Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Indonesian Teachers' Perspective on the Characteristics and How to Teach Science in Elementary School

Riska Dia Sapitri*, Rizka Sofia Irawan, Ryya Aulia Assirri

Master of Science Education, University of Mataram, Mataram, Indonesia
*e-mail: riskasapitri@gmail.com,

Received: June 17, 2025. Accepted: November 14, 2025. Published: November 27, 2025

Abstract: Science education plays a critical role in shaping students' scientific literacy and attitudes. Teachers' perspectives on the nature of science (NoS) are central to how science is taught in classrooms, particularly at the elementary level. This study aims to analyse the views of elementary school teachers in Indonesia on the fundamental characteristics of science and how they implement these views in their teaching practices. Using a descriptive quantitative approach, complemented by Focus Group Discussions (FGD), data were collected from 52 teachers across diverse geographical regions, including West Nusa Tenggara, Java, and East Nusa Tenggara. The data were analysed based on four core aspects of the nature of science: science is interesting to study, science is useful in life, science continues to develop, and science is a global human endeavour. The results show that most teachers have very positive views on the first three aspects, while their understanding of the global dimension of science is categorised as good. Further analysis revealed no significant differences in teachers' views based on length of service, gender, or PPG (Teacher Professional Education) status. These findings suggest the need to enhance teachers' pedagogical competence through globally oriented training programs and contextualised science teaching approaches. This study contributes to improving the quality of science education by encouraging a more holistic and globally relevant understanding of science among primary school teachers.

Keywords: Nature of Science; Primary School; Science Education; Science Learning; Teacher's Perspective.

Introduction

Science is a systematic effort to understand the universe through observation, experimentation, and logical reasoning, leading to evidence-based knowledge [1]. In the context of education, science is not merely a collection of facts but a dynamic process of inquiry that reflects scientific attitudes and promotes critical thinking. Thus, teachers' understanding of the Nature of Science (NoS) plays a crucial role in shaping the quality and depth of science instruction in schools [2]. Their views influence how they design learning experiences, select teaching approaches, and foster students' scientific mindsets.

However, several studies have identified persistent gaps between the ideal conception of science and the actual views held by teachers in practice. For instance, many teachers continue to perceive science in a reductionist way as static knowledge comprised of concepts and formulas, overlooking its tentative, evolving, and collaborative global nature [3]. This narrow perception can undermine efforts to develop students' scientific literacy and higher-order thinking skills [4]. The urgency to address this gap is reinforced by the implementation of Indonesia's Independent Curriculum, which emphasises conceptual understanding, inquiry-based learning, and character-building in science education [5].

Previous research has extensively explored teachers' understanding of NoS in secondary or preservice teachers; however, few studies have critically examined the perspectives of in-service elementary school teachers, especially across diverse Indonesian regions. This is a crucial omission, as early exposure to the nature of science has a significant influence on long-term student attitudes and literacy. Moreover, many prior studies focus on either epistemological aspects or instructional strategies in isolation, without linking them to contextual realities faced by elementary teachers, such as curriculum demands, student characteristics, and regional differences.

In general, there are four key aspects of NoS that are essential to investigate in elementary science teaching: Science is interesting to study because it explains phenomena logically and sparks curiosity [6]. Science is useful in daily life due to its applications in technology, health, and the environment [7]. science as evolving knowledge, highlighting its tentative nature and responsiveness to new evidence [8]; and science as a global human endeavour, emphasising cross-cultural collaboration and open scientific exchange [9].

Based on these considerations, this study aims to analyse Indonesian elementary school teachers' views on the nature of science and its implications for science instruction. By focusing on practising teachers from various regions, this study contributes a novel, context-sensitive understanding of how NoS is interpreted and applied in primary education. The findings are expected to support efforts to enhance teachers' pedagogical competencies through more contextual and globally relevant professional development.

How to Cite:
R. D. Sapitri, R. S. Irawan, and R. A. Atsiri, "Indonesian Teachers Perspective on the Characteristics and How to Teach Science in Elementary School", *J. Pijar.MIPA*, vol. 20, no. 7, pp. 1225–1231, Nov. 2025. https://doi.org/10.29303/jpm.v20i7.9369

Research methods

This study employs a quantitative approach with a descriptive method, aiming to obtain an empirical and objective understanding of the views of elementary school teachers (SD) on aspects of the nature of science. The quantitative approach was chosen because it allows for the systematic collection and analysis of numerical data, so that the results obtained can be generalized to a wider population [10]. Meanwhile, the descriptive method is used to describe the general tendencies, perceptions, and patterns of views held by teachers without manipulating the variables studied. The population in this study were all elementary school teachers in Indonesia. Because the population coverage is very wide, a simple random sampling technique is used, ensuring that each individual in the population has an equal chance of being selected [11]. The instrument used in this study was a closed questionnaire in the form of a Likert scale with 4 choices (Strongly Agree, Agree, Disagree, Strongly Disagree). The questionnaire consisted of 26 statements that measured four main aspects of the nature of science, namely:

1. Science is interesting to study
2. Science is useful in life
3. Science continues to evolve
4. Science is a global human endeavor, and there are also statements that ask how teachers teach science in schools.

Data collection was conducted online through the distribution of electronic questionnaires (Google Forms) shared through the elementary school teacher community network. Data were analyzed descriptively and quantitatively by calculating the percentage of respondents' frequencies in each answer category for each aspect of the nature of science. In addition to quantitative instruments, this study also employed a Focus Group Discussion (FGD) as a qualitative method to strengthen and deepen the quantitative findings [12]. FGD was conducted by involving Students and Lecturers from the Science Education Master's Study Program. This discussion aims to explore further explanations related to the views of teachers that emerged in the questionnaire, as well as to identify factors that influence their understanding of the nature of science. FGD was guided by a moderator using semi-structured discussion guidelines and took place online through direct class discussions. The results of the FGD were recorded, transcribed, and analyzed thematically. The criteria were determined based on the percentage data for analysis. We can use the following interpretive percentage criteria guidelines (commonly used in educational research).

Table 1. Criteria Guidelines

Percentage Range (%)	Criteria
81–100	Very good
61–80	Good
41–60	Enough
21–40	Not enough
0–20	Very less

Results and Discussion

FGD Instrument Analysis

The instrument used in the Focus Group Discussion (FGD) was designed to explore teachers' views on the nature of science and its teaching in schools. The preparation of this instrument involved a collaborative validation process between the instrument compiler, the lecturer in charge of the course, and other students who are members of the study group. Validation was conducted to ensure that each statement in the instrument reflects important dimensions of the nature of science, such as the fact that science is interesting to study, science continues to evolve, science is useful, and science has global applications, as well as appropriate pedagogical approaches in its learning. Of the total 28 initial statements designed to measure both aspects, 26 statements were declared valid and suitable for use in the implementation of FGD [10]. Additionally, the instrument is equipped with supporting statements in the form of open-ended questions, which serve as qualitative data. Of the 11 supporting statements designed, 8 of them were selected based on the suitability of the context and the expected depth of exploration. The combination of this closed instrument is expected to provide a comprehensive picture of teacher perceptions of the characteristics of science and their teaching strategies in the classroom [13].

The results of data collection, obtained from a questionnaire on teachers' views on the nature of science and how to teach science, were gathered from 52 elementary school teachers spread across various regions in Indonesia. Respondents included teachers from West Nusa Tenggara Province (both from Sumbawa Island and Lombok Island), Java Island, and East Nusa Tenggara (NTT). Although the number of respondents does not represent the entire population of elementary school teachers nationally, the geographical distribution of respondents has provided a fairly representative initial picture of teachers' perceptions of the nature of science. The aspects studied include four main characteristics, namely the view that science is interesting to study, science is useful for everyday life, science continues to develop, and science is a global human endeavor. In addition, the questionnaire also explored how teachers teach science in class, both in terms of approach and the learning activities they carry out.

The data analyzed further included the respondents' backgrounds, including the grade level taught (lower or higher grades), length of service as a teacher, gender, and participation status in the Teacher Professional Education Program (PPG). These variables were used to explore whether there were certain tendencies in teachers' views on the nature of science based on their personal and professional characteristics. By analyzing this diversity, the results of the study are expected to provide a deeper and more contextual understanding of how elementary school teachers in various regions of Indonesia understand the nature of science and implement it in the learning process [14].

Analysis of Teachers' Views on the Nature of Science Reviewed from the Classroom

The initial data analyzed in this study aimed to reveal teachers' views on the four main characteristics of science based on their experiences in teaching in high and low grades. The four characteristics of science that were the focus of the measurement included: (1) science is interesting to study, (2) science is useful in life, (3) science continues to develop, and (4) science is a global human endeavor. The analysis was conducted to determine how teachers interpret and apply these four characteristics in learning activities and whether there are differences in approach or understanding when teaching groups of students with high and low abilities. By comparing data from both class groups, a clearer picture was obtained regarding the consistency of teachers' perceptions and practices in building scientific understanding that aligns with the characteristics of the nature of science. The following table presents data analysis results, highlighting differences in achievement across each indicator in high grades, providing a basis for further studies on the effectiveness of the learning approach employed.

In general, the analysis results show that the first three indicators have achieved the Very good criteria in both class groups, high and low classes, reflecting teachers' consistent and optimal understanding and achievement of the measured aspects. This suggests that the learning strategies employed by teachers have been effective in facilitating the successful completion of tasks on the three indicators [15]. However, the achievement in the fourth indicator falls into the 'Good' category, indicating that there is still a gap for improvement to bring it in line with the other indicators. The low achievement in this indicator suggests the need to evaluate the learning approach used by teachers, particularly in terms of presenting materials, implementing learning activities, and the type of evaluation applied [16]. Improvement efforts can be made by strengthening more varied and contextual learning strategies, enriching materials that align with students' needs, and implementing a differentiation approach to accommodate the diversity of student characteristics. Thus, it is hoped that all indicators can achieve an optimal level of implementation evenly across all classes.

Table 2. Analysis results based on the teaching class

No	Aspect	High	Low	Criteria
1	Interesting Science studied	90.0	89.1	Very good
2	Science is useful	86.1	88.1	Very good
3	Science continues to evolve	85.9	85.0	Very good
4	Science is global	66.4	68.4	Good

Table 3. Analysis results based on working hours

		Working Time (%)		
No	aspects	> 5 years	< 5 years	Criteria
1	Interesting Science studied	88.9	91.8	Very good
2	Science is useful	86.5	88.0	Very good
3	Science continues to evolve	84.8	88.0	Very good
4	Science is global	66.3	69.7	Good

Teachers' Views on the Properties of Science Viewed from the Long Work Period

This study aims to explore teachers' views on the nature of science based on their length of service, which is grouped into two categories: teachers with a service period of more than five years and those with a service period of less than five years. The aspects measured include four main properties of science, namely: (1) science is interesting to study, (2) science is useful in life, (3) science continues to develop, and (4) science is a global human endeavor. The results of the analysis show that both teachers with a service period of more than five years and those with a service period of less than five years have very positive views on the nature of science, with average achievements in the first three indicators in the very good category. In the first indicator, namely "science is interesting to study", novice teachers recorded an achievement of 91.8% and experienced teachers 88.9%, with an average of 90.35%. This value shows that all respondents have a high interest in studying science. Similarly, the second indicator, "science is useful in life", showed an average achievement of 87.25%, consisting of 86.5% for experienced teachers and 88.0% for novice teachers, indicating a high awareness of the relevance of science in the context of everyday life. The third indicator, which measures the understanding that "science continues to develop", also showed very good results, with an average of 86.4% (84.8% for experienced teachers and 88.0% for novice teachers). This achievement demonstrates that teachers recognise the dynamic nature of science, which continues to evolve in tandem with advances in technology and knowledge.

However, lower achievement was found in the fourth indicator, namely "science as a global human endeavor", with an average of 68.0% (66.3% for experienced teachers and 69.7% for novice teachers), which is included in the good category. Although still in the positive range, this value indicates that teachers' understanding of the global dimension of science requires further strengthening. This can be used as evaluation material in teacher professional development, particularly in providing global insights and integrating international science issues into learning [17]. Overall, these findings confirm that both experienced and novice teachers possess a good understanding of the fundamental nature of

science. However, to improve the quality of learning that reflects the complexity and meaningfulness of science at the global level, strategies are needed to improve teacher competency through training, material enrichment, and global issue-based learning approaches [18].

Table 4. Analysis results based on gender

No	aspects	Gender (%)		Criteria
		Man	Woman	
1	Interesting Science studied	88.0	89.7	Very good
2	Science is useful	87.5	86.7	Very good
3	Science continues to evolve	87.5	85.0	Very good
4	Science is global	68.8	66.7	Good

Analysis of Teachers' Views on the Properties of Science Viewed from Gender

This study also examines the differences in teachers' views on the nature of science based on gender, namely, male and female teachers. The aspects evaluated include four indicators that represent the basic nature of science, namely: (1) science is interesting to study, (2) science is useful in life, (3) science continues to develop, and (4) science is a global human endeavour.

The results of the analysis show that both male and female teachers have positive views towards the characteristics of science, which are generally categorised as very good. In the first indicator, namely "science is interesting to study", female teachers showed an achievement of 89.7% while male teachers showed 88.0%, with both being in the category very good. This indicates that interest in science is high among both male and female groups.

The second indicator, which measures perceptions of the benefits of science in life, also showed very good results, with 87.5% of male teachers and 86.7% of female teachers achieving it. Likewise, in the third indicator, namely the perception that science continues to develop, the achievement rates were 87.5% for male teachers and 85.0% for female teachers-both remain in the category of very good.

The difference becomes more apparent in the fourth indicator, namely "science as a global human endeavour", where the achievement rate for male teachers is 68.8% and for female teachers, 66.7%. Although still in the 'Good' category, this value is lower than the previous three indicators. This suggests that both male and female teachers need to enhance their understanding of the global dimensions of science.

In general, these results suggest that gender differences do not significantly influence views on the nature of science. However, the low achievement in the indicator of globalisation of science is a notable point for the development of teacher competence, especially in building a cross-cultural and international perspective on science [19]. Therefore, there is a need for globally oriented training and capacity-building programs so that teachers can instil a broader understanding of science in students.

Table 5. Analysis results based on PPG status

No	Aspects	PPG Status (%)		Criteria
		Already	Not yet	
1	Interesting Science studied	88.8	92.9	Very good
2	Science is useful	86.8	87.5	Very good
3	Science continues to evolve	85.4	86.6	Very good
4	Science is global	66.9	68.8	Good

Teachers' Views on the Nature of Science Viewed from PPG Status

This study also analyzes the differences in teachers' views on the nature of science based on their participation status in Teacher Professional Education (PPG), by comparing teachers who have participated in the PPG program and those who have not. Four main indicators are used in this measurement, namely: (1) science is interesting to study, (2) science is useful in life, (3) science continues to develop, and (4) science is a global human endeavor.

The results of the analysis show that both teachers who have participated in PPG and those who have not have a very positive view of the nature of science. In the first indicator, "science is interesting to study", teachers who have not participated in PPG showed higher achievement (92.9%) compared to teachers who have participated in PPG (88.8%). Both are included in the category 'very good', which suggests that interest in science is formed not only through formal professional education, but also through personal experience and interests.

The second indicator, which measures the view that "science is useful in life", shows an achievement of 86.8% for teachers who have completed PPG and 87.5% for those who have not, also in the category very good. Similarly, for the third indicator, "science continues to develop", the value obtained was 85.4% (already PPG) and 86.6% (not yet PPG), with the same criteria. These three indicators reflect that both teachers who have participated in professional training and those who have not have a good understanding of the essence of science as a relevant and dynamic discipline.

However, in the fourth indicator, namely "science as a global human endeavor", both groups showed lower

achievements, namely 66.9% (already PPG) and 68.8% (not yet PPG), with the category *Good*. This finding shows that the aspect of globalization of science is still not fully understood in depth by both groups of teachers, and needs to be a concern in the development of teacher professionalism in the future.

Overall, these findings suggest that PPG status does not significantly affect the level of understanding of the basic properties of science [20]. However, the global aspect of science remains a significant challenge that requires strengthening in teacher training, both in the context of PPG and other continuing professional development initiatives.

How to Teach Science

Analysis of How to Teach Science in Schools Reviewed from Teachers' Length of Service. Teachers' understanding of the nature of science is closely tied to their professional experience, including the length of their service as educators. Therefore, this analysis aims to examine how teachers teach science in schools, reviewed from the perspective of length of service, which is grouped into two categories: teachers with more than five years of service and those with less than five years of service. Work experience is believed to help shape the perspective, learning strategies, and approaches used in communicating the nature of science to students.

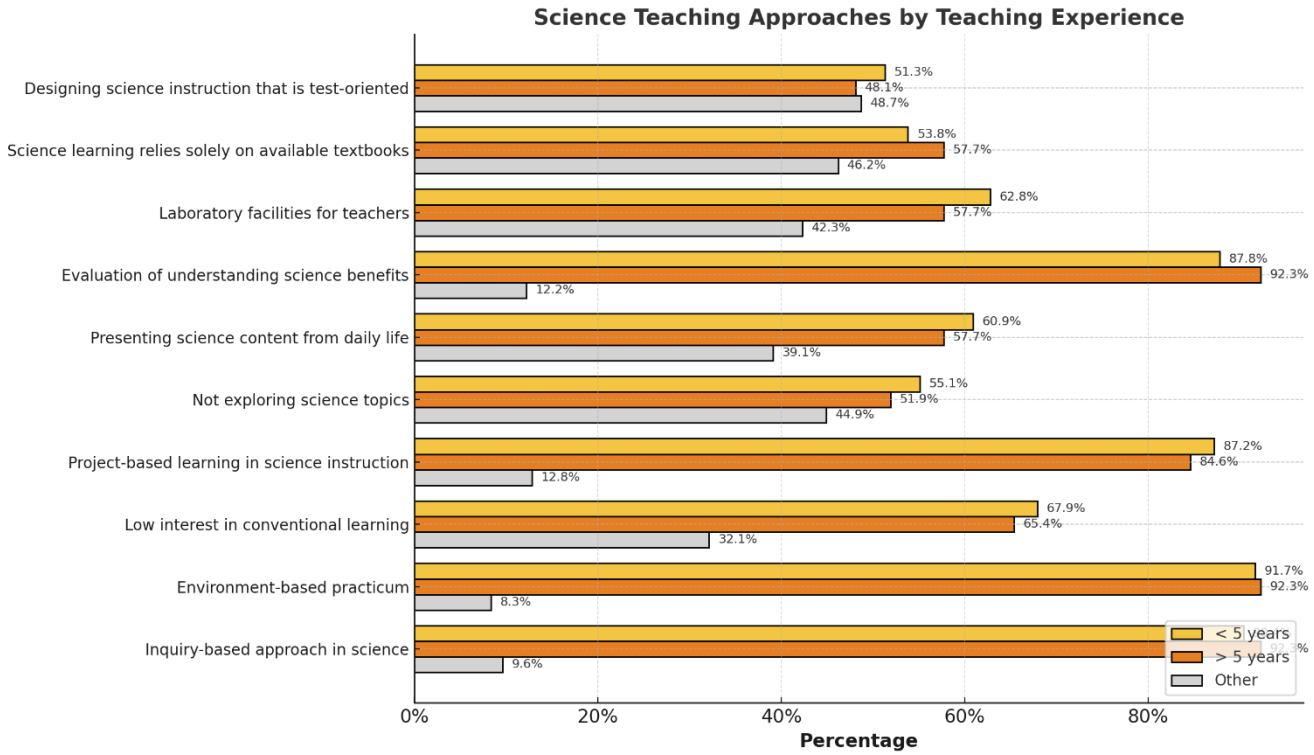

Figure 1. How to teach Science

The graph above illustrates how science teachers teach science based on specific learning approaches, which is associated with the length of their service. The majority of teachers, both those with less than 5 years of experience and those with more than 5 years, show a strong tendency to apply active approaches, such as inquiry-based learning, environmental-based practicums, and project-based learning, with a percentage above 90%. This shows that science teaching has been directed at activities that emphasize exploration, direct experience, and relevance to real life. The high positive response to the evaluation of the benefits of science and the use of everyday contexts also reinforces that science learning is no longer just memorization, but is starting to be directed at application understanding and the development of 21st-century skills [21]. However, the graph also shows challenges in implementing the ideal approach. For example, in negative statements such as “not exploring science” and “low interest in conventional learning”, a fairly high percentage indicates that some teachers still implement passive learning or have not completely shifted from the old method. This can be caused by limited facilities, time, or minimal ongoing training. In addition, teachers with longer tenure appear to be slightly more moderate in their responses to new approaches, such as the use of technology or project-based methods [22]. This finding emphasizes the importance of equitable support in the form of practical training, improving facilities, and strengthening learning communities so that all teachers are able to teach science actively, contextually, and relevantly to current developments.

Science Learning Confirmation

The interview results showed that most teachers realized that science is very relevant to students' daily lives. The main challenges remain, including limited tools, time, and the readiness of students and teachers to integrate science learning. Students like experiments and direct practice because they make the material more engaging and easier to understand, but their implementation still depends on the availability of tools.

Some teachers have utilized technology such as experimental videos and the latest scientific research in learning, although this is not yet evenly distributed. Common strategies used to foster positive attitudes towards science are providing real, applicable examples and conveying the importance of science for the future. However, teachers hope that the curriculum can be more flexible and that teacher training can focus more on real-world practice, providing adequate support facilities.

Table 7. Sample interview results

No	Statement
Q1	*"Shows that teachers are aware of the importance of connecting science to real life."*
Q2	*"Shows limitations of practice due to tools not always being available."*
Q3	*"Students are generally happy and enthusiastic during practice."*
Q4	*"Some teachers have used technology such as video experiments, but it is not yet widespread."*
Q5	*"Some teachers have not consistently discussed the contributions of scientists from various countries."*
Q6	*"General strategy: providing real and applicable examples and the relevance of science for the future."*
Q7	*"Main challenges: evaluation of memorization focus, time constraints, facilities, and student readiness."*
Q8	*"Key expectations: practice-based training, flexible curriculum, improved facilities, and support for teacher learning communities."*

The results of interviews with science teachers reflect understandings and practices that align with the four fundamental characteristics of science. First, science is considered an interesting subject to study, as reflected in the statement that students feel happy and enthusiastic when engaging in practical work (Q3), which suggests that exploratory activities in science can spark interest in learning. Second, science is viewed as useful in life, as evidenced by teachers' awareness of the importance of linking science material to real-life applications and students' futures (Q1, Q6). Teachers strive to present contextual and applicable learning, strengthening the relevance of science in everyday life. Third, science, as a field that continues to develop, is evident in the use of technology, such as experimental videos by some teachers (Q4), although it is not yet evenly distributed. This suggests that efforts are being made to keep pace with the times, but additional training and facility support are still needed (Q2, Q8). Fourth, science as a global human endeavor has not been fully reflected in learning practices, because some teachers have not consistently discussed the contributions of scientists from various countries (Q5). This is an important note to strengthen global insight in science learning [23]. Overall, although there is already awareness and positive initiatives from teachers, ongoing support is still needed so that the four characteristics of science can be internalized and implemented comprehensively in the learning process.

Conclusion

The results of this study indicate that, in general, elementary school teachers in various regions of Indonesia hold a positive view of the basic characteristics of science, particularly in terms of its interest in studying, its practical applications in life, and its ongoing development. These three aspects consistently yield very good results across various respondent groups, including those based on the background of the class taught (high/low), length of service, gender, and PPG status. However, the aspect of "science as a global human endeavor" showed relatively lower achievements and only reached the criteria *Good* across categories, indicating the need to strengthen teachers' insight into the dimensions of globalization in science. In terms of professionalism, both teachers with less than five years of service and those with more than five years showed similar performance achievements and were categorised as good. This suggests that the length of service is not the sole determinant of the quality of teaching assignments, but rather is influenced by factors such as training, motivation, and institutional support. Thus, it can be concluded that strengthening teachers' pedagogical competence needs to be carried out evenly and sustainably, without distinguishing between experience status, gender, or PPG status. These strengthening efforts can be carried out through global issue-based training, providing contextual learning resources, and increasing collaboration between teachers. Overall, this study emphasizes the importance of a complete understanding of the nature of science as a foundation for designing meaningful learning. Teachers who possess a deep understanding of the nature of science will be better equipped to foster critical-thinking, scientifically inclined students who are prepared to face the challenges of the 21st century. Therefore, policy support and ongoing professional development programs for teachers are urgently needed to improve the quality of science education at the elementary level.

Author's Contribution

Riska Dia Sapitri: contributed to the conceptualization, methodology design, and supervision of the study. Ryya Aulia Atsiri: managed the literature review, wrote the original draft, and edited the final manuscript. Rizka Sopia Irawan: was responsible for data collection. All authors have read and approved the final version of the manuscript.

Acknowledgement

The author would like to express his deepest gratitude to Prof. A. Wahab Jufri, M.Sc., for his guidance, direction, and support that were very meaningful during the process of compiling and implementing the assessment of the nature of science in Elementary Schools. His advice and input have contributed significantly to the improvement of this work.

References

[1] J. S. Lederman, N. G. Lederman, and A. Antink, "Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy," *Int. J. Educ. Math. Sci. Technol.*, vol. 2, no. 3, pp. 138–147, 2014.

[2] F. Abd-El-Khalick and N. G. Lederman, "Improving science teachers' conceptions of nature of science: A critical review of the literature," *Int. J. Sci. Educ.*, vol. 22, no. 7, pp. 665–701, 2000, doi: 10.1080/09500690050044044.

[3] R. Khishfe and F. Abd-El-Khalick, "Influence of explicit and reflective versus implicit inquiry-oriented instruction on sixth graders' views of nature of science," *J. Res. Sci. Teach.*, vol. 39, no. 7, pp. 551–578, 2002, doi: 10.1002/tea.1003.

[4] R. Gunstone, "The importance of students' views about learning science," in *The Re-emergence of Learning in Science Education*, Routledge, 2004, pp. 11–28.

[5] Kemdikbudristek, *Panduan Implementasi Kurikulum Merdeka*. Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022.

[6] M. Çalik, B. Turan, and R. K. Coll, "A cross-age study of elementary student teachers' scientific habits of mind concerning socio-scientific issues," *Int. J. Sci. Math. Educ.*, vol. 13, no. 2, pp. 289–307, 2015, doi: 10.1007/s10763-014-9601-7.

[7] H. A. Yacoubian, "A framework for guiding future citizens to think critically about nature of science and socioscientific issues," *Can. J. Sci. Math. Technol. Educ.*, vol. 15, no. 3, pp. 248–260, 2015, doi: 10.1080/14926156.2015.1051671.

[8] N. G. Lederman, "Nature of science: Past, present, and future," in S. K. Abell and N. G. Lederman, Eds., *Handbook of Research on Science Education*. Lawrence Erlbaum Associates, 2007, pp. 831–879.

[9] W. F. McComas, *Nature of Science in Science Instruction: Rationales and Strategies*. Springer, 2020.

[10] D. P. Lapang, "Menjaring data dan informasi penelitian melalui FGD (Focus Group Discussion): Belajar dari praktik lapang Achmad Rizal H. Bisjoe," *J. Biostatistik, Kependudukan, dan Informatika Kesehatan*, pp. 17–28, 2006.

[11] P. G. Subhaktiyasa, "Menentukan populasi dan sampel: Pendekatan metodologi penelitian kuantitatif dan kualitatif," —, vol. 9, pp. 2721–2731, 2024.

[12] B. William, "Evaluating the efficacy of focus group discussion (FGD) in qualitative social research," *Int. J. Bus. Soc. Sci.*, vol. 3, no. 7, pp. 54–57, 2012.

[13] J. A. Morrison, F. Raab, and D. Ingram, "Factors influencing elementary and secondary teachers' views on the nature of science," *J. Res. Sci. Teach.*, vol. 46, no. 4, pp. 384–403, 2009, doi: 10.1002/tea.20252.

[14] K. J. Chuene and S. K. Singh, "Exploring science teachers' views about the nature of science and the implications on their pedagogical content knowledge: A case of 11 in-service South African teachers," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 20, no. 1, pp. 1–16, 2024, doi: 10.29333/EJMSTE/14090.

[15] S. Lakin and J. Wellington, "Who will teach the 'nature of science'?: Teachers' views of science and their implications for science education," *Int. J. Sci. Educ.*, vol. 16, no. 2, pp. 175–190, 1994, doi: 10.1080/0950069940160206.

[16] K. Knowles and J. Guthrie, *The Effect of Teacher Characteristics on Student Achievement and Motivation*, p. 348, 2000.

[17] A. Aditomo, *Panduan Pembelajaran dan Asesmen Pendidikan Anak Usia Dini, Pendidikan Dasar, dan Pendidikan Menengah*, Edisi Revisi, pp. 1–72, 2024.

[18] A. D. F. Dwita Fitri, A. Asrizal, and F. Festiyed, "Effect size analysis of the influence of science teaching materials based on scientific approach on students' learning outcomes," *J. Innov. Phys. Teach.*, vol. 1, no. 2, pp. 104–112, 2023, doi: 10.24036/jipt/vol1-iss2/18.

[19] D. Dani, "Scientific literacy and purposes for teaching science: A case study of Lebanese private school teachers," *Int. J. Environ. Sci. Educ.*, vol. 4, no. 3, pp. 289–299, 2009.

[20] C. García-Ruiz, T. Lupión-Cobos, and Á. Blanco-López, "Effects of an inquiry-based science education training program on pre-service teachers: A mixed-methods case study," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 18, no. 12, 2022, doi: 10.29333/ejmste/12578.

[21] C. Gormally, P. Brickman, B. Hallar, and N. Armstrong, "Effects of inquiry-based learning on students' science literacy skills and confidence," *Int. J. Scholarsh. Teach. Learn.*, vol. 3, no. 2, 2009, doi: 10.20429/ijsotl.2009.030216.

[22] N. R. Dolenc, P. Beaulieu, and P. Sheppard, "Maintaining scientific inquiry in online education," *Res. Issues Contemp. Educ.*, vol. 5, no. 3, pp. 13–25, 2020.

[23] H. Suwono, L. Maulidia, M. Saefi, S. Kusairi, and C. Yuenyong, "The development and validation of an instrument of prospective science teachers' perceptions of scientific literacy," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 18, no. 1, 2022, doi: 10.29333/EJMSTE/11505.