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Teachers' Perceptions and Practices in Constructing Students' Scientific Attitudes in Elementary Science Learning

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ABSTRACT

Scientific attitudes are an important component of science learning because they shape how students think, evaluate evidence, and respond to scientific phenomena. However, in elementary classrooms, their development often receives less explicit attention than knowledge and science process skills. This study aims to explore teachers' perceptions and practices in fostering students' scientific attitudes in elementary science learning. A descriptive survey design was employed involving 57 elementary school teachers from several cities in Java, Indonesia. Data were collected through an online questionnaire consisting of five open-ended items. The responses were coded thematically and summarized using frequencies and percentages. The results show that most teachers have a general understanding of scientific attitudes, but this understanding remains limited and is mainly associated with curiosity and classroom activeness. Teaching practices are dominated by questioning and discussion, while inquiry-based activities are still less frequently implemented. In addition, teachers tend to assess scientific attitudes through observable student participation rather than structured indicators. The study offers a distinctive contribution by showing that the development of scientific attitudes in elementary science classrooms is shaped not only by teachers' conceptual understanding, but also by how they translate this understanding into instructional practices and classroom-based assessment. The findings indicate the need for

more explicit conceptual frameworks, structured inquiry-based learning, and practical assessment tools to support teachers in developing students' scientific attitudes.
***Keywords**: Scientific attitude; Teacher perception; Elementary science education.*

ABSTRAK
Sikap ilmiah merupakan komponen penting dalam pembelajaran sains karena membentuk cara siswa berpikir, mengevaluasi bukti, dan merespons fenomena secara ilmiah. Namun, di kelas sekolah dasar, pengembangan sikap ilmiah sering belum mendapat perhatian eksplisit dibandingkan pengetahuan dan keterampilan proses sains. Penelitian ini bertujuan untuk mengeksplorasi persepsi dan praktik guru dalam mengembangkan sikap ilmiah siswa pada pembelajaran IPA di sekolah dasar. Penelitian ini menggunakan desain survei deskriptif dengan melibatkan 57 guru sekolah dasar dari beberapa kota di Pulau Jawa, Indonesia. Data dikumpulkan melalui kuesioner daring yang terdiri atas lima butir pertanyaan terbuka. Respons guru dikodekan secara tematik dan diringkas menggunakan frekuensi serta persentase. Hasil penelitian menunjukkan bahwa sebagian besar guru memiliki pemahaman umum tentang sikap ilmiah, tetapi pemahaman tersebut masih terbatas dan terutama dikaitkan dengan rasa ingin tahu serta keaktifan siswa di kelas. Praktik pembelajaran masih didominasi oleh kegiatan bertanya dan diskusi, sedangkan aktivitas berbasis penyelidikan belum banyak diterapkan. Selain itu, guru cenderung menilai sikap ilmiah melalui partisipasi siswa yang tampak, bukan melalui indikator yang terstruktur. Penelitian ini menawarkan kontribusi khas dengan menunjukkan bahwa pengembangan sikap ilmiah di kelas IPA sekolah dasar tidak hanya dibentuk oleh pemahaman konseptual guru, tetapi juga oleh cara guru menerjemahkan pemahaman tersebut ke dalam praktik pembelajaran dan asesmen berbasis kelas. Temuan ini menunjukkan perlunya kerangka konseptual yang lebih eksplisit, pembelajaran berbasis penyelidikan yang terstruktur, serta alat asesmen praktis untuk membantu guru mengembangkan sikap ilmiah siswa.
Kata Kunci: Sikap Ilmiah; Persepsi guru; pendidikan IPA di Sekolah Dasar

INTRODUCTION

The need for individuals to continuously adapt in an uncertain and rapidly changing world has reshaped the role of education in preparing learners for complex and unpredictable challenges. Learning is no longer limited to the acquisition of knowledge, but also involves the development of the ability to respond critically, responsibly, and adaptively to emerging situations. This perspective is reflected in the concept of global competence, which emphasizes individuals' capacity to understand multiple perspectives, evaluate information, and take responsible action in both local and global contexts (OECD, 2018, 2021; Opertti, 2021). Within this framework, attitudes play a central role because they integrate beliefs, values, and behavioral tendencies that guide how individuals respond to real-world problems.

In science education, the development of attitudes becomes particularly significant. Science is not only concerned with understanding natural phenomena, but also with enabling individuals to make appropriate and responsible decisions based on scientific reasoning (Widodo, 2021). The notion of "action" in science learning reflects the application of knowledge through evidence-based decisions, which are guided by scientific attitudes. Therefore, scientific attitudes serve as a bridge between knowledge and action, ensuring that scientific understanding is applied meaningfully, critically, and responsibly.

Scientific attitudes can be understood as habits of thinking and acting that characterize scientific practice. They include dispositions such as curiosity, openness to new ideas, objectivity, critical thinking, intellectual honesty, cooperation, and persistence in problem solving (Arseculeratne, 2014; C. Gauld, 1982; Harlen & Qualter, 2018). These dispositions emerge from science as a process of inquiry, in which knowledge is continuously constructed, tested, evaluated, and revised based on evidence (Grinnel, 1988; Waddington, 1968). Thus, scientific attitudes should not be viewed as incidental outcomes of science learning, but as learning goals that need to be intentionally developed through classroom activities that engage students in observing, questioning, investigating, discussing evidence, and reflecting on scientific explanations (Contant et al., 2018).

Ideally, science learning integrates three equally important components: scientific knowledge, scientific processes, and scientific attitudes. However, in practice, the development of scientific attitudes is often less explicitly addressed than cognitive achievement and science process skills. Many science classrooms still prioritize students' mastery of concepts and procedural skills, while affective and dispositional dimensions receive limited instructional and assessment attention (Fahrunisa et al., 2020; Faizin et al., 2018; Misbah et al., 2018; Widodo, 2021). As a result, students may acquire scientific knowledge without necessarily developing the dispositions needed to use that knowledge critically and responsibly. Previous studies have also shown that students' low scientific attitudes are closely related to the lack of learning activities that explicitly support their development, particularly activities involving inquiry, experimentation, collaboration, evidence-based reasoning, and reflection (Firdaus & Darmadi, 2017; Gani et al., 2016; Olasehinde & Olatoye, 2014; Priyayi et al., 2020; Tosun & Genç, 2015; Wildayanto et al., 2020).

A growing body of research has examined scientific attitudes from several major perspectives. First, many studies have focused on measuring students' scientific attitudes and identifying their relationship with academic achievement, science process skills, critical thinking, or other learning outcomes (Eğmir & Ocak, 2020; Maed, 2015; Olasehinde & Olatoye, 2014). Second, experimental studies have investigated the effectiveness of instructional models such as guided discovery learning, inquiry-based learning, project-based learning, RADEC, STEAM, and other student-centered approaches in improving students' scientific attitudes (Alawiyah & Sopandi, 2016; Dwianto et al., 2017; Fahrunisa et al., 2020; Jaenudin et al., 2022a). Third, several studies have developed or validated instruments for assessing scientific attitudes, particularly to make affective assessment more systematic and reliable in science learning (Rusdiyanto et al., 2023; Sudana, 2018; Widyastika & Wahyuni, 2022). Although these studies have provided important evidence about the importance, measurement, and improvement of scientific attitudes, most of them remain centered on students' outcomes, instructional interventions, or assessment tools. Less attention has been given to teachers as the key actors who interpret the meaning of scientific attitudes, translate them into classroom practices, and assess them in everyday learning situations. Consequently, the relationship between teachers' conceptual understanding, instructional practices, and classroom-based assessment of scientific attitudes remains insufficiently explored, especially in elementary science education.

These issues highlight the central role of teachers in fostering students' scientific attitudes. Scientific attitudes do not develop naturally; they require intentional design of learning activities, meaningful classroom interactions, and assessment practices that make scientific dispositions visible and teachable. Teachers are expected not only to understand the concept of scientific attitudes, but also to translate this understanding into pedagogical practices that allow students to experience, practice, and internalize scientific ways of thinking. However, when teachers' understanding remains general or limited, scientific attitudes may be reduced to visible behaviors such as curiosity, activeness, or willingness to ask questions, while more complex dimensions such as evidence-based reasoning, objectivity, openness to alternative explanations, and critical judgment may be overlooked.

Based on this gap, the present study aims to explore teachers' perceptions and practices in fostering students' scientific attitudes in elementary science learning. Specifically, this study examines teachers' understanding of scientific attitudes, their instructional practices, their approaches to identifying and assessing students' scientific attitudes, and the challenges they encounter in classroom contexts. By addressing these aspects, this study positions itself as an effort to reveal the perception–practice–assessment gap in the development of scientific attitudes. The findings are expected to contribute to a more comprehensive understanding of how scientific attitudes are interpreted and enacted by elementary school teachers, as well as to inform the development of more structured instructional and assessment approaches in elementary science education.

METHODS

Type and Design

This study employed a descriptive survey design to explore teachers' perceptions and practices in fostering students' scientific attitudes in elementary science learning. This design was selected because the study aimed to describe teachers' self-reported understanding, classroom practices, perceived challenges, and views on activities that support the development of scientific attitudes. The study did not aim to test the effectiveness of a specific intervention, but to identify patterns in teachers' responses and interpret how scientific attitudes are understood, facilitated, and assessed in elementary school contexts.

Data and Data Sources

The data were obtained from an online questionnaire completed by 57 elementary school teachers from several cities in Java, Indonesia. Participants were selected through convenience sampling based on accessibility and willingness to participate. Most participants had more than 10 years of teaching experience (62.1%), followed by 6–10 years (22.4%) and 0–2 years (15.5%), indicating that the responses were largely derived from experienced teachers.

The questionnaire consisted of ten questions: five demographic questions and five open-ended questions exploring teachers' understanding of scientific attitudes, observed student attitudes, facilitation strategies, challenges, and influential activities. The instrument was developed based on the research objectives. Content validity was supported through discussion with a professor in science education and review by two doctoral experts in science education. Since the instrument used open-ended questions and did not measure a single latent construct, Cronbach's alpha was not calculated. Instead, methodological rigor was ensured through expert judgment and item alignment with the research objectives. The indicators and items are presented in Table 1.

Table 1. Criteria for Feasibility Percentage of Education Textbooks for MI / SD

Aspect	Indicator	İtem
Conceptual understanding	Teachers' interpretation of scientific attitudes	What do you know about scientific attitude?
Observed scientific attiude	Teachers' identification on scientific attitudes frequently observed in students	What scientific attitudes do you often observe in your students at school?
Instructional practice	Strategies used to facilitate scientific attitudes	How do you facilitate the growth of scientific attitudes in students?
Challenges	Difficulties in fostering scientific attitudes	Are there any difficulties in fostering scientific attitudes? If yes, what difficulties do you face?
Effective activities	Activities considered influential in developing scientific attitudes	In your opinion, what activities have the greatest influence on fostering scientific attitudes?

Data collection technique

The participants were 59 elementary school teachers from several cities in Java, Indonesia. They were selected using convenience sampling based on accessibility, willingness to participate, and relevance to the research focus. The participants were teachers who had experience teaching at the elementary school level and were familiar with science or integrated elementary learning. The use of convenience sampling enabled the researchers to collect data efficiently from teacher networks across different school contexts; however, this technique limits the generalizability of the findings. Therefore, the results should not be interpreted as representing all elementary school teachers in Indonesia, but as an exploratory description of teachers' perceptions and practices within the participating teacher networks (Andrade & Heritage, 2017; Jager et al., 2017).

Data analysis

The data were analyzed using descriptive statistics and thematic identification. Demographic responses were summarized using frequencies and percentages, while responses to the five open-ended questions were coded thematically. The coding focused on recurring ideas related to teachers' understanding of scientific attitudes, observed student attitudes, facilitation strategies, challenges, and influential activities. Similar codes were grouped into broader themes, and their frequencies were calculated to identify dominant response patterns. The findings were interpreted descriptively and exploratorily, considering the use of convenience sampling and self-reported data.

RESULTS AND DISCUSSION

This study explored how elementary school teachers understand, observe, facilitate, and experience challenges in fostering students' scientific attitudes in science learning. The analysis was based on 57 valid teacher responses. The findings are organized into six parts: teachers' understanding of scientific attitudes, scientific attitudes observed by teachers, teachers' facilitation strategies, challenges in fostering scientific attitudes, activities perceived as influential, and patterns across teaching experience.

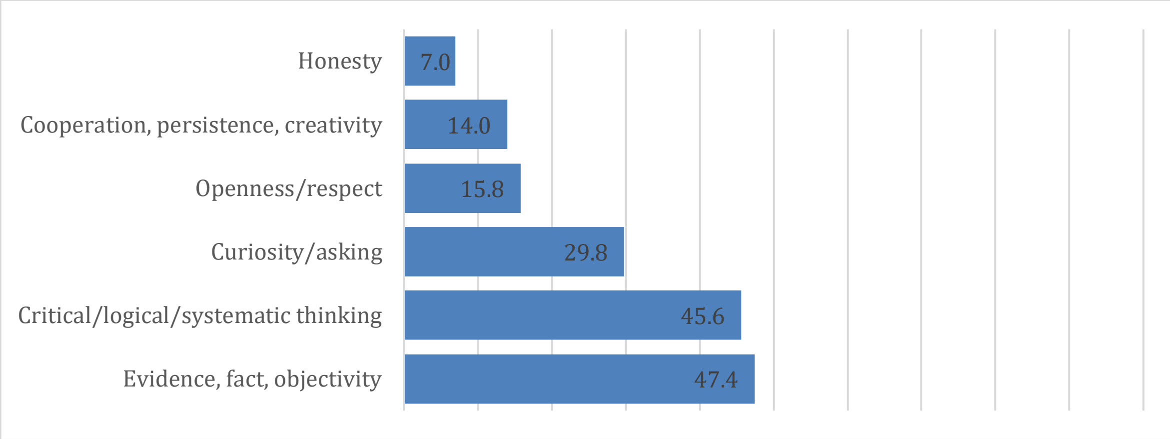

Figure 1. Teachers' understanding of scientific attitudes

These findings suggest that many teachers already associate scientific attitudes with important epistemic dimensions of science, especially objectivity, factual reasoning, and critical thinking. For instance, one teacher described scientific attitude as "an attitude that is logical and based on data and facts" (T7), while another defined it as "an objective, rational, and empirical mindset in responding to facts or phenomena" (T48). Such responses indicate that teachers do not merely understand scientific attitude as general classroom behavior, but also as a way of thinking grounded in evidence. This interpretation is consistent with the view that scientific attitude involves a disposition toward ideas, information, and the ways such information is evaluated (Gauld, 1982; Gauld & Hukins, 1980). Recent studies also emphasize that scientific attitude is a multidimensional construct involving curiosity, rationality, open-mindedness, critical-mindedness, objectivity, honesty, and willingness to suspend judgment (Pitafi et al., 2012; Khotimah, 2025).

However, the distribution also shows that teachers' understanding remains uneven. Although objectivity and critical reasoning appeared frequently, dimensions such as honesty, openness, cooperation, persistence, and respect for others' ideas appeared less often. This indicates that teachers tend to emphasize the cognitive and epistemic aspects of scientific attitude more than its ethical and social dimensions. In science education, scientific attitude is not limited to logical thinking or factual reasoning; it also includes intellectual honesty, openness to alternative explanations, willingness to revise conclusions, cooperation, and persistence in inquiry (Fahrunisa et al., 2020; Harlen & Qualter, 2018). Therefore, the findings suggest that teachers need a more explicit conceptual framework to understand scientific attitude as a multidimensional construct rather than as a single observable trait.

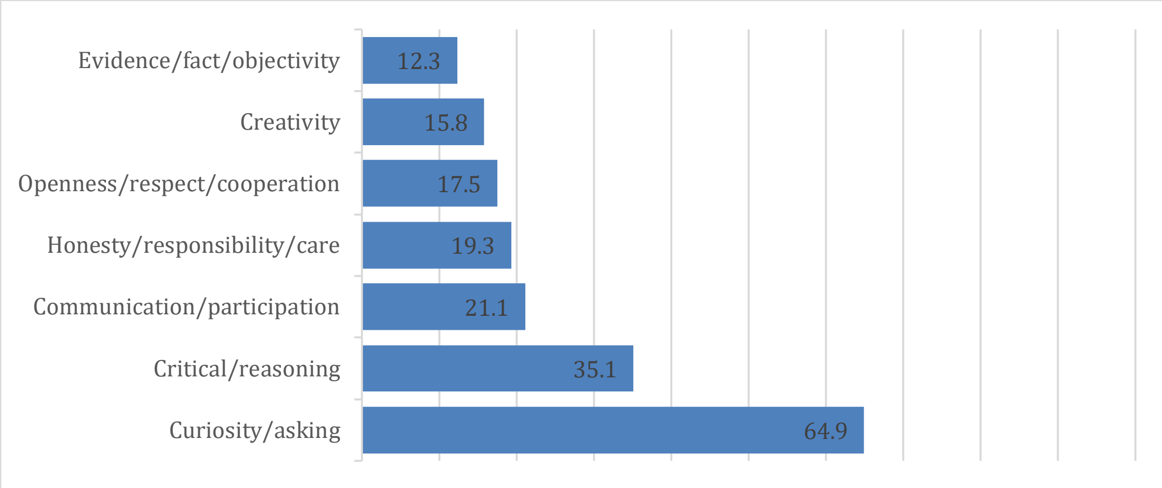

Figure 2. Scientific attitudes observed by teachers

The dominance of curiosity indicates that teachers tend to recognize scientific attitudes through visible and immediate student behaviors. Teachers often associated scientific attitude with students who ask questions, show interest in new things, or express curiosity about phenomena. For example, one teacher stated that the scientific attitude most often observed was "curiosity and critical thinking" (T1), while another described it as "curiosity, always asking" (T56). These responses suggest that curiosity functions as the most accessible marker of scientific attitude in elementary classrooms. This finding aligns with studies showing that curiosity is frequently positioned as an entry point for scientific inquiry and as a key affective disposition in elementary science learning (Jaenudin et al., 2022b; Prachagool, 2021).

Nevertheless, the low proportion of evidence-based and objective behavior (12.3%) indicates an important issue. Scientific attitude should not stop at curiosity; it should develop into disciplined inquiry, evidence evaluation, honest data reporting, and reasoned conclusion-making. Curiosity becomes scientifically meaningful when students are guided to observe carefully, compare information, justify answers, and revise ideas based on evidence. Fatonah et al. (2023) found that scientific attitude contributes to students' productivity, while other recent studies suggest that critical thinking and evidence-based reasoning are closely related to students' scientific performance and scientific literacy (Khotimah, 2025; Relita et al., 2023). Therefore, the finding suggests that teachers may find it easier to observe visible traits such as questioning and participation than deeper scientific dispositions such as objectivity, respect for data, or evidence-based reasoning.

This pattern also highlights the need for more structured classroom indicators. Studies on scientific attitude assessment emphasize that attitude dimensions should be made observable through clear behavioral indicators so that teachers do not rely only on intuition or general impressions (Maria et al., 2024; Rusdiyanto et al., 2023; Widyastika & Wahyuni, 2022). Without such indicators, scientific attitude may be reduced to students' activeness or curiosity, while students' ability to reason with evidence, report findings honestly, and revise explanations may remain under-recognized.

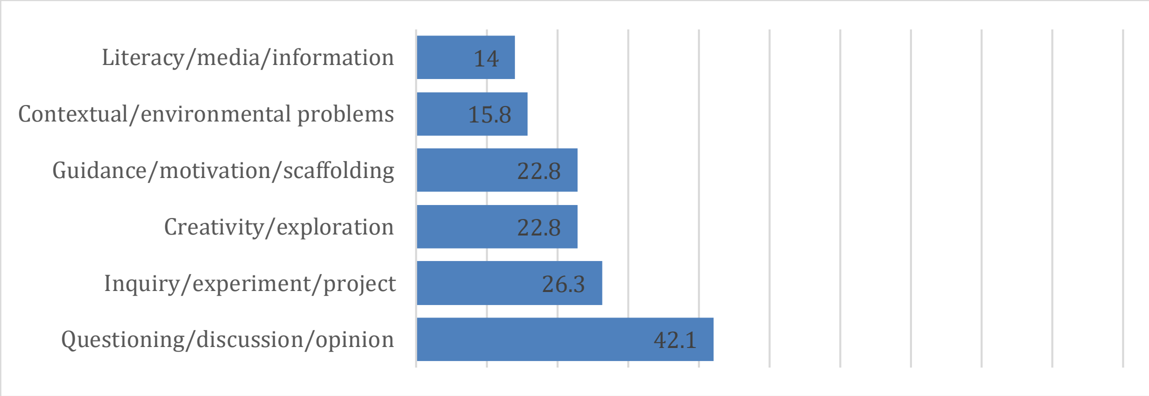

Figure 3. Teachers' facilitation strategies to foster scientific attitude

Based on figure 3, teachers most often facilitate scientific attitudes through verbal and interaction-based strategies. They stimulate students through questions, discussion, and opportunities to express opinions. One teacher explained that scientific attitudes were facilitated by "stimulating students to ask questions and preparing questions that make students think" (T1). Another teacher stated that the process involved "discussion, observation, comments, and analysis" (T9). These practices are valuable because they provide students with opportunities to articulate ideas, listen to others, and participate in classroom reasoning. Discussion-based interaction is also consistent with the RADEC model, in which discussion and explanation phases support openness, cooperation, and critical thinking (Jaenudin et al., 2022).

However, the relatively lower proportion of inquiry, experiment, and project-based facilitation (26.3%) indicates that the development of scientific attitudes is still more frequently approached through classroom interaction than through structured scientific inquiry. This creates a gap between what scientific attitude requires and how it is commonly facilitated. Scientific attitudes such as objectivity, honesty, persistence, and respect for evidence develop more strongly when students are directly involved in observing phenomena, collecting data, conducting experiments, and drawing conclusions (Fahrunisa et al., 2020). Some teachers did report such practices, for example by "providing projects and observation activities" (T56), "facilitating students to contribute actively in experiments" (T21), and using "practicum, reports, presentations, and discussions" (T47). Yet these responses were not dominant.

The finding suggests that teachers need practical support in translating questioning and discussion into more structured inquiry-based learning. Recent studies show that inquiry, discovery learning, project-based learning, STEAM, and outdoor learning can support scientific attitude because these approaches provide direct experiences for students to ask questions, investigate, collaborate, and communicate findings (Halimah, 2025). Therefore, questioning and discussion should not stand alone, but should be embedded in inquiry cycles that require students to formulate problems, collect evidence, test ideas, and reflect on explanations.

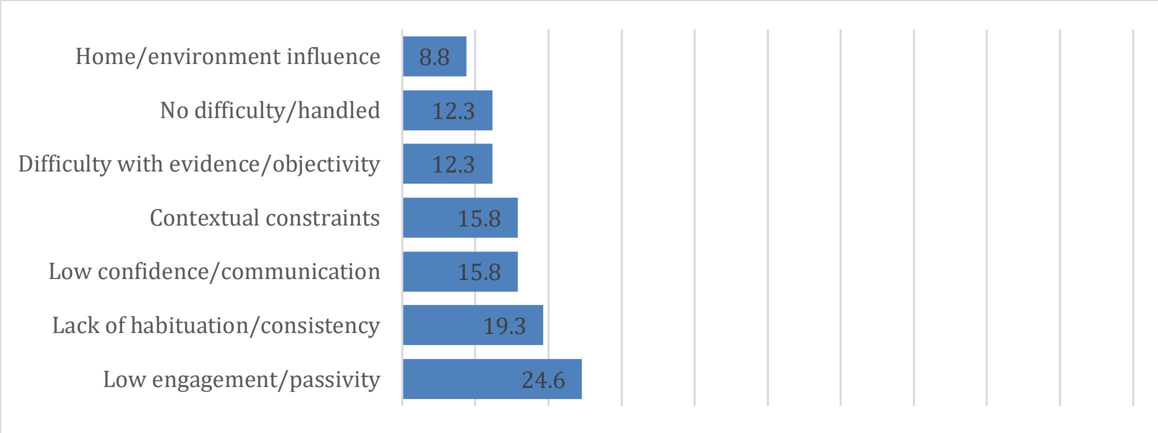

Figure 4. Challenges in fostering scientific attitudes

fostering scientific attitudes is not only a matter of teacher intention or instructional design, but also depends on students' readiness, classroom culture, and contextual conditions. Several teachers reported that students were passive, reluctant to think, or hesitant to express ideas. One teacher mentioned the difficulty of "facing passive students and developing teacher creativity in managing the object of the problem" (T20). Another teacher explained that students were "passive because they were less interested, lazy to think, or lacked motivation" (T27). These responses show that scientific attitude development is closely related to students' confidence, motivation, and willingness to participate in inquiry. This is consistent with studies showing that low engagement, monotonous learning, and limited learning resources can hinder the development of students' critical thinking and scientific dispositions (Oktarizka, 2024; Widyastika & Wahyuni, 2022).

The issue of habituation also appeared strongly. Teachers noted that students were "not yet accustomed to scientific attitudes" (T1) and that consistency was difficult because the development of scientific attitudes "takes a long time and the results cannot be seen quickly" (T46). This finding confirms that scientific attitudes are not formed instantly. They require repeated practice, consistent classroom norms, and continuous teacher modeling. Attitude theory also suggests that attitudes become more stable when they are repeatedly activated, considered important, and connected to actual behavior (Tormala, 2025). In the context of elementary science learning, this means that students need repeated opportunities to ask questions, observe phenomena, report findings honestly, compare evidence, and communicate conclusions.

In addition, contextual constraints such as online learning, limited direct interaction, time limitations, and home environment were also reported. One teacher noted that students' scientific attitudes were difficult to develop when parental intervention made children less independent (T37). Another teacher argued that teachers often focus more on completing learning targets than on exploring students' scientific attitudes (T49). These responses reveal that scientific attitude development is shaped by a wider instructional and social ecosystem. The development of scientific attitude is influenced not only by teachers, but also by family, school culture, curriculum, and environment. Thus, fostering scientific attitudes requires classroom-level strategies and broader support systems.

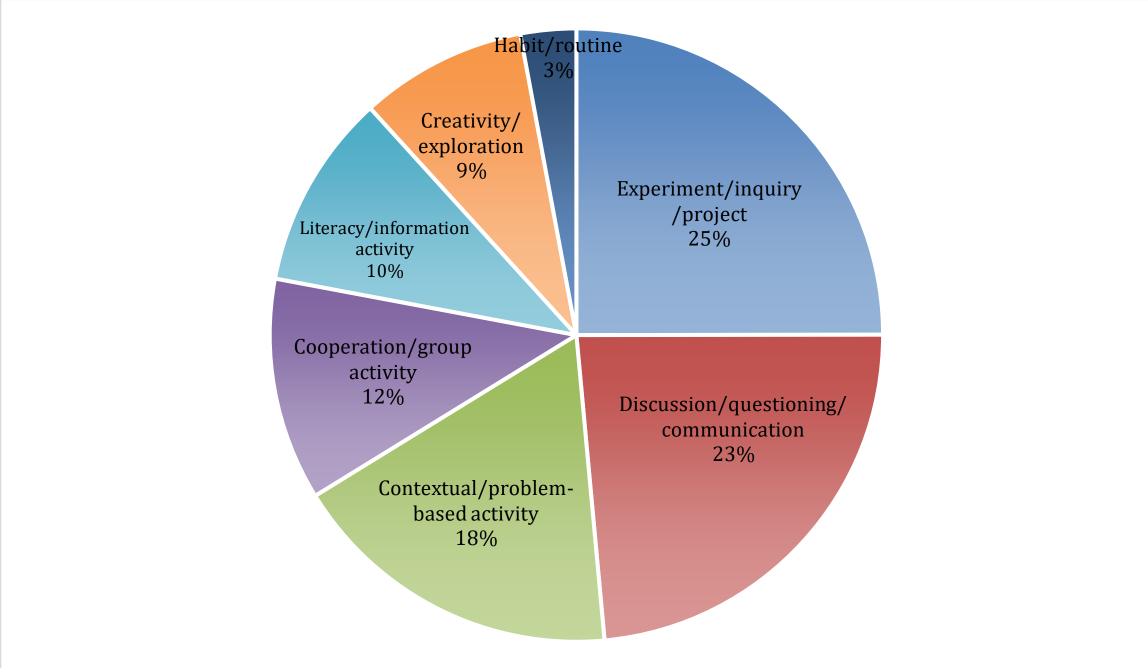

Figure 5. Activities perceived as influential in developing scientific attitude

This finding is particularly important because it shows that teachers recognize the value of inquiry-oriented activities, even though such activities were not the most dominant facilitation strategy reported in Figure 3. Teachers identified experiments, projects, practicum, observation, and problem-based learning as influential because these activities allow students to investigate directly and construct understanding through experience. One teacher stated that influential activities included "practice, experiments, and problem-based learning" (T21), while another mentioned "conducting experiments" (T44). Another teacher emphasized "practicum, reporting, and presenting the results" as activities that support scientific attitudes (T47).

This pattern is supported by recent empirical studies showing that scientific attitudes can be strengthened through student-centered and inquiry-oriented learning. Guided inquiry has been found to foster curiosity, respect for evidence, flexibility of thinking, critical thinking, and responsibility through problem formulation, hypothesis generation, experimentation, data processing, and conclusion-making. STEAM and project-based learning also support scientific attitudes by combining inquiry, creativity, collaboration, and real-world problem solving (Halimah, 2025). Outdoor learning further shows that direct engagement with the environment can strengthen curiosity, responsibility, and critical thinking because students interact with real phenomena rather than only textbook information.

At the same time, discussion and questioning remained highly valued. This suggests that teachers view scientific attitude development as a combination of active inquiry and classroom communication. Discussion allows students to express ideas, compare viewpoints, and respond to others' reasoning. However, discussion becomes more scientifically meaningful when it is connected to data, evidence, and reflection. Therefore, the findings suggest that the strongest learning design for developing scientific attitudes may be an integration of inquiry, discussion, contextual problem solving, evidence-based reasoning, and reflection. Such integration can help students move from merely asking questions to investigating, justifying, and communicating explanations.

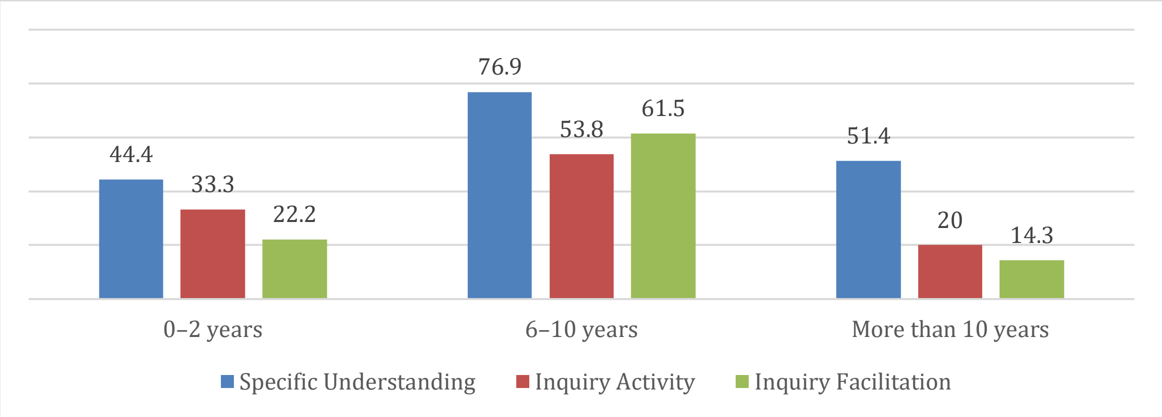

Figure 6. Patterns across teaching experience

Pattern in figure 6 should be interpreted cautiously because the number of teachers in each experience group was unequal and the study used convenience sampling. Nevertheless, the finding provides an important insight: longer teaching experience does not automatically result in stronger inquiry-oriented practice. Teachers with more than 10 years of experience may have rich classroom experience, but they may also rely on established instructional routines such as questioning, explanation, and discussion. Previous studies have similarly shown that science learning in schools often remains teacher-centered and that the affective dimension of science learning receives less systematic attention than cognitive achievement (Fahrunisa et al., 2020; Jaenudin et al., 2022b; Widyastika & Wahyuni, 2022).

In contrast, teachers with 6–10 years of experience appeared more likely to connect scientific attitudes with inquiry, project-based learning, and problem-based activities. This may indicate that mid-career teachers are more exposed to current pedagogical reforms or more willing to combine classroom experience with innovative learning approaches. However, this interpretation needs further investigation through larger samples, interviews, or classroom observations. The present finding suggests that professional development should not be designed only according to seniority or length of teaching experience. Instead, it should focus on how teachers conceptualize scientific attitudes, translate them into learning activities, and assess them through clear indicators.

Overall, the findings reveal a perception–practice–assessment gap in fostering scientific attitudes in elementary science learning. At the conceptual level, teachers generally understand scientific attitudes as related to evidence, objectivity, critical thinking, and curiosity. However, their understanding is still uneven because social and ethical dimensions such as honesty, cooperation, persistence, openness, and respect are less frequently emphasized. At the observation level, teachers mostly identify scientific attitudes through visible student behaviors, especially curiosity and questioning. At the practice level, teachers rely more on questioning and discussion than on structured inquiry, experiment, or project-based activities. At the challenge level, teachers face barriers related to student passivity, lack of habituation, low confidence, contextual constraints, and limited consistency.

These findings suggest that scientific attitude development requires more than general awareness. Teachers need conceptual clarity, inquiry-based pedagogical design, and practical classroom assessment tools. Scientific attitudes should be translated into observable indicators that are developmentally appropriate for elementary students, such as asking meaningful questions, observing carefully, reporting data honestly, using evidence to support ideas, respecting different opinions, cooperating in investigation, and revising conclusions when new evidence appears. This is consistent with recent assessment studies emphasizing the need for valid, practical, and context-sensitive instruments to help teachers assess scientific attitudes more systematically (Maria et al., 2024; Rusdiyanto et al., 2023; Widyastika & Wahyuni, 2022).

From a pedagogical perspective, teacher education and professional development programs need to support teachers in designing science learning that explicitly cultivates scientific attitudes. Teachers need examples of how to integrate questioning, observation, experimentation, discussion, reporting, and reflection into coherent inquiry-based learning. They also need simple assessment rubrics that distinguish general participation from scientific dispositions. The findings show that experience alone is not sufficient; teachers require structured support to transform scientific attitude from an abstract concept into a teachable and assessable component of elementary science learning.

CONCLUSION

This study shows that the development of students' scientific attitudes in elementary science learning is shaped by the connection between teachers' conceptual understanding, classroom facilitation, and assessment practices. Teachers generally associate scientific attitudes with evidence, objectivity, critical thinking, and curiosity. However, in classroom practice, they tend to identify scientific attitudes through visible behaviors such as asking questions, activeness, and participation. This indicates a perception–practice–assessment gap, in which scientific attitudes are recognized as important but are not yet consistently translated into structured inquiry-based learning and systematic assessment.

Theoretically, this study contributes by positioning teachers as key mediators in the development of students' scientific attitudes, not merely as implementers of science instruction. Practically, the findings suggest that teachers and schools need clearer indicators, inquiry-based learning examples, and simple assessment rubrics to make scientific attitudes observable and teachable. This study is limited by its use of self-reported questionnaire data, convenience sampling, and unequal teaching-experience groups. Future research should involve larger samples, classroom observations, interviews, and the development of practical assessment instruments to strengthen the connection between teachers' understanding, instructional practices, and students' scientific attitude development.

REFERENCES

Alawiyah, I., & Sopandi, W. (2016). Pembelajaran Berbasis Proyek untuk Meningkatkan Sikap Ilmiah Siswa Sekolah Dasar pada Materi Peristiwa Alam. *Jurnal Penelitian Pendidikan*, *16*(2), 167–176. https://doi.org/10.17509/jpp.v16i2.4241

Andrade, H. L., & Heritage, M. (2017). Using Formative Assessment to Enhance Learning, Achievement, and Academic Self-Regulation. In *Using Formative Assessment to Enhance Learning, Achievement, and Academic Self-Regulation*.

https://doi.org/10.4324/9781315623856

Arseculeratne, S. (2014). The Scientific Attitude (The Scientific Temper) in Eastern and Western societies. *Anuradhapura Medical Journal*, *8*(1), 22. https://doi.org/10.4038/amj.v8i1.6757

Contant, T. L., Bass, J. E., Tweed, A. A., & Carin, A. A. (2018). *Teaching Science Through Inquiry-Based Instruction*.

Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 23–31. https://doi.org/10.15294/jpii.v6i1.7205

Eğmir, E., & Ocak, İ. (2020). Prediction Level of the Fourth Grade Students' Scientific Attitudes on Reflective Thinking Skills for Problem Solving. *Open Journal for Educational Research*, *4*(2), 87–102. https://doi.org/10.32591/coas.ojer.0402.02087e

Fahrunisa, A., Mustadi, A., Toto, R. W., & Pudjiastuti, P. (2020). An Analysis of the Scientific Attitudes of Fifth Graders through Guided Discovery Learning. *Jurnal Penelitian Dan Pembelajaran IPA*, *6*(2), 225. https://doi.org/10.30870/jppi.v6i2.4704

Faizin, Jupri, A. W., & Jamaluddin. (2018). 5E Learning Cycle Model To Improve Students' Scientific Attitude. *IOSR Journal of Research & Method in Education*, *8*(3 ver), 3. https://doi.org/10.9790/7388-0803010103

Fatonah, S., Prasetyo, Z. K., Utami, A. D., Chasanah, U., Lusiana, L., & Siregar, V. V. (2023). *Jurnal Pendidikan IPA Indonesia SCIENTIFIC ATTITUDE AND ITS EFFECT ON STUDENTS ' PRODUCTIVITY*. *12*(4), 658–671. https://doi.org/10.15294/jpii.v12i4.47727

Firdaus, & Darmadi. (2017). Shaping Scientific Attitude of Biology Education Students through Research-Based Teaching. *AIP Conference Proceedings*, *1868*, 100004-1-100004–100005. https://doi.org/10.1063/1.4995214

Gani, A., Safitri, R., Habibati, & Saminan, N. . (2016). The Study of High School Student Scientific Attitude Learning Heat and Temperature with Cooperative Inquiry Labs Model. *Prosiding ICTTE FKIP UNS*, *2*(1), 11–40.

Gauld, C. (1982). The Scientific Attitude and Science Education: A Critical Reappraisal. *Science Education*, *66*(1), 109–121. https://doi.org/10.1002/sce.3730660113

Gauld, C. F. (1982). A Study of the Scientific Attitude of Science Educators Who Study Scientific Attitudes. *Research in Science Education*, *12*, 115–120. https://doi.org/10.1007/BF02357022

Gauld, C. F., & Hukins, A. A. (1980). Studies in Science Education Scientific Attitudes: A Review. *Studies in Science Educatio*, *7*(1), 129–161.

Grinnel, F. (1988). *The Scientific Attitude* (1st ed.). Westview Press.Inc. https://doi.org/https://doi.org/10.4324/9780429314452

Halimah, S. (2025). *The Effectiveness of the STEAM Approach on Critical Thinking Skills in Science and Scientific Attitudes in IPAS Learning in Primary Schools*. 4(3), 1736–1747.

Harlen, W., & Qualter, A. (2018). *The Teaching of Science in Primary School* (7th ed.). Routledge.

Islam Pitafi, A., Farooq Principal, M., & Khadizai, G. (2012). Measurement of Scientific Attitude of Secondary School Students in Pakistan. *Academic Rearch International*, *2*(2), 379–392. www.savap.org.pk%5Cnwww.journals.savap.org.pk

Jaenudin, I., Syaodih, E., Sopandi, W., & ... (2022a). Profile of Scientific Attitude of Elementary School Students in RADEC Model Science Learning with the Water Theme. *ICEE-4 "The Direction of Elementary Education in the Future Challenge,"* 336–345.

Jaenudin, I., Syaodih, E., Sopandi, W., & ... (2022b). Profile of Scientific Attitude of Elementary School Students in RADEC Model Science Learning with the Water Theme. *International …*, 336–345. http://proceedings.upi.edu/index.php/icee/article/view/2005%0Ahttp://proceedings.upi.edu/index.php/icee/article/download/2005/1847

Jager, J., Putnick, D. L., & Bornstein, M. H. (2017). II . MORE THAN JUST CONVENIENT : THE SCIENTIFIC MERITS OF HOMOGENEOUS CONVENIENCE SAMPLES. *Developmental Methodology*, 13–30. https://doi.org/10.1111/mono.12296

Khotimah, K. (2025). *No Title : Pengaruh Kemandirian dan Kreativitas Belajar terhadap Sikap Ilmiah IPA (Survei pada SMPN di Kota Bekasi)*. Unindra.

Maed, M. P. L. (2015). *The Scientific Attitudes of Students Major In Science in the New Teacher Education Curriculum*. *3*(5), 7–15.

Maria, R., Dewi, A., Gading, P., & Rohaeti, E. (2024). *Developing an Instrument for Scientific Attitude Assessment In Learning Chemistry*. *10*(3), 1039–1047. https://doi.org/10.29303/jppipa.v10i3.6669

Misbah, Dewantara, D., Hasan, S. M., & Annur, S. (2018). The Development of Student Worksheet By Using Guided Inquiry Learning Model To Train Student's Scientific Attitude. *Unnes Science Education Journal*, *7*(1), 19–26.

OECD. (2018). The Future of Education and Skills: Education 2030. *OECD Education Working Papers*, 23. http://www.oecd.org/education/2030/E2030 Position Paper (05.04.2018).pdf

OECD. (2021). *Embedding Values and Attitudes in Curriculum: Shapping a Better Future*. OECD Publishing. https://doi.org/10.1787/aee2adcd-en

Oktarizka, D. A. (2024). *Analisis Kebutuhan Pengembangan Media Virtual Reality Sistem Pencernaan untuk Meningkatkan Berpikir Kritis Kelas V SD*. *7*(1), 2225–2235. https://doi.org/10.31949/jee.v7i1.8819

Olasehinde, K. J., & Olatoye, R. A. (2014). Scientific Attitude, Attitude to Science and Science Achievement of Senior Secondary School Students in Katsina State, Nigeria. *Journal of Educational and Social Research*, *4*(1), 445–452. https://doi.org/10.5901/jesr.2014.v4n1p445

Opertti, R. (2021). *Ten Clues for Rethinking Curriculum*. *42*(61), 1–23. https://unesdoc.unesco.org/ark:/48223/pf0000375453.locale=en

Prachagool, V. (2021). Scientific Attitude of Young Children through Literature and Project-Based Learning Organization. *Journal of Educational Issues*, *7*(2), 217. https://doi.org/10.5296/jei.v7i2.19054

Priyayi, D. F., Airlanda, G. S., & Banjarnahor, D. R. V. (2020). Students' Scientific Attitude during the Implementation of Innovative Green Garden-based Education. *Jurnal Pendidikan Biologi Indonesia*, *6*(2), 293–304.

Relita, H., Sekarningrum, V., Setyaningsih, Y., Widharyanto, B., Dharma, U. S., Dharma, U. S., & Dharma, U. S. (2023). *Pengembangan Instrumen Penılaıan Karakter Rasa Ingın Tahu*

Dalam Pembelajaran Membaca Dan Menulıs Sıswa Kelas 1 SD. *6*(2), 275–287. https://doi.org/10.31949/jee.v6i2.5446

Rusdiyanto, D. R., Rubini, B., Ardianto, D., & Pakuan, U. (2023). *Instrument for Student Attitudes Assessment in Science Learning: A Review and Bibliometric Analysis*. *3*(2), 209–221.

Sudana, D. N. (2018). Pengembangan Instrumen Sikap Ilmiah untuk Siswa Sekolah Dasar. *Jurnal Ilmiah Sekolah Dasar*, *2*(2), 144. https://doi.org/10.23887/jisd.v2i2.14098

Tormala, Z. L. (2025). Attitudes : Form , Function , and the Factors that Shape Them. *The Handbook of Social Psychology, 6th Edition*.

Tosun, C., & Genç, M. (2015). Adaptation of Science Attitude Scale Developed for Primary School Students into Turkish: Validity and Reliability Studies. *İlköğretim Online*, *14*(3), 946–960. https://doi.org/10.17051/io.2015.08787

Waddington, C. H. (1968). *The Scientific Attitude* (1st ed.). Hutchinson Educational Ltd.

Widodo, A. (2021). Pembelajaran Ilmu Pengetahuan Alam. In M. Iriany (Ed.), *UPI Press* (1st ed., Vol. 53, Issue 9). UPI PRESS.

Widyastika, D., & Wahyuni, N. (2022). *Pengembangan Penilaian Sikap Ilmiah Berbasis Inkuiri Berorientasi Pendidikan Karakter Siswa pada Pelajaran IPA di Sekolah Dasar*. *6*(6), 9402–9409.

Wildayanto, A., Sudarmin, & N, S. E. (2020). Analysis of Science Literation and Scientific Attitude at Temperature and Calor. *Journal of Innovative Science Education*, *9*(2), 151–158.