Scientific Literacy and Climate Change Perceptions among Junior High School Students in Medan: Insights from the PISA Framework

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Abstract: Climate change is a global issue that requires scientific understanding and pro-environmental awareness, making scientific literacy and student perceptions important factors. This study analyzes the scientific literacy and perceptions of junior high school students in Medan City regarding climate change and the relationship between the two based on the PISA 2025 framework. The research design uses a quantitative descriptive approach with a correlational method, involving 130 students from five junior high schools selected through purposive sampling. The instruments included perception questionnaires (cognitive, affective, and conative dimensions) and scientific literacy tests (explaining phenomena, designing investigations, and evaluating information). The results showed that students' conceptual understanding and pro-environmental behavior were high, but their motivation and concern were moderate. Scientific literacy was strongest in evaluating and using information, while the ability to explain phenomena and design investigations still needed improvement. Correlation analysis showed a weak and non-significant positive relationship between perception and scientific literacy ($r = 0.113$; $p = 0.201$), indicating that perception alone was not a major factor in achieving scientific literacy. These findings emphasize the need for inquiry-based science learning, projects, problem-based learning, and the use of local contexts, which integrate the strengthening of knowledge, attitudes, and real practices. These strategies are expected to improve scientific literacy as a whole and shape students as agents of change in facing the challenges of climate change.

Keywords: Climate change; PISA 2025; Scientific Literacy; Students' perceptions

Introduction

Climate change is one of the most pressing global environmental issues of the 21st century because it has a widespread impact on ecosystems, health, the economy, and the quality of life of communities in various parts of the world, including urban areas in developing countries such as Indonesia (Legg, 2021). The dynamics of rising average temperatures, changing rainfall patterns, rising sea levels, and the frequency of extreme weather events pose new risks to the sustainability of human life and the environment (OECD, 2019). At the local level, major cities such as Medan face a combination of environmental problems in the form of increased greenhouse gas emissions, air pollution, declining water quality, and suboptimal waste management, which further exacerbate the impact of climate change in urban areas (Saxena, 2025). This requires the community, including students, to be prepared to understand the causes, impacts, and possible solutions to climate change in a scientific and responsible manner.

In the context of education, junior high school students play a strategic role as the generation that will directly face the long-term consequences of climate change and are expected to be able to participate in mitigation and adaptation efforts (Panjaitan et al., 2025). Early adolescence is an important phase in the formation

of perspectives, attitudes, and habits related to the environment, so a proper understanding of climate change is an important foundation for the formation of pro-environmental behavior in adulthood (Aminrad et al., 2013). At this level, science education is designed not only to introduce scientific facts and concepts, but also to build critical thinking skills, scientific reasoning, and evidence-based decision making in dealing with real problems in the surrounding environment (Maison et al., 2020).

Scientific literacy is seen as one of the key competencies of the 21st century, enabling students to understand scientific phenomena, use scientific knowledge to solve problems, and make responsible decisions in personal, social, and global contexts (Bybee, 2013). In addition to mastery of content, it also includes the ability to identify scientific questions, evaluate information, and apply scientific knowledge in everyday situations (Fensham, 2011). Several studies in Indonesia report that students' scientific literacy skills, including at the junior high school level, are still in the low to moderate range; students are relatively stronger at memorizing concepts, but weaker at scientific reasoning and applying concepts in new contexts, including environmental issues (Hasasiyah et al., 2019).

The results of the Programme for International Student Assessment (PISA) reinforce this description, with Indonesian students' science achievements consistently below the average of participating countries, and still experiencing difficulties in dealing with questions that require data interpretation, evidence evaluation, and the use of scientific knowledge to explain complex phenomena such as climate change (OECD, 2019). The PISA national report shows that many Indonesian students are only able to complete tasks at low to medium cognitive levels, while tasks that require information integration and higher-level reasoning remain a challenge (Kemdikbud, 2019). These findings indicate that strengthening scientific literacy in schools, particularly through the context of environmental issues, requires serious attention in efforts to improve the quality of science education.

The PISA 2025 framework views scientific literacy as the ability to explain scientific phenomena, evaluate and plan scientific investigations, and interpret scientific data and evidence for decision-making (OECD, 2025). Within this framework, these abilities encompass three main dimensions, namely scientific content, scientific procedures, and scientific epistemic knowledge, which are interrelated in helping students understand how scientific knowledge is generated and used (Fensham, 2011). In addition, PISA 2025 adds science and environmental competencies that emphasize the role of students as agents of change in environmental issues,

including climate change, so that science learning is directed at shaping students who are sensitive to environmental issues and able to respond critically and responsibly.

This study focuses on two main variables, namely scientific literacy and students' perceptions of climate change. Scientific literacy is defined as students' ability to use scientific knowledge to understand and interpret climate change issues, with indicators including climate change science content, scientific processes and data reasoning, and epistemic knowledge referring to the PISA 2025 science competency framework (OECD, 2025). Meanwhile, perceptions of climate change are understood as students' views, beliefs, and attitudes regarding the causes, impacts, threats, and mitigation and adaptation measures of climate change, which include cognitive (knowledge), affective (attitudes and concerns), and conative (intentions to act) aspects (Boon, 2016; Lee et al., 2020). Research shows that a better understanding of environmental issues tends to be linked to higher levels of scientific literacy, although there is often a gap between knowledge and actual practice in the field (Aminrad et al., 2013; Dianti & Sueb, 2022).

The Indonesian government has recognized the importance of climate change education and has included it in the national curriculum. The Ministry of Education and Culture has also developed a national curriculum for science education that emphasizes the importance of climate change education (Junanto & Sartika, 2023; Nugraheni, 2025). Learning that utilizes the context of climate change through inquiry, project, and problem-based learning approaches has been proven to improve students' scientific understanding, critical thinking skills, and environmental awareness, although this improvement has not been evenly distributed across all scientific literacy indicators (Peny et al., 2022). This shows that the use of climate change issues in science education still needs to be optimized so that it does not only focus on conveying information, but also trains students to analyse data, evaluate information, and design realistic and contextual solutions (Lestari & Widodo, 2021).

In Medan, as a major city with intense urbanization, population growth, and economic activity, climate change intersects with real issues like air pollution from transportation and industry, land use changes, and problems with flooding and waste management (Saxena, 2025). These environmental conditions can be used as authentic learning resources to connect scientific concepts with the realities of students' daily lives at school and in their neighborhoods (Arma, 2024). Science education that integrates the local context of Medan City into the topic of climate change has the potential to not

only improve conceptual understanding but also build students' sensitivity and responsibility towards the surrounding environment.

On the other hand, various national policies and curricula emphasize the importance of strengthening critical, creative, collaborative, and communicative thinking skills, which can be facilitated through the development of scientific literacy based on environmental issues (Kemdikbud, 2019). The use of the PISA 2025 framework as a reference in the development of test instruments and learning activities allows teachers to obtain a more structured picture of students' scientific literacy profiles, particularly in the context of climate change. This is expected to assist schools and education policymakers in designing scientific literacy strengthening programs that are more focused and tailored to the needs of students in the field (Hasanah & Yuliani, 2022).

Based on this urgency, this study aims to analyze the scientific literacy and perceptions of junior high school students in Medan regarding climate change based on the PISA 2025 framework, while also assessing the relationship between these two variables. The results of this study are expected to identify the strengths and weaknesses of students' science literacy and provide implications for the development of contextual science and environmental education. Thus, the results of this study are expected to contribute to the development of learning strategies that are more relevant, contextual, and oriented towards shaping students as agents of change in facing the challenges of climate change in the local and global environment (Junanto & Sartika, 2023).

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Method

This research uses a quantitative descriptive design with a correlational approach. This design was chosen to systematically describe students' perceptions of climate change and their scientific literacy skills, while also analysing the relationship between these two variables. The correlational approach was used to determine the extent to which students' perceptions of climate change are related to scientific literacy, although this study does not aim to determine a causal relationship.

This study involved 130 students from five junior high schools in Medan City, with a total population of students who had received environmental and climate change material. The research sample was determined using purposive sampling techniques, considering sufficient exposure to the material and availability of participation. The distribution per school is shown in Table 1, namely SMP A and SMP B with 23 students (17.7%) each, and SMP C, SMP D, and SMP E with 28

students (21.5%) each. Of the total, there were 85 male students and 45 female students.

Table 1. Profile of Respondents

School	Total Students (n)	Male	Female	Percentage (%)
SMP A	23	11	12	17.7
SMP B	23	11	12	17.7
SMP C	28	15	13	21.5
SMP D	28	20	8	21.5
SMP E	28	28	0	21.5
Total	130	85	45	100

An effective climate change education approach needs to include scientific literacy, environmental awareness, motivation, and pro-environmental behavior. Accordingly, the research instrument consists of two main parts, namely the instrument for measuring students' perceptions of climate change and the scientific literacy instrument. Perceptions of climate change measure three dimensions, namely conceptual understanding (knowledge), concern and motivation (attitude), and pro-environmental behavior (behavior/action), using a Likert scale (1–4). The scientific literacy instrument is in the form of multiple-choice questions compiled based on the PISA 2025 framework, covering the ability to explain phenomena scientifically, design and evaluate scientific investigations, and evaluate and use scientific information. The data obtained were analyzed in the form of competency achievement percentages to comprehensively assess students' scientific literacy levels. The combination of these two instruments enables a holistic assessment of students' scientific understanding, attitudes, and abilities. Both instruments underwent expert validation and reliability testing.

The data obtained from the research instruments were analyzed using a quantitative approach, with two main stages. First, a descriptive analysis was conducted to describe the students' perceptions of climate change and their level of scientific literacy. This analysis included calculating the average percentage achievement in each dimension of perception and scientific literacy competency, which was then presented in tables and diagrams to facilitate interpretation.

Perception scores were obtained from 15 questions using a 1–4 Likert scale. The minimum total score was 15 and the maximum was 60, which were then converted to percentages (0–100) to facilitate visualization and interpretation. Perception categories were determined descriptively based on score distribution, so that each category reflected the level of students' understanding, concern, and participation in climate change issues (Ho & Au, 2020; Ofori et al., 2023). This approach allowed for

a more contextual interpretation of the characteristics of respondents in the research sample.

Table 2. Students' Perception Categories Based on 15-Item Likert Scale (1–4).

Category	Percentage (%)	Score (15–60)
Very Low	0–19	15–23
Low	20–39	24–32
Medium/Enough	40–59	33–41
High	60–79	42–50
Highest	80–100	51–60

Table 3 presents the criteria for junior high school students' scientific literacy levels based on percentage scores (0–100) adjusted to the PISA level (Simatupang et al., 2024). This classification facilitates the interpretation of scienttific literacy results and serves as a basis for identifying students' scientific competency strengths and weaknesses.

Table 3. Scientific Literacy Level Criteria for Junior High School Student

Score	Level PISA	Literacy category
93–100	Level 6	Very good
73-92	Level 5	good
55-72	Level 4	Enough
40-54	Level 3	Not enough
14-39	Level 2	Low
7–13	Level 1a	Very Low
0–6	Level 1b	Very Low

Correlation analysis using the Pearson Product Moment test was used to assess the relationship between students' perceptions and science literacy. The correlation coefficient (r) and significance value (p) were obtained to determine the direction and strength of the relationship, with a significance level of $\alpha = 0.05$ as the assessment threshold. The results of the analysis enabled researchers to assess whether students' perceptions of climate change correlated with their scientific literacy abilities and provided an empirical basis for discussion of the factors that influence scientific literacy achievement holistically.

Results and Discussion

Studens' Perceptions of Climate Change

Based on the results of measuring perceptions of climate change, three main dimensions were identified, namely conceptual understanding (knowledge), concern and motivation (attitude), and participation or pro-environmental behavior (behavior/action). The average results for each indicator are shown in the following Table 4.

Table 4. Climate Change Perception of Junior High School Students

Perception Aspect	Indicator	Average (%)
Understanding of climate change concepts (Knowledge)	Understands basic concepts, causes, and impacts of climate change	72.31
Concern and motivation (Attitude)	Shows concern, motivation, and risk perception regarding climate change	64.26
Participation or pro-environmental behavior (Behavior/Action)	Carries out actual actions or intentions for pro-environmental behavior	73.53

Data analysis shows that students' understanding of climate change concepts is at 72.31%, which is classified as high. This indicates that most students understand the basics of climate change, including its causes and impacts on the environment and human life. This finding is in line with previous studies which state that a good understanding of concepts is an important foundation for developing environmental awareness and pro-environmental behavior (Geiger et al., 2019; Wong et al., 2018).

Meanwhile, student awareness and motivation regarding climate change stood at 64.26%, which is considered moderate. Although most students demonstrated awareness of the importance of climate change issues, their level of motivation and risk perception could still be improved. Research by Kollmuss & Agyeman (2002) showed that awareness and knowledge alone do not always correlate directly with behavioral change; internal factors such as values, attitudes, and risk perception greatly determine an individual's level of motivation to act.

Interestingly, student participation or pro-environmental behavior reached 73.53%, which is relatively high and even slightly higher than their conceptual understanding. This indicates that although motivation is still at a moderate level, students have demonstrated concrete actions or intentions to behave in an environmentally friendly manner. This phenomenon is in line with Sawitri et al. (2015) research findings, which state that pro-environmental behavior can be influenced not only by conceptual understanding but also by social norms, environmental support, and opportunities to act.

Overall, the results of this analysis show that students have a good understanding and high participation, but aspects of motivation and concern still need to be strengthened. This implies that climate

change education programs should not only emphasize knowledge transfer but also build critical awareness and intrinsic motivation through project-based learning, case studies, or real field activities. This approach is believed to be able to improve the alignment between students' knowledge, attitudes, and actions in facing the challenges of climate change in real life (Rocha et al., 2020).

Student Scientific Literacy Based on PISA 2025

The results of the scientific literacy assessment show variations across the measured aspects, namely explaining scientific phenomena, designing and evaluating scientific investigations, and evaluating and using scientific information. The percentages in each aspect reflect the participants' level of mastery of these competencies, as shown in Figure 1.
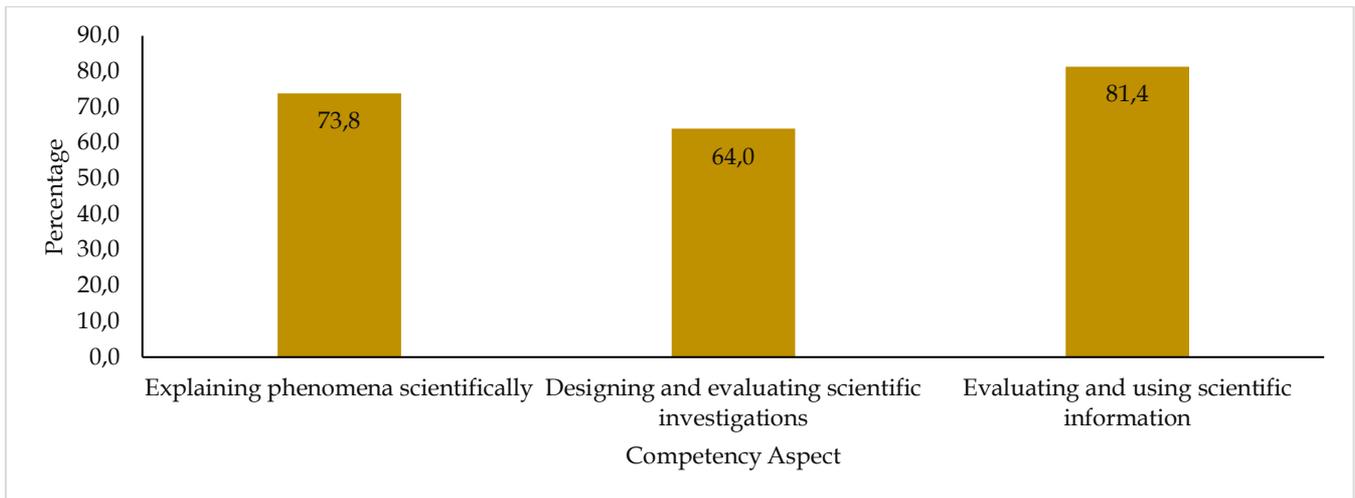

Figure 1. Scientific Literacy Profile of Pre-service science teacher

Data show that students' competency in evaluating and using scientific information reached 81.4%, which is considered high. This demonstrates that most students can critically identify, assess, and utilize scientific information in decision making or problem solving. These findings are in line with research by the Heim et al. (2022); Wiley et al. (2009) which shows that students tend to be stronger in evaluating information than in scientific investigation or explanation.

Meanwhile, students' ability to explain phenomena scientifically stood at 73.8%, which is considered adequate. This result indicates that students have understood basic scientific concepts but still need improvement in their ability to describe phenomena using evidence-based reasoning. This is consistent with Laliyo et al. (2023); Simatupang et al. (2025) findings, which state that students' ability to explain scientific phenomena is often weaker than their ability to evaluate information, especially at the junior high school level.

Similarly, the competency in designing and evaluating scientific investigations reached 64.0%, which is also considered adequate. This shows that students still have difficulty designing experiments, identifying variables, and evaluating scientific procedures systematically. The scientific investigation skills of junior high school students in many contexts are still at a moderate level and require inquiry-based or

project-based learning strategies for improvement (Sotiriou et al., 2020; Williamson, 2023).

Overall, the profile of junior high school students' science literacy competencies in Medan shows strengths in the aspects of evaluation and use of scientific information, while the ability to explain phenomena and design scientific investigations still needs to be improved. These findings have important implications for science learning practices, namely the need for a learning approach that integrates conceptual reasoning, investigative abilities, and information evaluation in a balanced manner to comprehensively improve students' science literacy.

Based on the results of the analysis in the table, the aspect of explaining phenomena scientifically shows that students have varying achievements. Most of the sub-indicators are in the good category, but the ability to recognize and apply scientific knowledge is still in the adequate category. These results indicate that students' conceptual understanding is not yet fully mature, especially when that knowledge must be applied in a specific context. Students are able to master scientific concepts separately but have difficulty relating them to real-world phenomena (Fortus et al., 2005; Niss, 2012). Students' scientific literacy skills are also often hampered because learning has not been integrated with socio-scientific issues that are relevant to everyday life (Li & Guo, 2021).

Table 5. Scientific Literacy Ability of Junior High School Students by Competency Aspect

Competency Aspect	Scientific Literacy Sub-Indicator	Percentage (%)	Category
Explaining phenomena scientifically	Recognizing and applying scientific knowledge	62	Enough
	Using representations and translating data	85	Good
	Making and justifying scientific predictions/solutions	74	Good
	Identifying and evaluating models	80	Good
	Developing explanatory hypotheses	74	Good
	Explaining the societal implications of science	68	Enough
Designing and evaluating scientific investigations	Identifying scientific questions	34	Very Low
	Proposing experimental designs	77	Good
	Evaluating experimental designs	65	Enough
	Interpreting data and drawing conclusions	80	Good
Evaluating and using scientific information	Evaluating information for decision-making	72	Enough
	Distinguishing scientific claims from opinions	74	Good
	Constructing scientific arguments from data	84	Good
	Critiquing weaknesses in scientific arguments	84	Good
	Justifying decisions based on scientific evidence	93	Very Good

Sub-indicators that received adequate to good ratings, such as the ability to use scientific representations and identify models, show that some students already have basic competencies in understanding scientific data representations. However, the achievement of a sufficient rating in the aspect of explaining the implications of science for society shows that science learning has not emphasized the social dimension of science. Comprehensive scientific literacy must include students' ability to apply scientific concepts to decision-making that impacts society (Bingle & Gaskell, 1994; Süerdem & Çağlıyor, 2016).

In the aspect of designing and evaluating scientific investigations, the ability to formulate scientific questions is in the low category. This shows that students are not yet accustomed to identifying problems that can be investigated scientifically. The tendency of school practicums to be procedural rather than investigative limits students' opportunities to independently design research (Gizaw & Sota, 2023). Meanwhile, students' ability to evaluate experimental designs falls into the good category, indicating that when procedures are already provided, they can judge the appropriateness of experimental steps. This ability, however, still needs to be strengthened through the implementation of inquiry-based learning. Strengthening inquiry is essential because improving the quality of inquiry-oriented instruction has been shown to significantly enhance students' scientific investigation abilities (Cairns, 2019; Lu et al., 2020).

In terms of evaluating and using scientific information, most sub-indicators were in the good to high category, including the ability to construct data-based scientific arguments and evaluate scientific claims. Nevertheless, the achievement of a sufficient category in certain sub-indicators shows that not all

students are able to accurately identify assumptions, evidence, and reasoning from scientific texts. In an international context, these findings are consistent with the PISA report (OECD, 2019), which confirms that students in many countries, including Indonesia, still have difficulty interpreting scientific data and evaluating evidence-based arguments. Research by Rahmawati (2023) also reveals that this low ability is related to the lack of practice in interpreting graphs and tables in science learning.

Overall, these findings show that the scientific literacy of science students has not developed evenly in all aspects. The ability to understand basic concepts and evaluate scientific information has shown a positive trend, but the ability to formulate investigative questions and connect science with social contexts still needs attention. Therefore, science learning needs to be directed towards an inquiry approach, strengthening the socio-scientific context, and using authentic problems as a basis for learning so that scientific literacy competencies can develop more comprehensively.
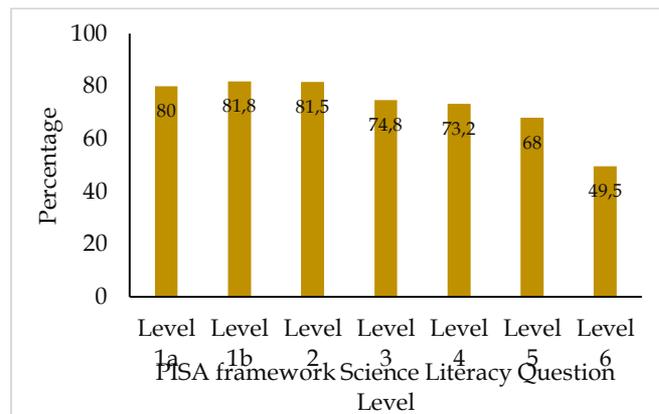

Figure 2. Junior High Students' Performance Across PISA Question Levels

The Figure 2 illustrates the pattern of junior high school students' scientific literacy results, which consistently decline from level 1a to level 6. These findings indicate that the higher the cognitive complexity of questions based on the PISA framework, the lower the students' ability to solve scientific problems. This pattern is in line with various scientific literacy studies in Indonesia, which generally report a dominance of abilities at low and intermediate levels with significant limitations at high reasoning levels (Ashari et al., 2023; Suroso et al., 2021). The results show that students achieved high scores at levels 1a (80.0%), 1b (81.8%), and 2 (81.5%), which require basic skills such as identifying information, recognizing familiar concepts, or reading data directly. High abilities at these basic levels indicate that students have mastered factual knowledge and simple procedures, in line with the characteristics of science learning in many schools, which are still dominated by lecture methods and direct exercise practice (Ango, 2002). This confirms that students are relatively comfortable with linear thinking processes and explicit question contexts, but the dominance of low-level abilities indicates that the learning process has not fully developed conceptual understanding and more in-depth scientific explanations.

At level 3 (74.8%) and level 4 (73.2%), student achievement began to decline because questions at these levels required students to interpret data, connect concepts, and apply science in indirect contexts. This decline indicates barriers to relational reasoning, which is the ability to connect separate pieces of information to produce new conclusions. These findings are in line with the study by Mustain (2015), which shows that junior high school students still have weaknesses in interpreting scientific representations such as graphs, tables, and diagrams, as well as with science learning conditions that rarely emphasize data analysis, making it difficult for students to understand scientific phenomena through patterns or relationships between variables (Ogundeji et al., 2019).

The achievement of 68.0% at level 5 indicates that students begin to experience difficulties in formulating evidence-based arguments, evaluating scientific solutions, or linking several sources of information simultaneously. Questions at this level require higher-order scientific reasoning, namely the ability to think critically by integrating knowledge, data, and arguments. This low ability is related to the lack of practice in solving complex problems and scientific discussions in learning, where teachers tend to use closed questions so that students are rarely exposed to questions that require evaluation or argumentation (Reznitskaya et al., 2007).

The lowest percentage (49.5%) at level 6 indicates that students find it very difficult to tackle questions that require higher-order scientific reasoning, such as evaluating contradictory evidence, predicting results based on complex models, or linking scientific phenomena to real-life situations at the macro level. These findings are consistent with OECD (2019) stated that most Indonesian students are still at low levels of science literacy (levels 1 and 2), and only a small proportion of students are able to reach levels 5 or 6. This low achievement indicates a gap in scientific inquiry skills and scientific argumentation abilities, which is influenced by several factors, including: teaching materials that lack context, making it difficult for students to relate real phenomena to theory; the lack of inquiry-based learning, which has been proven to improve science literacy (Aulia et al., 2018; Sutiani, 2021) as well as a focus on memorization and simple exercises rather than analysis or evaluation. These findings reinforce that strengthening science literacy requires not only mastery of concepts, but also a transformation of pedagogy that emphasizes the scientific process, argumentation, and complex problem solving.

The Correlation between Perception and Scientific Literacy among Junior High School Students in Medan

To assess the correlation between student perceptions and science literacy, a Pearson correlation test was conducted. The results of the analysis are as follows.

Table 5. Science Literacy Ability of Junior High School Students by Competency Aspect

Variable	r (Pearson)	Sig. (2-tailed)	N
Perceptions-Scientific Literacy	0.113	0.201	130

Pearson's correlation analysis indicates a value of r = 0.113 with a significance level of p = 0.201, indicating that the relationship between students' perceptions of climate change and science literacy is positive but very weak and not statistically significant. In other words, although descriptively there is a tendency for students with higher conceptual understanding and pro-environmental behavior to have better science literacy, the relationship is not strong enough to be considered significant in this sample. These findings indicate that student perceptions alone are not a major determining factor in improving science literacy, and that other factors such as learning methods, laboratory experience, teacher support, and the school environment are likely to influence students' science literacy achievements.

The implications of these findings are quite important for science education practices at the junior high school level. First, science learning should not only

emphasize conceptual understanding and mastery of material, but also integrate the development of attitudes, motivation, and pro-environmental behavior so that science literacy can develop holistically. Second, science literacy competencies, especially in the aspects of explaining phenomena and designing investigations, still require more attention through inquiry-based, project-based, or contextual learning strategies that encourage students to think critically and apply knowledge practically. Third, although the correlation is not significant, the descriptive pattern shows a potential positive relationship between perception and science literacy, so that interventions that foster motivation and environmental awareness can support long-term improvement in science literacy.

Theoretically, these findings are in line with previous studies showing that the relationship between students' attitudes or perceptions and science literacy is complex and not always linear, especially at the junior high school level, where factors such as motivation, practical experience, and learning context play an important role in shaping students' scientific competence (Fives et al., 2014; Osborne et al., 2003). Therefore, efforts to improve science literacy need to be carried out in an integrated manner, considering the cognitive, affective, and psychomotor aspects of students simultaneously.

Conclusion

The findings show that the scientific literacy level of junior high school students in Medan is moderate, with better abilities in basic PISA questions but still limited at levels that require complex reasoning, data analysis, and the application of scientific concepts in the context of climate change. Students' perceptions of climate change are also positive, marked by an awareness of the causes and impacts of the issue, although their ability to assess the quality of scientific information and evaluate evidence-based claims still needs to be improved. The analysis of the relationship shows a positive trend between science literacy and student perceptions, but the relationship is not statistically significant, so it cannot yet be declared a strong influence. These findings indicate that students' perceptions are not only influenced by science literacy skills, but also by other factors such as personal experience, media exposure, and learning environment. The PISA 2025 science competency framework remains effective for mapping students' abilities in a structured manner and can be used as a reference for teachers in designing learning strategies that encourage scientific reasoning and higher-order thinking skills. Based on these findings, this study has important implications for

the development of science education, namely the need for a more contextual, integrative, and inquiry-based learning approach to strengthen the relationship between science literacy and student perceptions. Teachers are advised to utilize authentic issues such as climate change, current scientific data, and project-based activities so that students gain relevant and evidence-based learning experiences. Furthermore, future research should consider other variables that may influence perceptions, such as media literacy, attitudes toward science, or socio-ecological factors, and use broader designs or mixed-methods approaches to enrich understanding of the dynamics of science literacy and student perceptions. Overall, this study emphasizes the importance of strengthening science literacy and issue-oriented learning strategies to shape students' critical understanding and perceptions of climate change.

Author Contributions
All authors contributed equally to the study's design, data collection, analysis, manuscript preparation, and revision. All authors have read and approved the final version.

Conflicts of Interest
The authors declare no conflict of interest.

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