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Exploring Learners' Concept Understanding of Static Electricity: A Scientific Literacy Case Study in a Malaysian Primary School

Agung Wibowo[1], Fidia Fibriana[1]✉, Nurzaimah Binti Asalal[2]

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[1]Universitas Negeri Semarang, Indonesia
[2]Universiti Pendidikan Sultan Idris, Malaysia

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Abstract

Understanding static electricity can be challenging for elementary students due to its abstract nature. As the ability to explain scientific phenomena is a key indicator of scientific literacy, contextual and interactive learning experiences are essential. This study aimed to explore the level of understanding of the concept based on a case study in a Malaysian primary school. This study investigated the implementation of a guided inquiry-based static electricity experiment and analyzed the scientific literacy outcomes of Grade 3 students in a Malaysian elementary school. Using purposive sampling, 28 students participated in a simple practicum that involved using a ruler and paper pieces, supported by a worksheet and a nine-item Likert-scale questionnaire to assess their scientific literacy. Data analysis confirmed normal distribution, with literacy scores indicating strong performance: 81% in understanding and explaining phenomena, 85% in designing and evaluating scientific inquiry, and 88% in applying scientific information for decision-making. Skewness values of 0.035, -0.836, and -0.917, respectively, suggest consistent data patterns. Despite overall positive results, the lowest score highlights the need to strengthen concept understanding. Findings demonstrate that simple, experiment-based learning can foster cognitive development and scientific literacy, emphasizing the role of teacher guidance in linking everyday experiences to scientific concepts.

How to Cite

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✉ Correspondence Author:
E-mail: fibriana.f@mail.unnes.ac.id

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INTRODUCTION

In the era of rapid global change, elementary education must nurture essential 21st century competencies beyond memorization and procedural skills. Developing creativity, critical thinking, communication, collaboration, character, citizenship, and adaptability enables students to thrive in dynamic environments. As emphasized by Adawiyah (2017), mastering these skills is crucial for students to navigate the complexities of modern society and technological advancement. The demands of the 21st century call for high-quality human resources who are not only knowledgeable but also capable of responding effectively to emerging challenges and opportunities. Therefore, early and continuous guidance is essential to ensure that students develop into resilient, innovative, and future-ready individuals (Mardhiyah et al., 2021).

Education systems must cultivate individuals who are not only adaptable but also capable of competing and contributing as high-quality, reliable human resources, thereby preparing students for the demands of the 21st century (Yusmar et al., 2023). Among the core competencies required for success in this era of rapid change is scientific literacy, a foundational skill that enables learners to interpret the phenomena, make informed decisions, and engage critically with scientific information (Rini et al., 2021). Far from being limited to the comprehension of scientific facts, scientific literacy encompasses a multidimensional set of abilities, including inquiry, evaluation, and application of scientific knowledge in real-life contexts (Nofiana & Teguh, 2018). Thus, fostering scientific literacy from an early age is crucial to equip students with the cognitive and practical tools necessary for lifelong learning and active participation in society. In the context of 21st century education, scientific literacy plays a crucial role in fostering critical thinking and informed decision-making (Putri et al. 2025). As such, embedding scientific literacy into early education is essential for nurturing future-ready individuals who can think critically, act responsibly, and contribute meaningfully to sustainable development.

One widely recognized method for evaluating students' scientific literacy is through international assessments. The Programme for International Student Assessment (PISA), administered by the Organisation for Economic Co-operation and Development (OECD), measures the competencies of 15-year-old students in reading, mathematics, and science, focusing on their ability to apply knowledge to real-world problems. Malaysia has participated in PISA since 2010, using the results to inform educational policy and reform. Despite ongoing efforts to enhance education quality, Malaysia's performance in PISA 2022 showed a decline across all three domains compared to 2018, with science literacy scores reflecting challenges in applying scientific knowledge critically and effectively (OECD, 2023). Similarly, findings from the Trends in International Mathematics and Science Study (TIMSS) have highlighted the need to strengthen students' reasoning and problem-solving skills. The Malaysian Education Blueprint has acknowledged these gaps, emphasizing the importance of improving higher-order thinking skills and aligning teaching practices with global standards to develop future-ready learners.

The scientific literacy level of Malaysian students generally aligns with the international average, yet remains uneven across different regions and school systems (Zhang et al., 2022). This disparity is influenced by several systemic challenges within the Malaysian education landscape, including the urban–rural divide, variations in instructional quality among national schools with different language mediums (e.g., Mandarin and Tamil), and ongoing issues related to integration and social cohesion in multicultural learning environments (Ristyana et al., 2024). To address these gaps and enhance student outcomes in international assessments such as the TIMSS and PISA, Malaysia has implemented targeted professional development programs for science educators. These initiatives have led to notable improvements in teacher competencies, although continuous efforts are still needed to ensure equitable and high-quality science education nationwide (Nur et al., 2018). Strengthening teacher capacity remains a crucial factor in promoting scientific literacy and equipping students to meet global educational standards.

Early assessment of students' scientific literacy supported instructional strategies and timely interventions, while contextual, low-cost hands-on experiments effectively enhanced students' conceptual understanding and engagement in scientific inquiry (Sariyyah et al., 2024). Structured worksheets guiding students through observation, hypothesis formulation, experimentation, and reflection not only reinforce concept and investigative skills but also support the development of broader 21st century competencies. According to Septaria et al. (2025), it is emphasized that inclusive, collaborative, and activity-oriented learning models, anchored by student worksheets, can significantly improve scientific literacy while responding to the demands of lifelong learning. Further evidence from Maisum et al. (2024) highlights the value of authentic practicum guides, though refinement is needed to optimize their impact. Winarni et al. (2023) also report substantial gains in students' literacy across context, knowledge, competence, and environmental care attitudes, with strong correlations between ecological awareness and scientific understanding. These findings underscore the importance of incorporating inquiry-driven learning models that are appropriate for strengthening students' cognitive development, environmental sensitivity, and scientific literacy from the elementary level.

Challenges in scientific literacy within learning were addressed through the implementation of instructional approaches that actively engaged students in the learning process (Pujana et al., 2022). The application of static electricity through age-appropriate, hands-on activities proved effective in capturing elementary students' scientific literacy. Abdulah et al. (2025) demonstrated that a simple experiment, utilizing a plastic ruler and paper pieces, enhanced students' curiosity, conceptual understanding, and interest in science, thereby supporting the early development of scientific literacy. Consistent with these findings, Sariyyah et al. (2024) reported significant improvements in students' scientific literacy after participating in similar experiments. Interactive practicum activities helped students connect scientific concepts with everyday experiences, enhancing their understanding and application, and developing essential inquiry skills, thereby highlighting the value of experiential learning in fostering scientific literacy.

This study aimed to explore the level of understanding of the concept of static electric force through an experiment using plastic rulers and pieces of paper conducted by primary school students in Malaysia. Implemented through a guided inquiry learning approach, the experiment provided a concrete and observable introduction to the concept of static electricity, allowing students to witness firsthand how electrostatic forces operate and to grasp the underlying scientific principles. By incorporating familiar materials from students' daily environments, the learning experience was designed to bridge theoretical knowledge with real-life contexts, thereby enhancing relevance, engagement, and concept clarity.

METHOD

Sample and Research Design

The research was conducted in August 2025 at a primary school in Tanjong Malim, Perak, Malaysia. The study involved 28 third-grade students, comprising 14 males and 14 females, all of whom were 9 years old on average. Participants were selected using purposive sampling to ensure relevance to the research objectives. The combination of quantitative and qualitative data provided a comprehensive understanding of students' development of scientific literacy through guided inquiry-based experimentation.

This research employed a case study method, which involves an investigation of individuals, enabling researchers to explore an issue in detail through direct observation and contextual analysis. By focusing on authentic conditions, this method allows for a comprehensive understanding of the dynamics and interactions that shape the subject of study, making it particularly suitable for examining educational practices and student learning experiences *in situ* (Poltak & Widjaja, 2024).

This study employed a descriptive quantitative approach, supplemented by qualitative analysis, to assess students' scientific literacy through a static electricity experiment. Data were collected using a scientific literacy questionnaire and a student worksheet designed to capture scientific literacy skills. These instruments enabled an evaluation of students' responses and engagement with the experiment. Figure 1 presents the sequential research steps undertaken, outlining the implementation process from planning to data analysis.

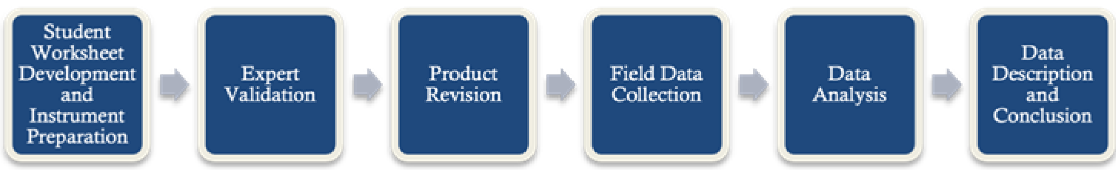

Figure 1. Research Design

Research Instruments

The research instruments used in this study were student worksheets and a scientific literacy questionnaire. The student worksheet used in this study was designed to integrate theoretical foundations, scientific methods, and elements of science play, presented through structured student analysis responses. According to Septaria et al. (2025), a systematically developed worksheet that combines practical activities with reflective theoretical components can effectively bridge abstract scientific concepts with students' real-life experiences. This integration not only reinforces concept understanding but also promotes meaningful learning by encouraging students to actively engage with scientific phenomena in a way that is both analytical and relatable.

Data collection was conducted using a questionnaire designed in alignment with established indicators of scientific literacy, capturing students' responses following their participation in static electricity experiments. The questionnaire employed a Likert scale enriched with emojis to accommodate the developmental characteristics of elementary school students and enhance engagement. The Likert scale is a widely used tool for measuring attitudes, perceptions, and views toward social phenomena, allowing variables to be operationalized into measurable indicators (Sugiyono, 2013). These indicators served as the foundation for constructing questionnaire items in the form of clear, age-appropriate statements. The instrument consisted of nine questions, each offering four response options, ranging from "Highly Agree" to "Highly Disagree". Supporting this approach, Soebandhi (2024) used a four-point Likert scale with emoji indicators from happy to unhappy expressions, which enhanced students' self-expression, participation, and comfort during data collection. This approach proved effective for assessing scientific literacy and cognitive competencies at the elementary level. Represented visually through expressive emojis, as illustrated in Figure 2.

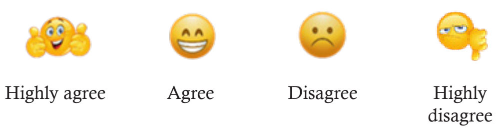

Figure 2. Likert Scale Emojis

Delivery Method and Data Collection

The language used in the student worksheet was adapted to Bahasa Malaysia to ensure accessibility and ease of understanding for primary school students during the experiment. This worksheet served as both a learning guide and an assessment tool, designed to evaluate students' knowledge and experiential understanding following the static electricity activity. The final version of the student worksheet, which integrates contextual language and structured inquiry prompts, is presented in Figure 3.

The validation of the student worksheet as an instructional and assessment instrument was conducted by expert validators, selected based on their relevant expertise, experience, and academic background. Following the expert review, the assessment was conducted based on the language aspect, visual design quality, and material suitability. The product underwent necessary revisions and was subsequently deemed valid for field implementation. For data analysis, quantitative responses from the scientific literacy questionnaire were processed using SPSS 31 (Trial Version), employing the Shapiro-Wilk non-parametric test to assess the distribution of student responses. Meanwhile, qualitative data derived from student worksheets were analyzed using content analysis techniques to identify emerging patterns in concept understanding, misconceptions, and scientific reasoning skills demonstrated during the static electricity experiment.

Data Analysis

Data analysis in this study was conducted using a descriptive quantitative approach, applying specific calculations to evaluate students' scientific literacy levels. Each student's total questionnaire score was calculated using the Students' Scientific Literacy Level (SSLL) equation (Eq. 1), and the resulting percentages were then matched against the criteria outlined in Table 1. This table categorizes scientific literacy into four distinct levels: Advanced, Proficient, Basic, and Need Special Intervention. These categories served as a benchmark for interpreting the extent of students' scientific literacy, enabling a clear and systematic assessment of their understanding and competencies based on the scores obtained. Data analysis was conducted using a quantitative descriptive approach, involving specific calculations to assess the level of scientific literacy. Table 2 presents scientific literacy indicators with the classification of question numbers on the questionnaire.

$$SSLL\ (\%) = \frac{Obtained\ Score}{Maximum\ Score}\ x\ 100 \quad \text{(Eq. 1)}$$

RESULT AND DISCUSSION

Learning Activities

This study implemented the guided inquiry learning model as the core instructional approach. Guided inquiry is a pedagogical strategy in which teachers facilitate students' active exploration by providing structured guidance to discover, formulate, and solve problems, thereby constructing a deeper understanding of science. The support offered typically includes probing questions and directional cues that help students arrive at meaningful conclusions (Erdani & Hakim, 2020). According to Khairiyah (2025), guided inquiry learning comprises five sequential phases: (1) identifying and orienting the problem, (2) formulating a hypothesis, (3) collecting data, (4) interpreting the data, and (5) drawing conclusions.

Figure 3. Student worksheet design, (A) Cover, (B) Theoretical foundations, (C) Materials and Methods, and (D) Memory in Playing Science

Table 1. Scientific literacy level category description (Putri et al. 2025; Firdaus & Asmali 2021)

Score	Category	Description
75–100	Advanced	Students demonstrated the ability to reflect on the content of the reading and make informed decisions related to scientific concepts with confidence. This level of autonomy enabled them to solve the given problems effectively, even in the absence of direct guidance, indicating a strong foundation in concept understanding and independent reasoning.
51–75	Proficient	Students demonstrated the ability to comprehend scientific texts at a literal level and successfully solve problems related to the concept of heat with minimal guidance. This indicates a growing independence in applying concept knowledge and reflects their readiness to engage with scientific content more autonomously.
26–50	Basic	Students demonstrated the ability to extract information from the provided science texts. However, they still required guidance in identifying the most relevant content to grasp the concept of heat fully and in verifying the accuracy of their understanding. This suggests that while foundational literacy skills are present, scaffolding remains essential to support a deeper understanding of concepts and critical evaluation.
0–25	Need Special Intervention	Students at this level exhibit minimal mastery of scientific concepts and require substantial support throughout the learning process. Assistance is needed in accurately recording experimental data, conducting procedures correctly, and engaging in reflective discussions to validate findings. Collaborative dialogue with more capable peers can serve as a valuable scaffold, enabling these students to develop foundational understanding through guided interaction and shared reasoning.

Table 2. Classification of questions based on scientific literacy indicators

Indicator No.	Indicator description	Questionnaire Statement No.
1	Understanding and explaining scientific phenomena	1, 2, and 3
2	Drafting and evaluating designs for scientific inquiry, as well as critically interpreting scientific data and evidence	4, 5, 6, and 7
3	Research, evaluate, and use scientific information for decision-making and action	8 and 9

These phases were applied during the static electricity experiment to scaffold students' inquiry process and promote deeper engagement with scientific concepts. Table 3 outlines the learning stages during the experiment, serving as a procedural guide for data collection and concept exploration. This framework ensured that students progressed systematically through each phase of inquiry, reinforcing both procedural fluency and concept understanding.

Table 3. Stages of guided inquiry learning activity by applying the static electricity practicum

Learning Stage	Teacher Activities
Orientation and Problem Identification	• The teacher greeted students and led a short prayer • Stimulated curiosity by asking why paper pieces were attracted to ruler rubbed on hair • Introduced the topic of static electricity
Formulating Predictions (Hypotheses)	• Demonstrated rubbing a plastic ruler on hair and bringing it close to small pieces of paper • Asked students to observe the phenomenon • Encouraged students to predict why the paper was attracted to the ruler • Facilitated discussion based on students' prior knowledge
Data Collection	• Divided students into small groups • Distributed materials (plastic rulers, paper pieces, and worksheets) • Guided students in experimenting independently
Interpreting Data	• Led a discussion on students' observations • Guided students in recording and analyzing their findings on the worksheet • Asked guiding questions to connect observations with the concept of electric charge
Drawing Conclusions	• Encouraged students to conclude that the ruler became charged and attracted light objects • Reinforced the scientific concept and provided moral reflection • Closed the lesson with a prayer

The learning activity commenced with an opening phase, during which the teacher greeted the students, took attendance, and created a joyful and engaging classroom atmosphere to prepare them for the lesson. As illustrated in Figure 4A, this stage also involved the teacher communicating the learning objectives and anticipated benefits, thereby motivating students and providing a clear overview of the material to be explored. According to Yulianti & Zhafirah (2020), the opening phase is designed to stimulate students' curiosity and prompt them to ask foundational questions related to the topic. This initial engagement catalyzes enthusiasm, encouraging students to actively participate and remain motivated throughout the subsequent stages of the guided inquiry process.

Figure 4. Practicum and learning activities showing students rubbing the plastic ruler and bringing it closer to the paper as the data collection activities (A), students are interpreting the data on practicum results (B)

The next stage involved demonstration and reinforcement activities, as illustrated in Figure 4B Demonstration and Strengthening of Experiments. In this phase, selected student representatives performed the static electricity experiment in front of their peers, modeling the phenomenon by rubbing a ruler on dry hair and attracting small paper pieces. This activity was designed to provide a concrete understanding of the concept before independent group experimentation, as described by Hawa et al. (2021). The use of demonstration methods in science education significantly enhances students' concept grasp by visualizing abstract phenomena. Furthermore, Wahidah et al. (2022) emphasize that such approaches are highly relevant in science learning, as they support students in conducting meaningful exploration and investigation through observation and interaction with real-world objects and natural phenomena.

The subsequent phase focused on Interpreting Data, during which students conducted static electricity experiments independently in small groups. In alignment with the experimental design, male students rubbed a plastic ruler against their hair, while female students used the fabric of their shirts to generate static charge. Following the hands-on activity, students completed the Student Worksheet, which incorporated elements of memory in playing science to reinforce their understanding of the concept. Beyond serving as a procedural guide, the worksheet functioned as a reflective tool, enabling students to document observations, analyze experimental data, and propose solutions to the problems encountered (Cahyanto et al., 2024).

Upon completion of the worksheet, an evaluation was conducted using a scientific literacy statement questionnaire. This instrument aimed to assess students' comprehension, reasoning, and ability to apply scientific concepts. As noted by Hawa et al. (2021), evaluation in learning is a systematic process used to determine the effectiveness, value, and impact of educational activities. It encompasses the assessment of learning programs, outcomes, and instructional methods, thereby providing critical insights into student progress and the quality of instruction.

The final phase of the learning activity was the Closing Activity, during which the teacher and students engaged in reflective dialogue about the entire series of static electricity experiments. The teacher facilitated a guided reflection, encouraging students to revisit their observations and draw conclusions based on their experiences. Students were allowed to express their thoughts, pose questions, and share insights related to the phenomena they had explored. To conclude, the teacher delivered a motivational message, emphasizing the importance of critical thinking and the relevance of connecting scientific concepts to everyday life. The session ended with a joint prayer and farewell greetings, reinforcing a sense of community and closure. As noted by Sani (2016), the closing activity plays a vital role in evaluating the achievement of learning objectives, gauging students' mastery of the material, and providing valuable feedback for teachers to assess the effectiveness of instructional delivery.

To ensure the appropriateness of subsequent statistical analyses, a normality test was conducted on the scientific literacy data. The results indicated a Kolmogorov-Smirnov significance value of 0.200 and a Shapiro-Wilk value of 0.716, both of which exceeded the threshold of $\alpha = 0.05$. These findings confirm that the data are normally distributed. Following this, a descriptive analysis was performed to determine students' scientific literacy levels across each indicator. According to Riyanto & Arini (2021), descriptive analysis was a basic data processing technique aimed at describing research conditions or phenomena without drawing conclusions or making predictions. It was commonly used in exploratory research. This analysis encompassed key statistical measures, including mean, median, mode, standard deviation, skewness, minimum and maximum scores, and score ranges. The detailed results of these calculations are presented in Table 4, providing a comprehensive overview of students' performance and their understanding of the concepts.

Table 4. The results of the descriptive analysis of the scientific literacy questionnaire on each indicator

Indicator	Indicator description	Mean	Median	Mode	Std. Dev.	Skewnees	Score Min.	Score Max.	Range
1	Understanding and explaining scientific phenomena	9.78	9.0000	9.00	1.618	.035	7.00	12.00	5.00
2	Drafting and evaluating designs for scientific inquiry, as well as critically interpreting scientific data and evidence.	13.71	14.0000	14.00	1.674	-.836	10.00	16.00	6.00
3	Research, evaluate, and use scientific information for decision-making and action.	7.07	7.0000	7.00	0.978	-.917	5.00	8.00	3.00

Based on Table 4, students scored an average of 9.78 (range = 5) in the Explaining Scientific Phenomena indicator, reflecting a generally good and evenly distributed understanding relative to the maximum score of 12. The highest average score, 13.71 (range = 6), was observed in Designing and Evaluating Scientific Investigations and Critically Interpreting Data, indicating strong comprehension, though with notable variability among students (Durasa et al., 2022). In contrast, the Using Scientific Information for Decision-Making indicator yielded an average of 7.07 (range = 3) out of a maximum of 8, suggesting near-perfect performance with consistent responses. The frequency distribution for each indicator is presented in Figure 5.

Figure 5 illustrates the distribution patterns of students' scientific literacy scores across three indicators. For Indicator 1, the data exhibit a positively skewed distribution (Skewness = 0.035), indicating that most students scored below the average, reflecting limited concept mastery (Ariawati et al., 2019). In contrast, Indicator 2 shows a negatively skewed distribution (Skewness = –0.836), suggesting that the majority of students performed above average, demonstrating strong inquiry and analytical skills (Ushani & Suarjana, 2019). Similarly, Indicator 3 also displays a negatively skewed curve (Skewness = –0.917), indicating high student performance and consistent understanding in applying scientific knowledge to real-life contexts (Durasa et al., 2022).

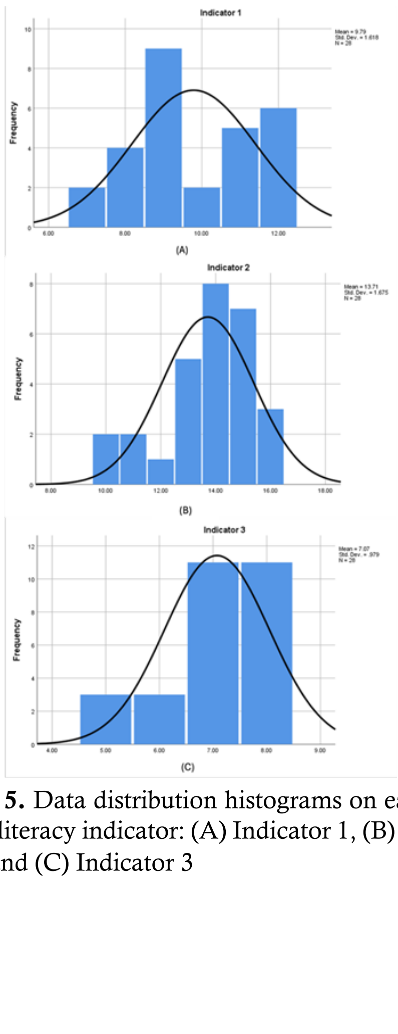

Figure 5. Data distribution histograms on each scientific literacy indicator: (A) Indicator 1, (B) Indicator 2, and (C) Indicator 3

Based on the data analysis in Table 5, students demonstrated a positive tendency toward understanding the basic concept of static electricity. In response to the first questionnaire item, *"I can explain what happens if the ruler is rubbed into the hair and then brought closer to the piece of paper"*, 48% of students highly agreed, and 32% agreed, indicating a high level of confidence in explaining the phenomenon. However, 19% disagreed, and 1% highly disagreed, suggesting some concept gaps. The item included a short fill-in section where students described their observations. Common responses included: *"Paper sticks to the ruler," "Paper can be attracted to rulers,"* and *"Rulers can pull pieces of paper,"* reflecting students' ability to articulate the effects of static electricity in simple terms.

Student responses indicate that most were able to observe and explain the real-life phenomenon of static electricity, specifically the interaction between a ruler and paper after the ruler was rubbed on hair. However, some students still demonstrated a limited understanding and failed to relate their explanations to the underlying scientific concept. As noted by Sariyyah et al. (2024), this temporary attractive force arises from electric charges on the plastic surface, which gradually dissipate over time. This finding aligns with responses to the second question regarding the interaction between hair and ruler. A total of 77% of students (52% highly agree, 25% agree) expressed confidence in their understanding, while 23% (22% disagree, 1% highly disagree) showed uncertainty. In the short-answer section, students wrote statements such as:

"Paper can be attracted to the ruler because there are positive and negative charge forces."

"There is a magnetic force that attracts the paper."

"There are positive and negative electrical forces so that the paper can be attracted."

These findings suggest that most students have developed a sound understanding of electric charge interactions, although a few still require further clarification. As explained by Maghfiroh et al. (2022), rubbing a plastic ruler on hair causes a transfer of electrons from the hair to the ruler, resulting in the hair becoming positively charged and the ruler negatively charged. This static charge enables the ruler to attract small pieces of paper, although the effect is temporary. The strongest comprehension was reflected in responses to the third question, *"I know that if the ruler is rubbed into the hair, the ruler can pull out a piece of paper,"* with 87% of students highly agreed and 11% agreed. This indicates a high level of understanding of the basic phenomenon of static electricity. Similarly, in the fourth question, 100% of students agreed that they knew a simple method to test whether an object can attract another after being rubbed. The fifth question further reinforced this concept, with 96% agreeing that increased rubbing strengthens the ruler's ability to attract paper, although 3% still disagreed.

Responses to the sixth question revealed that 91% of students (63% highly agreed, 28% agreed) recognized that the size of the paper affects its attraction to the ruler, although 8% remained uncertain. The seventh question showed a more varied understanding of the quantitative aspect, with 45% highly agreeing, 41% agreeing, and 14% expressing doubt about the effect of rubbing intensity. In the eighth question, 97% of students agreed that rubbed objects can attract small paper pieces, while only 4% disagreed. For the ninth question, 91% of students felt confident in concluding the experiment, indicating strong engagement with observable phenomena.

Table 5. The percentage of students who responded to each question in the scientific literacy questionnaire

Question	Score of students (%)			
	4 Highly agree	3 Agree	2 Disagree	1 Highly Disagree
I can explain the phenomenon that occurs when a plastic ruler is rubbed against hair and subsequently brought near small pieces of paper	48%	32%	19%	1%
I can explain the interaction between hair and a plastic ruler following friction, which results in the buildup of static electricity	52%	25%	22%	1%
I understand that when a plastic ruler is rubbed against hair, it becomes electrically charged and is subsequently able to attract small pieces of paper because of static electricity	87%	11%	2%	0%
I know a simple method to test whether an object can exert an attractive force on another object after undergoing friction	57%	43%	0%	0%
In my opinion, the more the amount of rubbing, the stronger the ruler pulls the paper	63%	33%	3%	0%
I think the size of the paper strip matters; smaller pieces are more manageable for the ruler to pull because they are lighter and move more easily when the ruler is charged	63%	28%	8%	0%
I believe that the more times you rub the ruler, the stronger it gets at pulling the paper, like charging up its power	45%	41%	14%	0%
I think that when you rub particular objects, like a ruler, they can pull tiny pieces of paper, because rubbing gives them a kind of invisible power called static electricity	82%	15%	4%	0%
After trying the ruler and hair experiment, I found out that the ruler can pull tiny paper pieces	67%	24%	9%	0%

Overall, these results demonstrate that students possess good scientific literacy, particularly in interpreting hands-on static electricity experiments using simple media like rulers and paper. Their enthusiasm aligns with findings by Febriana et al. (2024), who emphasize that visual media and simple teaching aids enhance concept clarity. As noted by Putri et al. (2025), effective learning strategies play a crucial role in fostering scientific literacy by encouraging students to apply new knowledge in everyday contexts.

Figure 6 illustrates high levels of student achievement in scientific literacy, particularly in the indicator "Explaining Scientific Phenomena." The lowest agreement was observed in questions 1 and 2 (75%), while question 3 reached the highest at 95%. These items included short-answer fields for students to explain their experimental observations. However, analysis revealed that some students left these fields blank or provided minimal responses, indicating difficulty in articulating the concept of static electricity. The high percentage of agreement may reflect students' confidence in selecting the correct option, rather than their ability to explain the phenomenon descriptively. These findings suggest that while students demonstrate a strong recognition of observable phenomena, their understanding of concepts remains underdeveloped. As emphasized by Rohmah et al., (2019), enhancing scientific literacy, especially among elementary students, is essential. This can be achieved through learning approaches that stimulate motivation and engagement, encouraging deeper participation and a better understanding of science activities.

Questions 4 to 9 yielded agreement rates between 79% and 92%, indicating that most students demonstrated a solid understanding of basic scientific literacy concepts and were able to connect scientific knowledge to everyday phenomena. However, some misconceptions and confusion remain, suggesting the need for further concept reinforcement. As noted by Merta et al. (2020), scientific literacy not only facilitates the understanding of concepts but also fosters inquiry and problem-solving skills.

Figure 7 presents the average percentage of student achievement across three scientific literacy indicators, all of which fall within the high category. The first indicator, Understanding and Explaining Scientific Phenomena, reached 81%, indicating that most students can describe scientific events, though some still struggle to connect concepts to everyday experiences. As Irwan (2020) notes, a reliance on rote memorization can hinder students' ability to apply the knowledge they have learned to real-world contexts. The second indicator, Designing and Evaluating Scientific Inquiry, and Interpreting Data, achieved an 85% success rate, suggesting that students are increasingly capable of constructing inquiry-based investigations and critically analyzing evidence. This higher score reflects the development of students' scientific reasoning and analytical skills. The third indicator, Using Scientific Information for Decision-Making and Action, scored the highest at 88%, demonstrating that students are confident in applying scientific knowledge to make informed decisions. This suggests a high level of maturity in translating classroom learning into practical understanding. Overall, these results show that elementary students possess strong foundational skills in understanding, interpreting, and applying science concepts. They can reflect on learning content, relate it to observable phenomena, and make decisions grounded in evidence. As emphasized by Hidayat (2024), scientific literacy is crucial for enabling students to connect scientific concepts to their daily lives and fostering lifelong inquiry.

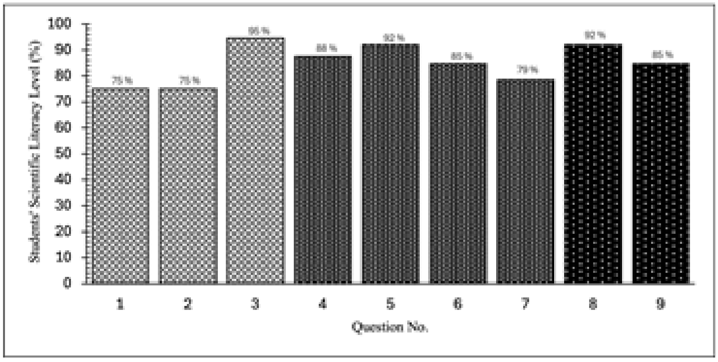

Figure 6. The results of students' scientific literacy level measured by 9 questions

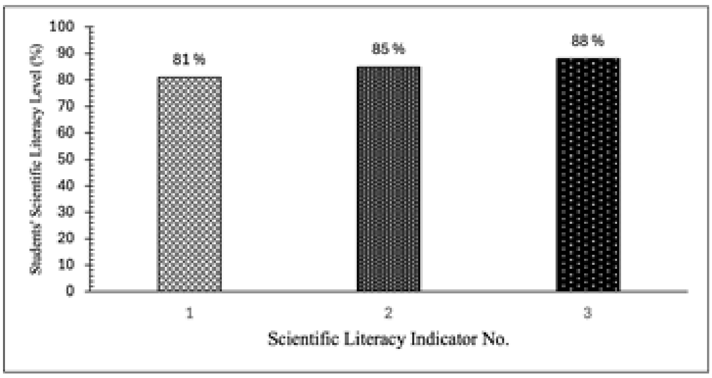

Figure 7. Average of students' scientific literacy level on each scientific literacy indicator

Descriptive Analysis of the Student Answer on the Student Worksheet

The static electricity experiment conducted through the student worksheet provided a clear overview of students' experiences, their understanding of the concept, and the learning challenges they faced. Group response analysis revealed how students engaged with the activity, formulated conclusions, and reflected on their scientific literacy. These findings highlight the effectiveness of hands-on experimentation in promoting observation, reasoning, and concept connection among elementary students.

Figure 8 presents findings from the "Memori Bermain Sains" or Memory in Playing Science sheet, highlighting students' enthusiasm and positive attitudes during static electricity experiments using plastic rulers and paper strips. Students demonstrated an emerging understanding of the basic concept that oppositely charged objects can attract each other. However, difficulties noted particularly in the rubbing stage indicate a need for more precise guidance in the experimental technique to ensure consistent results. Group 2 responses reflected high engagement and enjoyment, as seen in their mood selections and written reflections. Students successfully linked the rubbing activity to the appearance of attraction, though some misconceptions remained, such as referring to hair as the object being attracted rather than the paper. Challenges with rubbing the ruler against the fabric of the veil suggest exploratory thinking, although the outcomes were less effective.

Overall, Group 2 showed a foundational grasp of static electric attraction, but still requires support in using accurate scientific terminology, clarifying misconceptions, and documenting observations more precisely. Group 3 also expressed intense enjoyment, with reflections indicating excitement and a sense of curiosity. However, a key misconception emerged: students described the ruler as producing magnets, rather than acquiring a static electric charge. This highlights the importance of reinforcing correct terminology and differentiating between magnetic and electrostatic phenomena. According to Gupita et al. (2022), one factor that contributes to misconceptions in students is the lack of variety in teaching methods, which can lead to feelings of boredom. Static electricity matter is classified as abstract, especially in the electrical charge that appears in the application of static electricity.

In the difficulty section, students commonly wrote "none," indicating that the experiment proceeded smoothly without major obstacles. In their conclusions, most students successfully identified the core concept: a ruler rubbed on hair can attract small pieces of paper. This reflects a foundational understanding that an attractive force arises after friction, although teacher guidance is still needed to clarify misconceptions, particularly the confusion between static electricity and magnetism. Across all three groups, students conducted the static electricity experiment effectively, using a plastic ruler and paper strips.

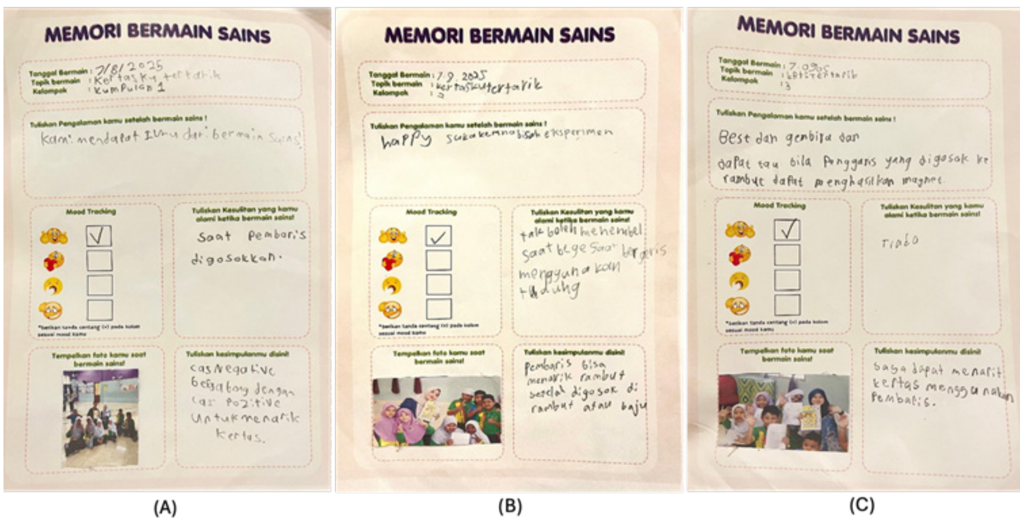

Figure 8. Answer results for memory in playing science, (A) group 1, (B) group 2, and (C) group 3

The activity not only sparked enthusiasm but also served as a valuable opportunity to address concept errors, such as the belief that the ruler produces magnets. Through this hands-on experience, students gained a clearer and more accurate understanding of static electricity. According to Clarawati et al. (2024), learning through direct experience helped students gain deeper and more meaningful knowledge.

The implications of this study suggest that primary school science education needs to be designed and enhanced through contextual and experiential learning. Activities such as simple experiments helped students explore and understand abstract concepts, making learning more meaningful and aligned with the demands of 21st-century education. Science learning in schools was expected to integrate scientific literacy into the learning process effectively. Through science instruction based on scientific literacy, students were expected to develop the abilities needed to respond to advancements in science and technology (Irsan, 2021). This was also conveyed by Barus (2021) Scientific literacy needed to be developed from an early age at the elementary level so that students could progressively acquire more comprehensive competencies.

CONCLUSION

The implementation of a simple static electricity experiment using a plastic ruler and paper strips, as presented in the student worksheet, provided valuable insights into the scientific literacy of elementary students. Analysis of student responses revealed strong enthusiasm and the ability to draw conclusions based on direct experience, underscoring the value of hands-on learning in cultivating scientific literacy from an early age. However, performance on the first indicator suggests that some students still require targeted teacher support to deepen their understanding of concepts and improve future learning outcomes. The statistical analysis showed high levels of scientific literacy achievement, with percentages of 81% in understanding and explaining scientific phenomena, 85% in designing and evaluating scientific inquiry, and 88% in applying scientific information for decision-making. The normal data distribution and skewness values of 0.035, -0.836, and -0.917 indicated the consistency of the research results. Limitations of this study included a limited research timeframe, a small number of research variables, a relatively small sample size, and a restricted research scope confined to the primary school where the study was conducted. Therefore, future research was expected to expand and develop research variables, involve a larger sample size, and employ more diverse and comprehensive research designs. These efforts were expected to provide a deeper understanding of students' scientific literacy in science learning.

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