-emotional, religious and moral values, and physical development. During early childhood, a child's brain develops rapidly and is ready to receive various forms of stimulation through meaningful learning experiences. At this stage, children possess a high level of curiosity and a natural tendency to explore their surroundings. Therefore, the learning experiences provided must be able to stimulate the development of higher-order thinking skills in a fun and meaningful way. One higher-order thinking skill that needs to be developed from an early age is critical thinking, as this skill forms the basis for children to solve problems, make decisions, and think logically and reflectively about various situations they face in daily life (Vasquez, 2017).

Early childhood critical thinking skills are a vital asset for addressing future educational challenges (O'Reilly et al., 2022). Critical thinking can develop through early exposure to certain practices, including cultivating the habit of observing, analyzing, and seeking solutions to problems encountered. Critical thinking skills are one of the key 21st-century competencies that need to be developed from an early age. (Facione, 2015)explains that critical thinking encompasses the ability to analyze, evaluate, and make decisions based on logical reasoning and relevant evidence. In young children, critical thinking is reflected in their ability to ask questions, interpret information, connect experiences, and discover new ways to solve simple problems. If this ability is cultivated from an early age, children will grow into more independent, reflective, and creative individuals when facing life's challenges (Fisher, 2011).

In this context, critical thinking skills are essential for preparing children to face the complex and dynamic challenges of the 21st century (Widiawati et al, 2024).Therefore, learning in early childhood education must be designed to provide children with opportunities to explore, discover, and construct their own knowledge through active interaction with their environment. One approach considered effective for stimulating critical thinking skills in young children is through the enhancement of science literacy in daily learning activities (Leonia et al., 2025). Science literacy in early childhood education is not merely understood as an introduction to simple scientific concepts but also encompasses children's ability to observe phenomena, ask questions, conduct explorations, foster curiosity, and construct simple explanations for various events encountered in daily life (Agustini et al., 2024). Various studies indicate that exploratory and inquiry-based science learning experiences can encourage children to engage in higher-order thinking processes through activities such as observing, predicting, testing, and communicating their findings to others. Thus, science literacy holds a strategic position as a vehicle for developing critical thinking skills from an early age.

The urgency of developing science literacy in early childhood is increasing in line with educational demands that are no longer oriented solely toward the mastery of knowledge but also toward the ability to use that knowledge to understand and respond to various life issues rationally (Leonia et al., 2025). Recent research indicates that science learning that provides children with opportunities for active exploration can enhance curiosity, engagement in learning, the ability to ask questions, and the capacity for deeper reasoning compared to one-way instruction (Agustini et al., 2024). Furthermore, strengthening science literacy from an early age also contributes to the development of evidence-based thinking habits, which are a key characteristic of individuals capable of critical thinking (Golob & Ungar, 2025). Therefore, the development of science literacy in preschool settings requires greater attention as part of efforts to improve the quality of early childhood education.

Science literacy in early childhood education is viewed as children's foundational ability to understand natural phenomena through the processes of observing, exploring, experimenting, communicating findings, and connecting learning experiences to daily life (Leonia et al., 2025). The development of science literacy in childhood is not oriented toward mastering complex scientific concepts but rather toward the formation of scientific thinking characterized by curiosity, the ability to ask questions, the courage to try, and the habit of seeking explanations for various phenomena encountered by children (Leonia et al., 2025). This approach aligns with the developmental characteristics of young children, who learn most effectively through direct experiences, play, and interactions with their physical and social environments (Roy et al, 2022; Leonia et al., 2025). Scopus-indexed research indicates that science experiences from an early age play a crucial role in building reasoning, argumentation, and problem-solving skills, which form the foundation for the development of children's critical thinking (Roy et al., 2025). Therefore, science literacy in early childhood education must be positioned as a process of building the foundation of scientific thinking that will support the development of critical thinking skills in subsequent developmental stages.

Various previous studies have shown a positive relationship between science learning and the development of critical thinking skills in early childhood. A study (Yuliani et al., 2023) found that the Inquiry Project-Based Learning model has a significant impact on improving the critical thinking skills of 5–6-year-old children because it encourages children to actively engage in the process of investigation and problem-solving. Other findings indicate that inquiry-based and science exploration learning approaches can enhance curiosity, the ability to ask questions, and reasoning skills, key components of critical thinking in young children (Agustini et al., 2024). Scopus research results also indicate that science investigation activities involving observation, prediction, experimentation, and discussion can develop children's critical thinking, scientific reasoning, and decision-making skills from an early age (Saçkes et al., 2020). Furthermore, a systematic review on science literacy in early childhood education reveals that meaningfully designed science activities contribute to the development of children's critical thinking, problem-solving, and decision-making skills across various learning situations (Leonia et al., 2025). These findings indicate that science literacy holds significant potential as a tool for developing critical thinking skills from an early age; however, its effectiveness heavily depends on how teachers understand and implement it in daily teaching practices.

Given these conditions, this study offers a novel approach by integrating three aspects that have traditionally been studied separately: teachers' perceptions of science literacy, science literacy practices implemented in kindergartens, and their contribution to stimulating critical thinking skills in young children. The novelty of the study also lies in the use of empirical data obtained directly from kindergarten teachers as the primary implementers of learning, thereby providing a more contextual picture of the implementation of science literacy in the field. By identifying the relationship between teachers' perceptions and practices, this study is expected to contribute to the development of teacher competency enhancement programs and the strengthening of science learning in early childhood education. Support for strengthening teachers' capacity is crucial because research indicates that strategies such as scaffolding, posing open-ended questions, and facilitating exploration play a vital role in fostering children's critical thinking skills (Saçkes et al., 2020).. Furthermore, research by (Roy et al., 2025) confirms that teachers' engagement in building meaningful scientific dialogue as described in the can enhance children's ability to explain phenomena, provide reasons, and draw conclusions based on observed evidence.

Based on the above, this study aims to describe kindergarten teachers' perceptions of the importance of science literacy, identify the science literacy practices implemented in learning, and analyze how these practices contribute to stimulating critical thinking skills in young children. Additionally, this study aims to identify various challenges faced by teachers in implementing science literacy within the kindergarten setting. The research findings are expected to serve as a foundation for the development of policies, teacher training programs, and instructional innovations that support the enhancement of science literacy and critical thinking skills in young children.

METHOD

The study used a convergent mixed-methods design in which quantitative closed-item responses and qualitative open-ended responses were collected through the same online questionnaire, analyzed separately, and integrated at the interpretation stage. The design was selected to combine a descriptive overview of teachers' reported perceptions and frequency of practice with contextual accounts of children's responses and implementation barriers. The mixed-methods claim in this revision rests on explicit integration through a joint display rather than on parallel presentation alone (Creswell & Plano Clark, 2023)

The survey was administered online through Google Forms during March–April 2026 using convenience participation. The raw export supplied for analysis contained 111 response records. A data audit identified repeated submissions under the same respondent identifier. 15 repeat records were removed by retaining the most complete response across the substantive questionnaire fields; when completeness was equal, the first record in export order was retained. This procedure yielded 96 unique respondents (see Table 1).

Table 1. Data screening and available participant context

Indicator	Result
Raw Google Forms submissions	111 records
Repeated submissions identified by respondent identifier	15 records
Valid respondents for main closed quantitative items	96
Respondents with analyzable open-ended responses	96

The researcher-developed questionnaire contained identifying/context fields and seven substantive survey items relevant to this analysis, plus a file-upload field for a practice report. The substantive items covered prior introduction of science, science topics used, perceived importance, monthly activity frequency, children's preferred science topics, teacher observations of children during science activities, and implementation barriers.

The closed quantitative items were descriptive single items rather than a multi-item psychometric scale. Accordingly, internal-consistency reliability coefficients such as Cronbach's alpha are not applicable to these items. The importance item used a numeric 1–5 response, with higher scores interpreted as greater perceived importance in the original study. The exported dataset does not preserve the textual anchor wording for every scale point; this is reported as an instrument limitation. The frequency item used categories 1–5, and the original manuscript treated category 5 as five or more activities per month.

Before data collection, the questionnaire was substantively reviewed by early childhood education experts for clarity and relevance. No formal content-validity index, pilot-test coefficient, or psychometric validation record was available in the materials supplied for this revision; therefore, the manuscript does not claim formal psychometric validation. To improve transparency, Table 2 maps each item to its intended construct and the level of inference permitted.

Table 2. Construct and item map

Construct/domain	Survey item/data source	Response format	Permitted interpretation
Science exposure	Whether science had been introduced in the institution	Yes/no	Reported prior classroom exposure
Science content/practice	Science topics previously introduced	Multiple selection	Breadth of reported science content
Perceived importance	Importance of science literacy in PAUD	Numeric 1–5	Ordinal teacher perception; not a validated scale score
Frequency of practice	How often science activities were introduced per month	Category 1–5	Reported frequency of implementation
Child interest	Science topic/activity most liked by children	Open-ended	Teacher perception of preferred activities
Child response during science	What the teacher saw, heard, and felt during activities	Open-ended	Teacher-reported behaviors only; not direct child assessment
Implementation barriers	Challenges in introducing science	Open-ended	Teacher-reported constraints and contextual factors

Data analysis

Quantitative data were analyzed descriptively using frequencies and percentages. Missing responses were handled by valid-item analysis: the denominator is stated for each item rather than assuming that every respondent answered every question. Means are not reported because the revised analysis focuses on ordinal distributions and categorical frequency patterns.

Open-ended responses were analyzed thematically following familiarization, initial coding, grouping of related codes, review of theme boundaries, and interpretation against the conceptual distinction between learning dispositions, science-process skills, and foundational reasoning behaviors (Braun & Clarke, 2006, 2022). All 96 unique respondents provided analyzable answers to the two principal open-ended questions about child responses and barriers. Respondents were anonymized as R001-R096. The analysis also examined deviant or boundary cases, such as reports of passive children, difficulty following instructions, or an absence of major barriers.

For mixed-methods integration, quantitative patterns and qualitative themes were merged in a joint display. Integration focused on convergence (findings that point in the same direction), complementarity (qualitative data that explain or contextualize a quantitative pattern), and boundaries or divergence (evidence that cautions against a stronger inference).

RESULTS

Teachers' reported perceptions and frequency of science activities

Among the 96 respondents with valid closed-item data, all reported that they had introduced science activities in their institutions. One additional unique respondent had missing data on this item and was retained only in the qualitative strand. Thus, the cleaned dataset supports the statement that 96 of 96 valid respondents (100%) reported prior science exposure; it does not support treating all raw submissions as independent teachers (see Table 3).

Table 3. Perceived importance of science literacy (valid n = 96)

Score	Frequency (n)	Valid %
1	1	1.04
2	0	0.00
3	5	5.21
4	13	13.54
5	77	80.21
Total	96	100.00

One unique respondent had missing data on the importance item. The exported file did not retain verbal labels for all scale anchors; scores are therefore presented as ordinal categories.

The distribution is strongly concentrated in the highest category: 77 of 96 valid respondents (80.21%) selected score 5, while 13 (13.54%) selected score 4 (see Table 4). This indicates a very positive reported orientation toward science literacy, but it should not be interpreted as a validated attitude-scale score.

Table 4. Reported monthly frequency of science activities (valid n = 96)

Monthly frequency category	Frequency (n)	Valid %
1	3	3.13
2	13	13.54
3	31	32.29
4	32	33.33
5 / ≥5 in the original coding	17	17.71
Total	96	100.00

One unique respondent had missing frequency data. The original manuscript interpreted category 5 as five or more times per month.

Sixty-three of 96 valid respondents (65.63%) selected the three- or four-times-per-month categories, and 80 of 96 (83.33%) selected three or more. The data therefore support the conclusion that science activities were reported as recurring practices in this sample, while still showing variation in implementation frequency.

Reported science-literacy practices

The multiple-selection topic item indicates that teachers used a broad range of concrete science content. The most frequently selected topics in the cleaned data were water (n = 74), fire (n = 73), air (n = 72), plants (n = 64), natural phenomena (n = 53), properties of objects (n = 52), the senses (n = 43), animals (n = 40), sound (n = 28), the solar system (n = 23), magnets (n = 18), and color or color mixing (n = 11). Because teachers could select more than one topic, these counts are not mutually exclusive.

Open-ended responses further indicate that teachers frequently used hands-on activities such as color mixing, floating and sinking, water and air demonstrations, observing plant growth, simple volcano models, magnet exploration, and experiments using familiar household materials. These practices are consistent with early science approaches that privilege direct manipulation, observation, and guided inquiry (Eshach & Fried, 2005; Worth, 2010).

Teacher-reported child behaviors during science activities

The qualitative strand does not assess children directly. It documents what teachers reported seeing and hearing during science activities. Five recurring patterns were identified and then classified according to their conceptual status. Curiosity and enthusiasm are treated primarily as learning dispositions; observation and experimenting as science-process skills; questioning, prediction, comparison, and simple explanation as behaviors that may provide foundations for later critical thinking when they involve reasons or evidence (see Table 5).

Table 5. Teacher-reported behaviors and their conceptual interpretation

Theme	Teacher-reported manifestation	Conceptual classification	Illustrative anonymized response
Curiosity and engagement	Children approached materials, showed surprise, enthusiasm, and a desire to know what would happen.	Learning disposition supporting inquiry	R003: “They kept asking ‘how can that happen?’ and wanted to try again.”
Questioning	Children asked why a change occurred or what would happen next.	Inquiry behavior; potential entry point for reasoning	R009: “Why is the color moving?”
Observation and comparison	Children watched changes, noticed details, and compared outcomes.	Basic science-process skill	R004: “Look, mine grew… mine is taller.”
Trying, repeating, and exploring	Children handled materials, repeated actions, and asked for another turn.	Exploration and early problem-solving behavior	R016: children wanted to touch, observe more closely, and repeat the experiment.
Explaining and predicting	Some reports described children offering simple explanations, opinions, or guesses about what might happen.	Emerging interpretation/inference; not a validated critical-thinking score	R064: the teacher reported children “guessing what would happen next” and trying to explain the result in their own words.

The strongest recurring feature in the responses was positive engagement. Many teachers described children as excited, surprised, or curious when visible changes occurred. Questioning often appeared alongside this engagement, including causal questions such as “why” or “how can that happen?” Teachers also reported children moving closer to observe, handling materials, repeating experiments, comparing plant growth or color changes, and commenting on outcomes.

At the same time, the data contain boundary cases that complicate an exclusively positive account. Some teachers described children who were initially passive, hesitant, confused, or unable to follow multi-step instructions; others noted that high enthusiasm could become competition for materials or difficulty waiting for turns. These cases suggest that participation in a science activity does not automatically produce the same depth of reasoning for every child and that teacher scaffolding remains important.

Barriers to implementation

Barriers clustered around five recurring areas: (1) limited tools, materials, media, or facilities; (2) limited instructional time and the additional time needed for preparation and cleanup; (3) classroom-management demands, including turn-taking, short attention spans, large groups, and differing levels of understanding; (4) limited teacher knowledge, confidence, references, or access to training; and (5) environmental and institutional support, including room size, weather, budget, and parental or institutional expectations. Two respondents explicitly reported no major barrier at the time of the survey, providing a useful deviant case.

The qualitative data also show how these barriers interact. Limited materials often force teachers to simplify activities or make children share tools; sharing increases waiting time and can intensify competition; time constraints then encourage shorter experiments, reducing opportunities for extended questioning or repeated trials. Teacher knowledge and confidence affect whether simple materials are transformed into meaningful inquiry or remain demonstration activities. Thus, barriers concern not only whether science is offered but also the depth and quality of the experience.

Mixed-methods integration

Table 6 integrates the quantitative and qualitative findings, showing that teachers' high ratings of science's importance (80.21%) and frequent implementation (83.33% at least three times monthly) align with qualitative accounts of engaging, hands-on, and exploratory practices, while reported barriers such as limited materials, time, and institutional support help explain variation in implementation depth. These inferences, however, are bounded by key limitations: importance was measured with a single non-validated item, frequency does not reflect instructional quality, children's behaviors were reported by teachers rather than observed directly, and no statistical or causal link was established between barriers, frequency, and children's critical-thinking outcomes, as no child-level data were collected.

Table 6. Joint display of quantitative and qualitative findings

Quantitative pattern	Qualitative evidence	Integrated inference	Interpretive boundary
80.21% selected the highest importance category	Teachers described science as engaging, meaningful, and capable of stimulating curiosity.	Perceived importance is consistent with a positive orientation toward science in classroom practice.	Importance was measured with a single self-report item; it is not a validated attitude construct.
83.33% reported science activities ≥3 times/month	Teachers reported frequent hands-on activities using water, air, plants, colors, magnets, and everyday materials.	Frequency and practice descriptions converge in showing recurring science exposure.	Frequency does not indicate instructional quality, duration, or fidelity.
Broad range of reported science topics	Open responses described observation, experimenting, questioning, repetition, and discussion.	Qualitative data explain how reported science exposure commonly takes an exploratory form.	Children were not observed by researchers; behaviors are mediated through teacher perception.
Regular implementation despite positive perceptions	Barriers included materials, time, management, teacher knowledge, and institutional conditions.	Barriers help explain why implementation depth may vary even when science is valued and offered regularly.	No statistical association between barriers and frequency was tested.
No child-level quantitative outcome	Teachers reported behaviors consistent with curiosity, science-process skills, and emerging reasoning.	The study identifies perceived manifestations that may be relevant to critical-thinking foundations.	No causal, correlational, or developmental claim about children's critical-thinking performance is warranted.

Discussion

Research findings indicate a strong correlation between teachers' perceptions of the importance of science literacy, the teaching practices implemented in the classroom, and the development of critical thinking skills in early childhood. This is evident from the high percentage of teachers who view science literacy as a crucial aspect of early childhood education, as well as the consistent implementation of science activities in their teaching. The positive perceptions held by teachers appear to contribute to their willingness to incorporate various exploratory activities that allow children to gain hands-on learning experiences. In other words, teachers' belief in the importance of science literacy does not remain at a conceptual level but is also reflected in the daily teaching practices they carry out.

These findings align with research indicating that teachers' beliefs and perceptions significantly influence the pedagogical decisions made during the learning process. According to (Roy et al., 2025), teachers with a positive understanding of science are more likely to create learning environments that support exploration and scientific inquiry among early childhood students. Furthermore, a study by Saçkes et al. (2020)indicates that teachers' self-confidence and perceptions of science are closely linked to the frequency and quality of science experiences provided to children. Thus, the high level of teachers' awareness regarding the importance of science literacy in this study can be understood as a factor driving the more consistent implementation of science activities in kindergartens.

This study also indicates that the science literacy practices implemented by teachers primarily employ a direct-experience-based learning approach. Activities such as mixing colors, observing plant growth, experiments with floating and sinking objects, exploring the properties of water, and various other simple experiments provide children with opportunities to actively engage in the learning process. The characteristics of these activities indicate that science learning in early childhood education is not oriented toward mastering abstract scientific concepts, but rather toward concrete experiences that allow children to build understanding through direct interaction with observed objects and phenomena.

These findings align with Piaget's constructivist theory, which emphasizes that children construct knowledge through active interaction with their environment. In the context of early childhood science education, Eshach & Fried (2005) explain that hands-on experiences through observation and simple experiments enable children to develop more meaningful conceptual understanding than learning that is purely verbal. Furthermore, research (Wulandari & Suyadi, 2020) confirms that scientific inquiry activities in early childhood help children develop skills in observing, classifying, predicting, and drawing conclusions as the foundation of scientific thinking. Therefore, the science literacy practices identified in this study align with the principles of inquiry-based science learning recommended in various international studies.

Through these various activities, children gain the opportunity to engage in thinking processes that form the foundation of critical thinking skills. The research findings indicate that children do not merely act as recipients of information but also as active participants who observe, ask questions, make hypotheses, explore various possibilities, and explain their observations to others. These abilities serve as early indicators of critical thinking that develop in alignment with the cognitive developmental characteristics of young children. Thus, science literacy functions as a means enabling children to learn to think through the real-world experiences they encounter during the learning process.

This finding is supported by research by Gimenez et al. (2025),which shows that children's engagement in exploration-based science activities contributes to the development of higher-order thinking skills, including the ability to analyze, solve problems, and make decisions based on observed evidence. Furthermore, according to Worth (2010), the processes of observing, comparing, predicting, and communicating observation results constitute a crucial foundation for the development of scientific thinking, which is closely linked to critical thinking skills. Thus, the science literacy activities conducted by teachers in this study not only introduce scientific concepts but also cultivate the thinking processes that form the basis for the development of children's critical thinking abilities.

The research findings also indicate that curiosity is the most dominant aspect emerging during science activities. Curiosity drives children to further explore observed phenomena and serves as a catalyst for the emergence of various investigative questions. In the context of critical thinking development, curiosity plays a crucial role as it forms the basis for information-seeking processes, investigation, and reflection on acquired experiences. When children are motivated to understand the reasons behind an event, they begin to develop thinking skills that go beyond merely accepting information; they strive to comprehend and explain the phenomena occurring.

These findings align with the perspective (Vasquez, 2017) that curiosity is the primary driver of learning in children and the foundation for the development of scientific thinking skills. A learning environment that provides children with opportunities to explore and ask questions enhances cognitive engagement and fosters deeper thinking processes. Furthermore, research (Hawkins, 2014) also confirms that curiosity has a positive relationship with critical thinking skills because it encourages individuals to seek explanations, evaluate information, and build understanding based on the evidence found.

In addition to curiosity, the ability to ask questions that emerges during science activities indicates that children are beginning to engage in reflective thinking processes. The questions children ask regarding cause-and-effect relationships, changes occurring during experiments, or the possible outcomes of an experiment demonstrate an effort to understand phenomena more deeply. This ability to ask questions serves as a key indicator that science education can create an environment that supports the development of critical thinking skills from an early age. The more opportunities children are given to ask questions and discuss their findings, the greater the likelihood of developing more complex critical thinking skills in subsequent stages of development.

This finding is supported by Vygotsky's sociocultural theory, which emphasizes the importance of social interaction and dialogue in children's cognitive development. Through the process of asking questions and discussing, children have the opportunity to construct knowledge together with teachers and peers. Research (He & Chen, 2024) indicates that questioning activities are a crucial component of science learning as they help students develop reasoning, argumentation, and evaluation skills regarding the information they acquire. Therefore, the high frequency of questions arising during science activities in this study can be viewed as an indicator of the development of critical thinking skills in early childhood.

Nevertheless, the research findings also indicate that the success of science literacy implementation remains influenced by various supporting and hindering factors. Limitations in tools and materials, limited learning time, differences in children's characteristics, and the need to enhance teachers' competencies present challenges that require attention. These findings suggest that strengthening science literacy cannot focus solely on classroom activities but also requires institutional support, the provision of adequate learning resources, and continuous professional development programs for teachers. Therefore, improving the quality of science literacy requires a comprehensive approach through strengthening teacher capacity, providing learning facilities, and implementing school policies that support exploration-based learning.

Overall, this study demonstrates that teachers' positive perceptions of science literacy contribute to the high frequency of science activities in kindergarten. Science literacy practices conducted through various exploratory activities then provide children with opportunities to develop curiosity, the ability to ask questions, observational skills, the courage to try, and the ability to explain observed phenomena. These findings reinforce previous research indicating that early science experiences play a crucial role in building scientific literacy and critical thinking skills-essential tools for children to face 21st-century challenges (de los Santos et al., 2025). Thus, science literacy serves not only as a means of introducing scientific concepts but also as an effective medium for stimulating critical thinking skills in young children through active, meaningful, and exploration-based learning experiences.

CONCLUSION

This study indicates that kindergarten teachers hold a very positive perception of the importance of science literacy in early childhood education. Nearly all respondents have integrated science activities into their lessons with a relatively consistent frequency of implementation. The science literacy practices implemented by teachers are dominated by exploration and simple experiments closely related to children's daily lives, such as mixing colors, observing plant growth, exploring the properties of water, and various other observational activities. These findings indicate that science literacy has become an integral part of the learning experiences provided to children in kindergarten. This study also reveals that science literacy practices contribute to stimulating critical thinking skills in young children. Through observation, exploration, experimentation, and discussion, children demonstrate the development of curiosity, the ability to ask questions, the courage to try, the ability to observe, and the ability to explain observed phenomena. These findings indicate a relationship between teachers' positive perceptions of science literacy, the consistent implementation of science activities, and the emergence of early indicators of critical thinking skills in children. Nevertheless, the implementation of science literacy still faces various challenges, particularly limitations in tools and materials, limited learning time, and the need to strengthen teachers' competencies. Therefore, improving the quality of science literacy in early childhood education requires continuous, support through the provision of adequate learning resources, teacher professional development programs, and institutional policies that encourage exploration-based learning. The findings of this study imply that strengthening science literacy can be an effective strategy to support the development of children's critical thinking skills from an early age.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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